FOREIGN DIRECT INVESTMENT AND ECONOMIC DEVELOPMENT IN CHINA AND EAST ASIA

by

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Abstract

This thesis provides an empirical analysis on how Foreign Direct Investment could affect economic growth. The analysis focuses on China and two East Asian countries, South Korea and Taiwan, for the period from 1980 to 2006. A VAR system is applied to China and the other two countries, while innovation analysis, including variance decomposition and impulse response, is then undertaken to evaluate the influence of shocks on each variable. Cointegration analysis is introduced to capture the long-run equilibrium relationships. The results suggest a small negative effect of FDI on economic growth in China and Taiwan, and no significant influence on economic growth in South Korea. But we find that FDI could be attracted by rapid economic growth of all these countries. The traditional elements for growth, such as capital and labour are demonstrated to play important roles in stimulating economic growth, while the sustainable elements suggested by new endogenous theory, such as technology development and human capital, are found playing different roles across countries with respect to their strategies of development.

In addition, a simultaneous equation model is estimated to capture the effects of policy instruments on output, FDI and other endogenous variables in China. Both direct coefficient effects and multiplier effects are calculated. The results indicate that the changes in capital formation, employment and human capital could decelerate the economic growth, while the changes in technology transfer and saving could have

accelerating effects on the change in output directly. FDI could affect the change in economic growth indirectly through an accelerating effect on capital formation and human capital. For the impacts of policy instruments, It draws a conclusion that the monetary policies, fiscal policies and commercial policies committed by the government are indeed appreciative for accelerating economic development in China.

Together with the specific empirical results for China and other two East Asian countries, this thesis provides a more comprehensive framework to study the relationships between economic growth and FDI, with the VAR system focusing on the general overview and the simultaneous equation model targeting on the intermediates.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1. Introduction

During last three decades, the world economy has been increasingly integrated, with foreign direct investment (FDI) becoming a particularly significant driving force behind the interdependence of national economies. Even though most of FDI concentrates in developed countries, its importance is undeniable for developing countries as well. According to UNCTAD (2007), from 1980 to 2006, FDI inflows in developing countries grew by over 30 times, from US$ 8.4 billion in 1980 to US$ 412.9 billion in 2006. Its share in total FDI flows grew from 15% in 1980 to 29.2% in 2006 (see Table 1.1). Through receiving private direct investment, developing countries are participating more than ever before in the worldwide production network (Xu (2003)). However, the regional trend is uneven, in favour of East Asian countries, whose share in FDI in developing countries increased from 11% in 1980 to 31% in 2006. Among it, there is no doubt that most of this rise is attributed to China after 1990. Since its economic reform in 1979, China achieved an impressive success in economic development, with an average growth rate over 9%, for the period from 1979 to 2006. This achievement was observed being accompanied by the gradual involvement of FDI. Encouraged by the Chinese government, FDI inflows expanded remarkably from null in 1979 to over US$ 72 billion in 2006. By the end of 2006, China had accumulated US$ 706 billion FDI. The contribution of FDI to Chinese economy also becomes non ignorable. In 2006, foreign invested enterprises (FIEs) accounted for 28% industrial value-added output and 21% taxation in China. They exported about 58% of the total exports of goods and services and imported 51.4% of total imports. In addition, foreign invested enterprises accounted for 11% local employment by the end of 2006 (China Investment Yearbook (2006)). Hence, FDI is more and more involved in the Chinese economy. The remarkable achievement of China in developing its economy and attracting FDI, as well as the experiences of development in East Asian countries, has raised awareness of the link between FDI and economic growth. The question about the impact of FDI on economic growth becomes more important for China and other developing countries to promote economic development in the future.

Table 1.1. *FDI shares in the world and in developing countries*

FDI shares in the world								
	1980	1985	1990	1995	2000	2002	2004	2006
Developing countries	15.34%	26.27%	17.19%	34.46%	18.12%	21.72%	35.99%	29.27%
China	0.10%	3.39%	1.68%	11%	2.91%	7.37%	9.35%	5.15%
FDI shares in developing countries								
	1980	1985	1990	1995	2000	2002	2004	2006
China	0.12%	4.60%	2.03%	17.15%	3.59%	9.63%	15.95%	17.61%
East Asia	11.23%	14.85%	24.60%	39.60%	45.90%	43.26%	45.04%	31.93%

Source: calculated from UNCTAD (2007)

1.2. Review of the empirical literature

The impact of FDI on economic growth and development has been discussed extensively. As the traditional neo-classical theory represented by the Solow model

(Solow (1957)) failed to address the linkage between FDI and economic growth, most of researches are associated with the new endogenous growth theories, represented by Romer (1986 and 1990) and Lucas (1988), focusing on the relationship between technology and economic growth in details. They suggested that FDI can positively affect economic growth, not only directly through enhancing the capital formation, employment opportunities and exports, but also indirectly through promoting human capital and technology progress, so as to increase capability of productivity in the host country (Johnson (2005)). Despite the straightforwardness of the theoretical consideration, the empirical evidence on a positive relationship between FDI inflows and economic growth of the host country has been elusive. When a relationship between FDI and economic growth is established empirically it tends to be conditional on the host country's characteristics such as the level of human capital and technology (see Borensztein *et al.* (1998)).

Empirically, by cross-section analysis, Balasubramanyam *et al.* (1996a) found positive growth effects of FDI by cross-section data and the ordinary-least-squares (OLS) regression model with regarding FDI inflows in a developing country as a measurement of its interchange with other countries. They suggested that FDI is more important for economic growth in export-promoting countries than in importing-substituting countries, which implied that the impact of FDI varies across countries and the trade policy can affect the role of FDI in economic growth. UNCTAD (1999) found that FDI has either a positive or negative impact on output depending on the variables that are entered alongside it in the test equation. These variables include the initial per capita GDP, education attainment, domestic investment ratio, political instability, terms of trade, black market premium, and the state of financial development. Borensztein *et al*. (1998) tested the effect of FDI on economic growth in a cross country regression framework, using data on FDI from both industrial countries and developing countries. They suggested that FDI is an important vehicle for the transfer of technology, and contributes more to growth than domestic investment. However, they found that FDI could not achieve higher productivity unless human capital stock reaches a certain threshold. Using data of 80 countries for the period from 1971 to 1995, Choe (2003) detected a two-way causation between FDI and economic growth, but the effect is more apparent from economic growth to FDI. Li and Liu (2005), using a panel data of 84 countries over the period of 1970 to 1999, established a simultaneous equation system on GDP and FDI. They concluded that FDI not only directly promotes economic growth by itself but also indirectly does so via its interaction terms; the interaction of FDI with human capital exerts a strong positive effect on economic growth in developing countries, while that of FDI with the technology gap has a significant negative impact.

Among the time series analyses, Bende-Nabende and Ford (1998) developed a simultaneous equation model to analyse the economic growth in Taiwan with respect to FDI and government policy variables. With the analysis of the direct effects and the multiplier effects, they confirmed that FDI could promote economic growth and that the most promising policy variables to stimulate growth are infrastructural development and liberalization. Kim and Hwang (2000) analysed the FDI effect on total factor productivity in South Korea, but failed to find the causal link between these two. Chan (2000), from another side, analysed the role of FDI in Taiwan in manufacturing sector with the Granger causality test and a multivariate model. He investigated the relationships between FDI and the spillovers as fixed investment, exports and technology transfer, and found that technology transfer is the main channel for FDI to affect the economy of Taiwan

Zhang (2001a) studied the causality between FDI and output by a vector-autoregression model (VAR) in 11 countries in East Asia and Latin America. He found that the effects of FDI are more significant in East Asian countries. He recognised a set of policies that tend to be more likely to promote economic growth for host countries by adopting liberalized trade regime, improving education and thereby the human capital condition, encouraging export-oriented FDI, and maintaining macroeconomic stability. Bende-Nabende *et al.* (2003) investigated five countries in East Asia by a panelled VAR analysis, and confirmed the positive impact of FDI, but the effects on spillovers are different across countries. The less developed countries have higher spillover effects on output. The VAR model with panel data was also be estimated by Baharumshah and Thanoon (2006) to investigate the relationship between FDI, saving and economic growth in eight East and Southeast Asian countries. They confirmed the positive long-run effects of FDI and saving on economic growth. They also suggested that countries that are successful in attracting FDI can finance more investments and grow faster than those deterring FDI.

The above studies show that the impact of FDI on economic growth is far more from conclusive. The role of FDI seems to vary across countries, and can be positive, negative, or insignificant, depending on the economic, institutional, and technological conditions in the host economy. However, even in one country, the conclusion is still controversial with respect to different time periods in observation and scopes of the research. In the case of China, the positive relationships are not always significant. In the analysis on the economic growth by time series data, Tan *et al.* (2004) detected the direct relationship between FDI and GDP, and found that the positive effect is small but significant. With a VAR model, Tang (2005) analyzed the relation between FDI, domestic investment and output, and concluded that FDI has a positive relationship with output, but with limited impact on domestic investment. Shan (2002) developed a VAR model, with the technique of innovation accounting, to figure out the relationships between FDI and output through labour source, investment, international trade and energy consumed, and found that output is not caused by FDI significantly, but has an important influence in attracting it.

Some other literature focuses on the effects of FDI on spillovers. Cheung and Xin (2004) evaluated the spillovers of FDI on technology development by panel data of the province level from 1995 to 2000. With a single regression model, they confirmed the positive effects of FDI on technology progress. Their results were consistent with both the estimation with pooled time series and cross-section data estimation, and the analysis with panel data for different types of patent applications (invention, utility model, and external design). They suggested that the spillover effect is the strongest for minor innovation such as external design patent, highlighting a ‘‘demonstration effect’’ of FDI. Galina and Long (2007) analysed the spillovers and productivity using a firm–level data set. They found that the evidence of FDI spillovers on the productivity of Chinese domestic firms is mixed, with many positive results largely due to aggregation bias or failure to control for endogeneity of FDI. After the adjustment of bias, there is a failure to find evidence of systematic positive effect of FDI on productivity spillovers. Lo (2007) investigated the productivity of FDI across provinces and sectors by a single regression model for the variables as industrial value-added and total productivity factor. The main analytical finding is that FDI in China has promoted economic development in one respect (improving allocative efficiency), but has an unfavourable effect in another respect (worsening productive efficiency), resulting in an overall impact that tends to be on the negative side. Zhang (2006) investigated FDI, fixed capital formation and output in a single regression model by using panel data from the province level. He concluded that FDI seems to promote income growth, and this positive effect is stronger in the coastal region than the inland region. Xing (2006) focused on the exchange rate policy and its role on FDI from Japan. With a single regression model, the results suggested that the devaluation of Chinese Yuan did enhance the inflows of FDI from Japan.

The existing empirical studies, especially for China, have rather been limited so far and produced incomplete and conflicted answers on the role of FDI. This is partly due to the use of different samples by different authors and partly due to various methodological problems. Shan (2002) argued that cross-country studies implicitly impose a common economic structure and similar production technology across different countries, which is most likely not true; and further, the economic growth of a country is influenced not only by FDI and other inputted factors, but also a set of policies by the government; finally, the significance of the conclusions drawn from cross-section data analysis is suggested not to be sufficient in finding a long-run causal relationship (see Enders (1995) and Martin (1992)).

Although some studies built a simultaneous model (see Li and Liu (2005)) to overcome the problems of simultaneity bias, they are still limited and lack adequate theoretical consideration. With respect to time series analysis, one important problem is the possible endogeneity of variables. Most of studies employed the Granger causality test in a bivariate framework without considering effects from other variables. But omission of such endogenous variables could result in spurious causality for those tests (see Granger (1969), Lütkepohl (1982), and Gujarati (1995)). Furthermore, Caporale and Pittis (1997) have shown that such an omission can result in an invalid inference about the causality structure of a bivariate system. Hence, the use of a VAR model, which treats all variables as endogenous, has been proved to generate more reliable estimates when dealing with the possible endogeneity of the variables (see Gujarati (1995)).

However, most of studies using a VAR model still focused on the Granger causality test (for example, see Shan(2002)) or the innovation analysis (see Tang (2005), Bende-Nabende *et al.* (2003)), little attention has been drawn on the cointegration relationships, which may reveal the long-run equilibriums of the economic system.

In fact, there is still another way to treat the problem of endogeneity by the estimation of a simultaneous equation model, where the FDI equation is treated within the economic system that could interact with each other simultaneously. And the simultaneity bias could be reduced if the whole economic system is considered rather than accounting for only a few variables. The advantage of this method is that it can take into account of policy instruments determined outside the production process, at the same time treating other inputted factors endogenously. Recent examples refer to Bende-Nabende and Ford (1998) and Bende-Nabende *et al.*(2000), who employed a system of equations in which FDI and economic growth are both treated as the endogenous variables for their respective studies of Taiwan and East Asian economies, But their studies are geographically limited as the basic simultaneous structures are rather specific to relative economies, and may vary from others, hence, the conclusions based on those. Thus, the specific structure of the simultaneous equation system is needed if one particular country is targeted into the study of economic growth and FDI.

1.3. Purpose of the study

Based on the time series analysis, the objective of this study is to encompass the various narrow studies into one comprehensive framework, where the several feasible determinants of aggregate output and of FDI could be incorporated and be allowed potentially to interact with one another. The resultant VAR framework and the simultaneous equation model, for the aggregate production function based on the "modern" endogenous growth theories, are to be estimated for both the overview and intermediates of economic growth and FDI in selected countries.

Specifically, this study is to provide an empirical analysis, based on a theoretical approach from a supply side of view, to evaluate the possible linkages among economic growth, FDI, capital formation, technology, employment, human capital, international trade and government policies,. The analysis is carried out mainly on China and two other economies in East Asia, South Korea and Taiwan, for the period from 1970 to 2006.

It seeks to answer the following questions: (1) What is the role FDI plays in the economy? (2) Does FDI indeed promote economic growth? (3) How could FDI and its spillovers affect economic growth? (4) How does FDI affect spillovers? (5) What factors determine FDI? (6) What are the roles of policy interventions in the economy? In order to achieve this, this study firstly presents a review on related theoretical literature to build a link between economic growth and FDI, which construct the main framework of the analysis. Though the fundamentals of this study is followed the endogenous growth theory from the supply side, the system in estimation does not depend on one particular theory and is still open to any considerations that have better explanations for economic growth with involvement of FDI.

1.4. Plan of the study

The study actually undertakes the analysis with two econometric tools. Firstly, a Vector autoregression (VAR) model is estimated to investigate the relationships between output, FDI and spillovers. A cointegration test is conducted to ensure the long-run equilibrium relationships would not be neglected when estimating I(1) variables. An error-correction model (ECM) that transformed from the original VAR, is expected to identify the long-run equilibrium relationships and the short-run corrections. From the original VAR model, the innovation analysis, including impulse response and variance decomposition, is employed to investigate the dynamic effects of one particular variable on others.

A simultaneous equation model is developed to analyse the economic growth in China, with considering the effects of the policy instruments and other exogenous variables. The specification of the simultaneous equations is also based on the endogenous growth theory, but opened to experiments. The only requirement for this model is that it must be mathematically stable. By excluding insignificant variables, a restricted model then is estimated to investigate the direct effects from both endogenous and exogenous variables. The Multiplier effect analysis is employed to determine the responses of the endogenous variables to changes in the exogenous variables, or the policy instruments. Hence, we can evaluate the effects from policy instruments to output and other endogenous variables.

The following content of the thesis consists of five chapters. Chapter 2 contains the theoretical framework for economic growth and FDI based on the reviews on the FDI theory and the growth theory. Chapter Three provides the VAR analysis of China after reviewing the FDI and the economic growth in China. In Chapter 4, the VAR analysis is employed to estimate the relationships between economic growth and FDI in two new industrialised countries, South Korea and Taiwan. The simultaneous equation model of China is presented in Chapter 5, where the direct effects and the multiplier effects are all discussed. In the last Chapter, the general conclusion is drawn with a review of findings.

CHAPTER TWO

THE THEORETICAL FRAMEWORK OF FDI AND ECONOMIC GROWTH

2.1. Introduction

The issue of FDI and its impact on economic growth involves not only FDI and multinational enterprises (MNEs), but also economic growth and development. It is necessary to incorporate the theories of FDI and MNEs into economic development theories. And it is a complex task as the theories of FDI are essentially microeconomic analyses of international investment activities by MNEs, while the economic growth and development theories explore the macro-conditions of economies. This chapter provides a literature review of FDI theory, as well as the economic growth theory. Through it, we expect to establish the literature linkage between these two theories and provide the theoretical framework for the research on FDI and economic growth.

2.2. Review of FDI theories

FDI theories comprise theories of international trade and international production. The international trade theories are those developed in attempts to explain trade motives, underlie trade patterns and benefits for nations, and enable individual firms and governments to behave based on their own benefits within the trading system. The theories of international production on the other hand explain reasons and patterns for production activities in a foreign country, suggesting that the propensity for a firm to engage in foreign production depends on a combination factors in the target market. Both trade and investment should be carried out according to the same principle of comparative costs, and be contributed to the international division of labour (Kojima (1975)).

2.2.1. International trade theory

The classical theory of trade was pioneered by Adam Smith (1776) in his classic work, the Wealth of Nations, which suggested that nations generate more benefits when they acquire through trade those goods that they could not produce efficiently, and produce only those goods that they could produce with most efficiency. This absolute advantage concept meant that a nation would only produce those goods that they made best use of its available natural (land and environmental conditions) and acquired resources (skilled labour force, capital resources, and technological advances). But the absolute advantage of trade presented a major question. For example, it a country produce both or several goods at costs lower than the potential trading partner, then there is no intention for it to trade. In the 1910s, Ricardo (1913) proposed the concept of comparative advantages with a two-country and two-commodity model, which considered the nation's relative production efficiencies when they apply to international trade. In his view, the exporting country should look at the relative efficiencies of production for both commodities and make only those goods it can produce most efficiently. The consequence is that each country specialises in producing those in which it enjoys a comparative advantage, and exchange the excess for the commodities with less efficiency if produced domestically (Bende-Nabende (2002)).

These classical theories explained trade of goods and services between countries by simplifying production activities into the two-countries, two-commodity model. However, their assumptions of perfect information on international markets and opportunities, full mobility of labour and production factors, as well as perfect competition in market are unrealistic in the real world. Thus, they could only partially account for international trade. Besides, these models only consider costs associate with labour in production, and disregard the costs from other factors inputted in production such as transaction cost and cost of capital.

Ricardo's idea was extended to the theory of factor endowment, primarily by Heckscher (1919) and Ohlin (1933), which attempted to address all factors in production into international trade. They suggested that the determinants of comparative costs lie in difference in factor endowments of the two national economies and in the ways in which the two commodities are produced. These factors include land, labour, capital, technology, and management skills. Hence, countries would have an advantage in producing goods required factors that are in abundance, as they are relatively cheap than other countries and lower the cost of the production. Through international trade, they can get products from other countries at a relatively lower price than if produced by themselves. Therefore, both countries are better off from trade. Rybxzynski (1955) extended the H-O theorem into analysing the dynamic change of factor endowments in production. He stated that the growth of one factor of production must always lead to the absolute increase in the output of the commodity using intensively the growing factor, while resulting in an absolute decrease in the output of the commodity using intensively the non-growing factor. Similarly, this theory assumed perfect competition and perfect information among trading partners, and took no account of the transaction costs. Furthermore, this theory ignored the importance of technology development, and skills of labour, such as expertise in marketing and management, which indeed all would affect the efficiency of distributions of factors enrolled in production. But this theory is persuadable to explain international investment behaviours if considering the effects of foreign investments as an extension of the H-O theorem when taking into account the costs of capital and transferring goods. Therefore, it built a basis for theories of international production or FDI.

2.2.2. International production theory

The FDI theory, or the international production theory, basically is consisted of two main literature groups. One group pioneered by Hymer (1960) and Caves (1974), who regarded FDI as an aggressive action to extract economic rent from a foreign market (Chen *et al.* (1995)), and suggested that FDI is undertaken by firms that possess some intangible asset. These firms invest in a foreign country in order to exploit the specific ownership advantage embodied in the intangible asset. The other group, represented by Vernon (1966) and Kojima (1973), took FDI as a defensive action undertaken by firms to protect their export market which is either threatened by competitors in the local market (Vernon (1966)) or damaged by unfavourable developments in macroeconomic conditions at home (Kojima (1973)), such as wage increase or currency appreciation. This defensive FDI is often made in low-wage countries where cheap labour cost enables investors to reduce their production cost to keep international competitiveness, whilst aggressive FDI may be made in any countries where local production is seen as the best way to enter the market. Actually, it is difficult to distinguish one from the other as FDI may be undertaken for a mixture of reasons including market-seeking and cost-seeking motivations. Hence, we review both of the two main groups of literature, as well as other studies on FDI, to provide a complete picture of FDI theories in the existing literature.

The neoclassical theory of capital movement

Before the 1960s, the prevailing explanation of international capital movements relied upon a neoclassical financial theory of portfolio flows. Under perfect competition and no transaction costs, capital moves in response to changes in interest rate differentials (see Iversen (1936)). Accordingly, capital was assumed to be transacted between independent buyers and sellers and there was no role for the multinational enterprises (MNEs); neither was there a separate theory of foreign direct investment. The neoclassical theory of capital movement regarded the movement of foreign investment as part of the international factor movements. Based on the Hecksher-Ohlin (H-O) model, international movements of factors of production, including foreign investment, are determined by different proportions of the primary production inputs available in different countries. International capital movement implies a flow of investment funds from countries where capital is relatively abundant to countries where capital is relatively scarce. In another word, capital moves effectively from countries with low marginal productivity of capital to countries with high marginal productivity of capital (Bos *et al.* (1974)). Such the international investments may benefit both the investing and host countries. The host country may benefit in increased income from foreign investment to the extent that the productivity of the investment exceeding what foreign investors take out of the host country in the form of profit or interest.

However, the assumptions of the neoclassical theory hardly exist in the real world, which required perfect competition, fully mobilization of labour and capital, no transaction cost and perfect information. Thus, the neoclassical theory failed to explain the behaviour of MNEs, in particular, the two-way capital flows between capital-abundant countries, for example, FDI between developed countries like the US and Japan. In addition, it still failed to distinguish FDI from other forms of capital.

Industrial organisation approach

In the 1960s, economic theory started to explain foreign direct investment by the industrial organisation approach, which regarded FDI as part of international production. The primary concern of this approach was the characteristic of MNEs and the market structures in which they operated. Hymer (1966) related FDI with the behaviours of MNEs and stated that foreign direct investment from the US would be a natural consequence of the growth and expansion of oligopolistic firms, who have superiority in searching for control in an imperfect market in order to maximise profits. Even further, Caves (1971, 1974) claimed that newest products usually tend to be oligopolistic in their nature. They suggested that firms participate into FDI because of their oligopolistic characters and that their investments and operations abroad enable them to survive by expanding their oligopolistic systems. Accordingly, market structures and competitions conditions are important determinants of this type of firms which engage in FDI. This theory used firm-specific advantages, such as their market positions, to explain MNEs' international investment. These firm-specific advantages include patents, superior knowledge, production differentiation, expertise in organizational and management skills, and access to the foreign market. Advantages that some firms have in the home country can be extended into foreign markets through international direct investment. This theory mainly characterised the US FDI motivation or market-oriented FDI, but have not explain others like resource-oriented FDI or efficiency-oriented FDI.

Location theory

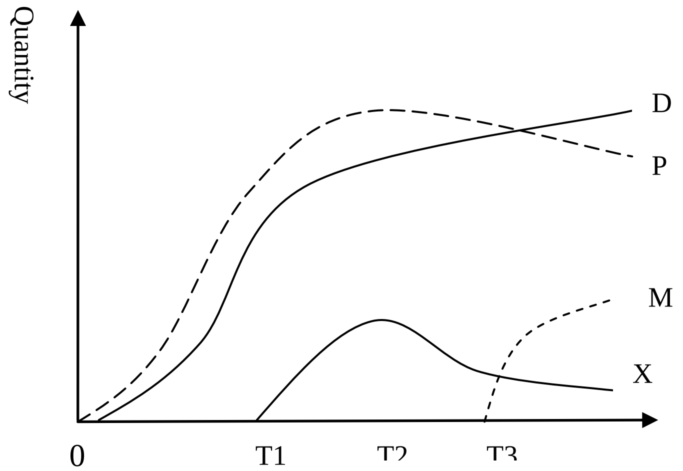
Contrary to the industrial organization approach, location theory drew attentions on country-specific characteristics. It explained FDI activities in terms of relative economic conditions in investing and host countries, and considered locations in which FDI would operate better. This approach includes two subdivisions: the input-oriented approach and the output-oriented one. Input-oriented factors are those associated with supply side variables, such as costs of inputs, including labour, raw materials, energy and capital. Out-oriented factors focus on the determinants of market demand (Santiago (1987)), including the population size, income per capita, and the openness of the markets in host countries. Hence, the country-specific factors not only determine where MNEs locate their FDI, but also are utilized to distinguish the different types of FDI such as market-seeking investment, and efficiency-seeking export-oriented investment.

Product cycle approach

Another approach is developed by Vernon (1966) as the product cycle approach, which focused on consumer durables and was also based on the US experience in the post-war period. The product cycle approach was a response to the observation that US firms were among the first to develop new labour-saving techniques in response to the high cost of skilled labour and a large domestic market (Vernon (1966)). It suggested that the role of FDI follows a three-stage life cycle of a new product: innovation, growth, and maturity. The implicit assumption of this theory was that firms which developed the products in their domestic markets would shift the manufacturing plants to the countries identified with abundant unskilled labour, rather then sell or license their technology to host-country competitors.

In the innovation stage, new technologically advanced product is invented under the intensive research and development efforts by the lead firm in advanced industrial countries. This product is firstly introduced in the home market, and close co-ordination of production and sales are undertaken while the product is improved. As customers who like the new product would like to pay a premium price for it, the location of the product requires high per capita income, and a strong technological base. Consequently, these factors served to improve the innovation and launching of the new product in the home market like the US. This stage would end when the product is accepted and sales are increased according to the demand.

Figure 2.1. *Product life cycle*



D: domestic demand; P: domestic production; M:imports; E:exports.

The growth stage relates to the period when the product is starting to be exported. The production method and sale channel are also improved for the enhancement of productivity with respect to increased demand. Other companies start to emulate it because of its success at this stage, and customers become sensitive to the price. Cost saving is now a big issue for the lead company to keep its advantage and it becomes realistic to shift producing the product to overseas countries. Also at this stage, the product starts to be exported.

The product eventually reaches maturity in the third stage, while the production process is standardised and the cost is reduced. Competition from similar products narrows profit margins and threatens margins on both export and home market. Instead of the decisive role played by research and development (R&D) or managerial skills at the innovation stage and the growth stage, low-cost labour becomes important to meet the requirement of cost saving in the producing process. Consequently, the production location moves to low-wage, developing countries through FDI. The costs of marketing exports of the product from these countries may be lower compared with other competitors, since the productivity is standardised. FDI in this model is undertaken as a monopolistic defence of the market.

Vernon's product cycle theory again only considered the situation from the US perspective and emphasized the technology advantage from the leading firm in developed countries. Therefore, it could not explain the FDI with no advanced technology like textile and garments industry. Neither had it considered FDI among developing countries.

Internalisation Theory

Represented by Caves (1982), Rugman (1981, 1986), and Buckley (1987), this approach explained the FDI activities of MNEs as a response to market imperfection, which causes increased transaction costs (Sun (1998)). From one aspect, market imperfection is associated with regulatory structure of the market, such as tariffs, import quotas, foreign exchange controls, and income taxes. MNEs tend to internalize this type of market imperfection for a rent-seeking purpose. Market imperfection also relates to market transaction costs, such as technology transfer. In order to keep their competitive advantages and to keep full control of technology distribution, MNEs prefer FDI rather than trade or licensing the use of their firm-specific intangible assets. This internalized FDI allows MNEs to maintain their market shares and to maximize their benefit. The main hypothesis of the internalisation theory was that, given a particular distribution of factor endowments, MNEs' activities would be positively associated with the costs of organising cross-border markets in intermediate products (Michael (2000)). Hence, it stood for the private welfare of MNEs and omits the social welfare for a nation, therefore ignored the macroeconomic effects of FDI.

Eclectic theory of international production

This view, developed by Dunning (1981), combined the industrial organization approach with both the location theory and internalisation theory to explain FDI and international production. It suggested that the propensity for a firm to undertake FDI depends on the combination of ownership-specific advantages, internalisation opportunities and location advantages in the target market and each of these determinants of FDI relates to an advantage of direct investment over alternative ways to serve the customers abroad.

The ownership advantage requires firms to own firm-specific assets to undertake FDI, such as technology, managerial resource and marketing skills, which usually lead to more efficient production and give such firms an international competitive advantage than locals. The selection of FDI location requires the host country to own a location advantage. It would take into consideration such factors as a large or a potential domestic market, a low-cost effective export production base with abundant low-cost high quality labour, low transportation costs, generous investment incentives and favourable macroeconomic policies. The location advantages are highly dependent on the stage of development and the industrialisation strategy of the potential host country. Eventually, an internalisation advantage enables the firm to evaluate the risks and costs between direct investment and other arrangements such as licensing or franchising. Only under the circumstance that all the three advantages are owned, could FDI be undertaken in the specific country. This eclectic theory approach provides a framework for discussing the determinants of FDI and helps to explain the regional economic integration (see Bende-Nabende (2002)).

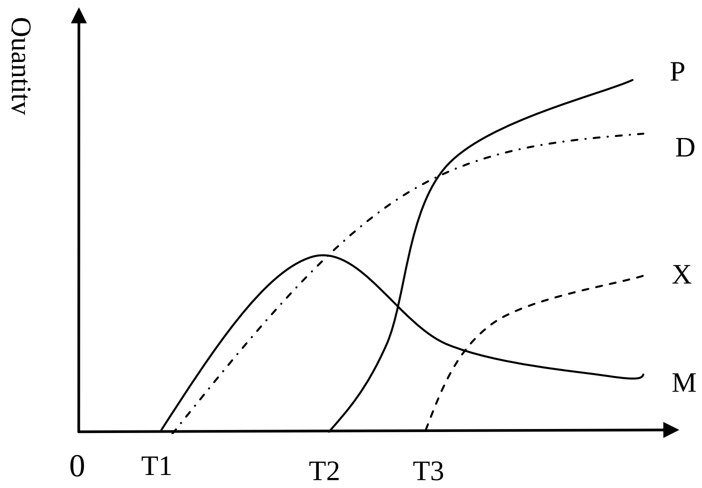
The eclectic theory and the theoretical approaches discussed above, all concentrate on the microeconomic analyses to explain behaviours of MNEs, and the characteristics, motivations, and types of FDI. Thus, they could hardly explain the macroeconomic effect of FDI on the host country (Sun (1998)).

Catching-up product cycle approach

Based on the experience of Japan, Akamatsu (1962) initiated a so called ‘geese-flying pattern’ approach to explain why and how FDI performs in developing countries by breaking the product cycle into three stages in developing countries: importing, domestic production and exporting. In a view from developing countries, the particular product cycle starts with import of the new product. As the demand increased, it becomes economical to substitute the import by domestic production. With assistance by importing technology and learning skills from FDI, developing countries then begin to produce the product for domestic demands. The expansion of production leads to an increase in productivity, the improvement of quality and the reduction in costs, and gradually substitutes import of the product. However, when the domestic cost reaches the international cost threshold, foreign markets are developed, and the production needs further improvement to catch up with the new standard. Thus, the expansion of export that is initially being made possible by the growth of domestic demand, then provides a stimulus to industrial development.

Besides the commodity analysis like Vernon’s model, Akamatsu had another model for the process of development of industrialisation, which suggested that industrialisation follows a “wild geese-flying” pattern from one industry to another, lead by developed countries with advanced technology. The catching up and upgrade of the industry in developing countries would improve the comparative advantages by inputs of capital, technology and managerial skills, therefore finally stimulate economic development.

Figure 2.2. *Catching-up product cycle*



D: Domestic Demand; P: Domestic Production; M: Imports;
E: Exports.

Macroeconomic theory of FDI

Another Japanese economist Kojima (1973, 1975) extended the Akamatsu's approach and presented a macroeconomic theory of FDI within the framework of relative factor endowments from Heckscher-Ohlin international trade theory and against the background of post-war Japanese experience. It firstly classified FDI into two different types, trade-oriented FDI (Japanese type) and anti-trade-oriented FDI (American type). The Japanese type FDI is primarily a trade-oriented respond of pursuing comparative advantage in the process of production; but the American type FDI is mainly undertaken with an oligopolistic market structure, leading to the long-term disadvantage as the anti-trade-oriented consequence of both the investing and the host countries. He suggested that outbound FDI should be undertaken by firms that produce intermediate products required resources and capabilities with the investing country having a comparative advantage in such as technology, financial capital and high-skilled labour force, but generating value-added activities required resources and capabilities in which the investing country is comparatively disadvantaged, such as low-cost labour force and raw material resources. Inward FDI should import intermediate products required resources and capabilities, such as high technology and labour skills, in which the host country is disadvantaged, but the use of which requires resources and capabilities in which it has a comparative advantage. Hence, FDI build a linkage of trade between the investing country and the host country for the intermediate products to the host country and the final products back to the investing country. Kojima suggested that FDI would be undertaken from a comparatively disadvantaged industry in the investing country to a comparatively advantaged industry in the host country. Thus FDI would promote an upgrading of industrial structure on both sides and accelerate trade between these two countries. By comparing FDI outflow from Japan and the US, Kojima argued that Japanese FDI, especially that to developing countries of Asia, is mostly in labour-intensive and resource-based industries, in which the host countries have advantages over Japan. These investments complement the comparative advantage position of Japan in technology-intensive and high value-added industries with increased trade between them. Comparably, American FDI concentrates in capital-intensive and high technology industries in which they have comparative advantages, and is undertaken by large and oligopolistic firms in these industries. By setting up foreign subsidiaries, these firms seek to keep their oligopolistic positions against competitors either from the investing country or in the host country, and consequently cut off their own advantages and lead to trade-substitutive effects.

In his macroeconomic theory of FDI, Kojima established a linkage between FDI and trade, that FDI actually could stimulate complemented trade against the conclusion based on the neoclassical theory that FDI has an anti-trade, or “substitutive” effect on international trade (see Mundell (1957)). In addition, Kojima pointed out the linkage from FDI to economic growth. He argued that money capital is a homogeneous factor of production, and its movement can only results in an expansion of production to new equilibrium with the increases in general factors into the production function, but FDI has a gradual effect, through training and technology transfer, on increasing competitive capability of the specific industry in the host country, and ultimately improving the production function of this industry. He concluded that the lower the technological gap between the investing and host countries, the easier it is to transfer and upgrade the technology in the latter (Kojima (1978)). Practically, technology involved in labour-intensive industries, such as textiles, is more easily to be transferred to developing countries than capital-intensive industries, such as steel and computers.

However, it still provided little insight for the analysis of impacts of FDI on other macroeconomic factors for both investing and host countries. In addition, a distinction he suggested between trade-oriented (Japan) and anti-trade (US) FDI dose not always exist. The two types of FDI could co-exist in one country, even in one industry. His classification of these two types of FDI made his approach less practicable for empirical studies (Sun (1998)).

2.3. Review of the economic growth theory

The economic growth theory comes in many forms. In the early stage, the classical theories were pioneered by Adam Smith (1776), and David Ricardo (1817), and later by Ramsey (1928), Harrod (1939) and Domar (1947). The main issues of the classical theories were focused on the expansions of factors in production, such as capital, labour and land. In their models, the expansion of production would be limited by supply of land and labour with discounting any effects of technology improvement that could create greater efficiencies. Malthus (1798) predicted that the finite availability of land would constrain the economic development, and that the natural equilibrium in labour wages would be restricted at subsistence levels as a result of the interaction of labour supply, agricultural production, and the wage system. Harrod (1939) and Domar (1947) argued that labour expansion would lead to declines in the accumulation of capital per worker, then lower worker productivity, and lower the income per person, eventually cause economic decline. Hence, the classical theories did not expect a sustainable economic growth because of limited resources and they failed to capture the effect of technology development on the economic growth at that time, which, in fact, provided greater efficiencies overtime in production and greater returns on inputs of land, capital and labour.

The neoclassical theories then took the technology into the production function and demonstrated that the economic growth is not unstable as suggested by the classical economists. Solow (1957), in his model, built a basic feature of a closed economy with a comparative market, and a production technology exhibiting diminishing returns to capital and labour and constant returns to all input. His model provided a unique steady-state growth path along which all input and output grow at the same rate, where the steady-state growth rate is the exogenous rate of growth of the labour force or population, and output per worker is constant along the steady state with given technology. Technology development, in this model, is exogenously determined but the only reason accounting for growth in output per capita. Thus, neo-classical models in general demonstrated the importance of technology development to economic growth over the contribution from expanding quantities of productive factors.

However, in Solow's production function, the technology factor, which is assumed to be exogenous, might subsequently be visualised either as an upward shift of the production function, or as an inward shift of isoquant towards the origin. Such a shift might be caused by innovations or education of the labour force. The shift representing technical progress might be incorporated in the production function as:

$$Y = f(K, L, t); \qquad f_t > 0 \tag{2.1}$$

where *Y* is output, *K* is capital stock, *L* is labour and *t* is time period. With technical progress, *Y* still increases following a change in *t*, when *K* and *L* keep constant. Here t represents the stock of knowledge, and in this model, captures the technology progress and its change is independent from any economic variables. Its assumption of diminishing returns means that the growth of output could not be accounted for by the growth of inputted factors. Hence, there would be large residuals on output estimation caused by the automatic increase in technology progress, which becomes a major deficiency of the neo-classical theory.

Neo-classical economists introduced the concept of convergence in their models with the assumption of diminishing returns to capital. They hypothesised that poorer economies that have a lower initial level of capital stock per worker tend to have higher returns and higher growth rates, which eventually make them catch up with the richer economies and converge with them in the long-run. Thus, the growth of developing countries could be rapid for a period, but would decelerate when the gap with the developed countries diminished.

Reminding that the basic Solow model is based on a production function of the form:

$$Y_i=f(K_i, AL_i) \quad (2.2)$$

where Y is output, K is capital stock, L is labour, A is a technology factor. The subscript i indicates that this is a production function for firm i. The key point in the neo-classical model is that the growth of inputted factors has no effect on output per capita in the long-run and technical progress alone determines the growth of output per capita. Moreover, technical progress A is fully exogenous and is a public good. The approach of endogenous theory was developed to overcome the deficiency in the neo-classical theory by modifying the assumption on exogenous technology variable with treating it as an explicit factor. The key characteristic of the endogenous growth is the presence of some factors, such as human capital or the stock of knowledge, whose accumulations are not subject to diminishing returns.

Initially, Kaldor and Mirrlees (1962) endogenised technical progress and output growth rate by relating productivity of workers operating newly produced equipment to the rate of growth of investment per worker. Arrow (1962) introduced a "learning-by-doing" model, which makes technological progress a result from the learning process. As Learning-by-doing being a function of cumulative gross investment, the total factor productivity (TFP) that representing technical progress then is treated as an increasing function of cumulated investment. Their approaches reform the production function from the basic Solow model to:

$$Y_i=A(K)f(K_i, L_i) \quad (2.3)$$

Following this idea, Romer (1986) established an equilibrium model of technical progress in which the long-run growth is driven by the accumulation of capital goods and knowledge. His approach reformed the production function as:

$$Y_i=A(R)f(R_i, K_i, L_i) \qquad (2.4)$$

The notation is as before, except that R here is expenditure on research and development or investment in knowledge. In this case, there would be spillover effects resulted from total spending on research and development. In his model, investment in knowledge or R&D is assumed to have diminishing returns, but the utilisation of knowledge in productive activity has increasing returns, which is due to the spillovers of knowledge.

Considering an economy in which there are n identical firms. Each firm has a production function:

$$Y_i=f(R_i, R, K_i, L_i,) \qquad (2.5)$$

Where R_i is investment in knowledge or R&D by individual firm i, $R = \sum_1^n R_i$ is the total aggregate stock of knowledge or accumulation of R&D in the economy. K_i and L_i is physical capital stock and labour in firm i. Although the choice of R as a total is external to individual firm, it is assumed to have a positive spillover effect on the output of each firm. Romer suggested that the knowledge invested or R&D employed by one firm can have a positive spillover to all firms, as any technical progress made by one firm would benefit all others through public diffusion of this knowledge.

These spillovers across producers help avoid the tendency for diminishing return to the accumulation of investment in knowledge and give a sustainable economic growth in the long-run.

Lucas (1988,1993), on the other side, extended the Arrow's model of learning-by doing and argued that human capital formation drives growth not just directly but also by producing externalities. His idea can be expressed in the production function as:

$$Y_i = A(H) f(K_i, H_i, L_i) \qquad (2.6)$$

where H refers to human capital. Lucas argued that the human capital accumulation is a social activity and the interaction between educated workers would actually improve productivity by learning-by-doing from each other. He suggested that human capital exerts two effects on the production process. One is the internal effect of the individual's human capital on his own productivity. The other is the external effect that no individual human capital accumulation decision can take into account, that is, people interact with others who are more educated in the production process and thereby learning-by-doing. Hence, the production cost would eventually decrease with human capital increase, as learning-by-doing increases the productivity with no more input of investment. According to this argument, there are significant positive social rates of return to investment in human capital. A well-educated workforce tends to be more responsive to new ideas and new technology, and in this way the diffusion of knowledge is much faster. Moreover, a country well-endowed with human capital will be better able to attract and keep capital in the form of FDI from multinational enterprises.

Grossman and Helpman (1991b) analysed the dynamic spillover effects of export expansion. They argued that, despite the existence of differences in levels of output and of consumption, international spillovers of investment may provide over above the effects of capital mobility and cause a convergence of growth; the intensity of spillovers depends on the volume of international trade and foreign investment that occurred between this country and others. It suggested that countries can benefit more from the trade and foreign investment through spillovers with those in the higher development stage.

As Balasubramanyam *et al.* (1996b) observed, the endogenous growth theory for the most explores the mainsprings of technical progress or the residual left unexplained in the neo-classical models. It postulates that human capital accumulation is one of the key factors that generate fast technical progress through learning-by-doing, as well as education. It complements the neo-classical theories by explaining technical progress by human capital formation and by spillover effects of investment in knowledge.

Generally, long-run economic growth may be achieved by a series of factors. It can be promoted by investment that expands the productivity of physical resources. Or it can be achieved by innovation and technology development, which improve productivity and create new competitive advantage. Alternatively, it can be achieved by the development of labour skills or investment in human capital. Further it is possible to be achieved by international trade and investment, which allow taking comparative advantages of domestic resources in the international production network.

2.4. FDI and economic growth

The FDI theories suggest that the role of FDI in the host economy can be approached within the theoretical framework of economic development. The investigation of the impacts of FDI on economic growth should consider not only the direct causality between FDI and total output, but also the impacts on the conditions and determinants of economic growth that indirectly affect economic growth. From this aspect, studies of the role played by FDI on economic growth could be discussed from different perspectives, and may generate either complement or contradict conclusions.

Within the framework of the neo-classical models, the impact of FDI on the growth of output was constrained by the existence of diminishing returns in the physical capital. Therefore, FDI could only exert a level’s effect on the output per capita, but not a rate effect. In other words, it was unable to alter the growth rate of output in the long-run. Thus, FDI was not considered seriously as a driven engine of economic growth. In the context of the endogenous growth theory, FDI may affect not only the level of output per capita but also its rate of growth. With the consideration of the new endogenous theories, FDI could be regarded as recourse of new technology and high skilled labour. Since these factors have increasing returns on output, FDI then could have consistent influence on economic growth through its spillovers. Under this context, the impact of FDI on host economies may be analysed by its effects on these growth driven factors, such as capital formation, employment, human capital, exports, and technology. Consequently, FDI has been integrated into theories of economic growth as the "gains-from-FDI" approach (Graham and Krugman (1995)).

Firstly, foreign direct investment can be considered to boost domestic investment. In an open economy, investment is financed not only by domestic savings, but also from foreign capital flows. FDI may promote growth by expanding the stock of physical capital in host countries. Also it can increase the efficiency of domestic investment by creating competition. For instance, some of the empirical works indicated a strong link between the volume of foreign direct investment and domestic investment. Bosworth and Collins (1999) and Mody and Murshid (2001) found that a dollar of foreign direct investment results in an increase of almost one dollar in domestic investment. Baharumshah and Thanoon (2006) confirmed the positive link between FDI and domestic saving in their analysis of some East Asian countries. But studies do not always support this. Bende-Nabende *et al.* (2000) found ambiguous results in Southeast Asian countries; Rand and Tarp (2002) found that FDI inflows were very volatile. Their results revealed no connection between domestic investment and FDI.

There are three basic mechanisms for FDI to generate employment in the recipient countries. Firstly, foreign firms employ local people directly in their investment operations. Secondly, through backward and forward linkages, employment is created in enterprises that are suppliers, subcontractors, or service providers to them. Thirdly, as FDI-related industries expand and the local economy grows, employment is also created in sectors and activities that are not even indirectly linked to the original FDI. Empirically, the OECD (2000) investigated that in China total employment in foreign owned enterprises increased significantly from 4.8 million (0.74% of total employment) in 1991 to 18.38 million (2.64% of China's total employment) in 1999. UNCTAD (1999) reported that the employment in MNEs in developing countries tends to take large shares of manufacturing-sector employment.

FDI can promote international trade by providing opportunities to expand and improve the production of goods and services. Particularly, the efficiency-seeking and export-oriented FDI can create exports of finished products to the investing countries, at the same time increasing imports of components and processed materials from the investing countries or other countries. UNCTAD (1999) has observed a statistical significant positive relationship between FDI and manufactured exports across 50 countries. In addition, they suggested that the relationship is stronger for developing countries than developed countries and in high-technology activities than low-technology activities. In the East Asian countries, Feder (1992), and Rodriguez and Rodrik (1999), demonstrated that FDI expanded the manufacturing exports and confirmed the role of exports as an engine of growth.

Studies by Rodriguez-Glare (1996) and Blomstrom *et al.* (1992) also suggested that FDI might be able to enhance economic growth of host countries through technology transfer and spillover efficiency. Direct technology transfer from multinational enterprises (MNEs) to local subsidiaries allows host countries to upgrade their industries by absorbing new technology in production. R&D that comes along with FDI induces competition which encourages local firms to increase their R&D that may stimulate innovation (see Barrios and Strobl (2002)). In addition, FDI can also lead to indirect productivity gains for local firms through the realization of external economies (technology spillovers). For example, MNEs may provide training of labour and management which may then become available to the economy in general. MNEs may also benefit local firms through training of local suppliers to meet the higher standard of quality control required by the technology of the foreign-owned companies. However, technology transfer and the spillover efficiency do not appear automatically but depends on host countries' absorptive capability that is largely determined by the conditions of human capital in host countries (Borensztein *et al.* (1998)). Empirical evidence shows that technology transfer to developing countries has a beneficial impact on economic growth through increased productivity of factors inputted in production (UNCTAD1999).

Technology transfer and the spillover efficiency from FDI is not the only channel to improve human resources development in the host country, MNEs can also improve labour skills through on-the-job training, seminars, and formal education. For example, Athukorala and Menon (1995) showed that foreign direct investment to Malaysia facilitated technology transfer and improved the skills of the labour force. Foreign direct investment also contributes indirectly to growth through domestic firms emulating foreign affiliates and the diffusion of skills throughout the economy when employees move to domestically owned firms. These spillover benefits of FDI are greater in countries with sound investment climates marked by well-developed human capital, efficient infrastructure services and governance, and strong institutions. For example, Wei (1995) found that FDI increasingly exposes local workers and firms to international management, and technical standards and knowhow. Also the FDI spillovers appear to depend on human capital. The results from existing studies indicate that higher levels of human capital raise the benefits from foreign direct investment liberalisation and flows. For example, for a country with a high level of human capital, such as South Korea, increasing the openness measurement by the average gap between closed and open economies can raise the economic growth rate by as much as a quarter of a percent a year (World Bank (1999)).

The role of FDI in host economies, however, is still subject to considerable disputes. As summarised by Helleiner (1989), FDI may not lead to higher growth rates because MNEs tend to operate in imperfectly competitive sectors, especially those with high barriers to entry or a high degree of concentration. As a result, FDI may have a consequence to crowd out domestic savings and investment (Papanek (1973)). Moreover, FDI may have a negative impact on the external balance because profit repatriation will tend to affect the capital account negatively. In addition Rueber *et al*. (1973) pointed out that, foreign firms might not generate enough linkages, and be unlikely to make local purchases of inputs if these firms engage in labour-intensive processing of components for export. Hymer (1960) and Dunning (1981) also argued that MNEs have an incentive to prevent spillovers of technology to other firms through intellectual protections of their brands and patents, since MNEs are dependent on its firm-specific advantage, for example, in the form of technology, for profitable business operations in a certain time. Hence, FDI may not necessarily stimulate technology development in host countries.

From another aspect, Fujita and Hu (2001) suggested that integration of FDI may increase regional disparity, and cause agglomerations of human capital and technology diffusion in host countries, which can only benefit agents with new production function and worse those with lower human capital. Other critics argued that FDI is often associated with enclave investment, sweatshop employment, income inequality and high external dependency (Bende-Nabende (2002)). All these arguments imply that, in the absence of certain conditions, the negative effects of FDI may outweigh the positive impacts and cause damages on economic development.

Empirical evidences show that the effect of FDI on economic growth is dependent on a set of conditions in the host country, for example, the level of human capital and infrastructure. In absence of these preconditions, FDI may only result in raising the private return to investors with little positive impact in the host country. The study by Balasbramanyam *et al*. (1996a) also found significant results supporting the assumption that FDI is more important for economic growth in export-promoting countries than in importing-substituting countries. This implies that the impact of FDI varies across countries and the trade policy can affect the role of FDI in economic growth. Borensztein *et al.* (1998) found empirical evidence that the contribution of FDI to economic growth is related to its interaction with the level of human capital. They suggested that the difference in the technological absorptive capability may explain the variation in effects of FDI across countries. In their analytical framework, the level of human capital determines the ability to adopt foreign technology. Thus, countries may need a minimum threshold stock of human capital in order to experience positive effects of FDI. Similarly, Olofsdotter (1998) considered the absorptive capability of FDI in host countries and found that the beneficial effects of FDI are stronger in those with a higher level of institutional capability and bureaucratic efficiency. Bengoa and Sanchez-Robles (2003) showed that FDI is positively correlated with economic growth only if host countries reach certain levels of human capital, economic stability, and liberalized markets.

Therefore, economic theory and empirical evidence have not concluded on the role of FDI on economic growth. On the one hand, FDI might be more important than domestic investment in terms of its individual contribution to the growth rate; on the other hand, it is disputed that technology and human capital spillovers do not exert from the mere presence of FDI, and they have to be boosted or enforced by effective policies.

2.5. Conclusion

It has been increasingly recognised that growing foreign direct investment inflows can contribute to economic development and promise potential benefits to developing host countries. To sum up, economic theory identifies a number of channels through which FDI may exert an impact on economic growth both directly and indirectly. FDI flows can promote economic growth directly if they lead to an increase in the investment rate; or FDI flows can indirectly promote economic growth if they lead to investments that are associated with positive spillovers, which may enhance the productivity of labour and capital in the host economies. As summarized by UNCTAD (1992), this theoretical review of FDI highlights the role of the spillover effects of FDI on economic growth, that FDI is playing an increasingly important role in the economic growth of host developing countries, through its contribution in capital formation, human resources development, technology transfer and international trade. The criticisms on FDI also rely on its damages on spillovers of investment, technology or human capital. Thus, it suggest that the effects of FDI and its spillovers are interacting with each other and should not be discussed separately, as improvement or damage in one factor would interact with others and lead to impacting economic growth through multiple channels.

Our framework to analysis the relationship of FDI and economic growth, therefore, would be established on this consideration by taking consideration of all possible channels that could affect economic growth, and testing the hypothesis that FDI could stimulate economic growth through the creation of dynamic comparative advantages that lead to new technology transfer, capital formation, human resources development, and expanded international trade.

CHAPTER THREE

FDI AND ECONOMIC DEVELOPMENT IN CHINA

3.1. Introduction

Since adopting opening-up policy and starting the economic reform in the late 1970s, China has made remarkable progress in economic development and become one of the fast growing economies in the world. From 1979 to 2006, its economy increased at an average annual growth rate of 9% and the real output grew over 7% each year. Along this rapid process of economic growth for more than twenty years, it has been seen tremendous inflows of foreign direct investment (FDI) participating in Chinese economy. China has now become one of the most attractive destinations for cross-border direct investment. It has become the largest FDI recipient among developing countries since the early 1990s. In recent years, FDI to China accounted for about one third of total FDI inflows in developing countries. Since 2000, China became the world second largest recipient after the United States. According to China Investment Yearbook (2006), China has attracted US$ 706 billion FDI for the period from 1979 to 2006. By no doubts, FDI has made increasingly important contribution in the economic reform. During the year of 2006, foreign funded enterprises accounted for 28 % of China's industrial value-added output and 21% of taxation. They exported about 58% of the total exports of goods and services, and imported 51.4% of total imports. Foreign funded enterprises accounted for 11%t of local employment (China Investment Yearbook (2006)). In related to the high economic growth, many would argue that FDI play an important role in accelerating economic growth in China.

This success of China in improving its economic growth and attracting foreign capital also attracts numerous attentions, which focus on the role FDI played in economic development. What is the impact of FDI in economic growth? Does FDI indeed improve output? How can FDI affect the economy? Can international integration benefit domestic economy? Answers to these questions would be beneficial not only for China to achieve sustainable economic growth in the future, but also for other developing countries to learn experience to develop their economies. In this chapter, we make some empirical contributions to the literature by investigating the effects of FDI on Chinese economic development with the VAR methodology.

Theoretically, the neo-classical theory could only explain the potential effects of FDI on output as the increased input of physical capital, while it regards other factors affecting economic growth as exogenous. Sustainable economic growth could hardly be maintained in the equilibrium as capital has diminishing returns. Particularly, technology progress could not be captured in the production function in the neo-classical Solow model (Solow (1957)). This constraint therefore can be released by the new endogenous growth theory. Endogenous growth models developed several endogenous factors in the production process, which represent quality improvements in the labour force of an economy, like health, education, training and technology development (see Grossman and Helpman (1991a), Barro and Sala-I-Martin (1997), Romer (1986), Lucas (1988)). Thus it builds a mechanism for FDI to affect economic growth in the long-run. By these considerations, FDI can affect the output through the effects that lead to new technology, capital formation increase, human resources development and international trade expansion (UNCTAD 1999).

However empirical works have not generally confirmed these effects of FDI. For example, UNCTAD (1992), and Bende-Nabende and Ford (1998) observed a positive direct link between FDI and economic growth. Bende-Nabende *et al.* (2003) found FDI and economic growth to be positively related for some countries, while those for others to be negatively related. UNCTAD (1999) found that FDI exhibits either a positive or negative relationship with output depending on the variables that were entered in the test equation. Furthermore, because the FDI is a comparatively new phenomenon, lack of information cumbers the channel to investigate its long-run relationship with output.

In the case of China, researchers have unambiguously yet to agree on the relationships between FDI and output and the effective mechanisms. For instance, with a time series analysis, Tan *et al*. (2004) detected a direct relationship between FDI and GDP and found that the effect is small but significant. Tang (2005) analyzed the relationshps between FDI, domestic investment and output by a cointegration analysis, and concluded that FDI has a positive relationship with output, but with a limited impact on domestic investment. Liu *et al.* (2002) focused on the mechanism of FDI and economic growth through international trade. Shan (2002) developed another VAR model to investigate the relationships between FDI and output with involvement of labour, investment, international trade and energy consumed. By the technique of innovation accounting, he found that output is not caused by FDI significantly, but has an important influence in determining it. Most of these efforts focused on some specific aspects which are assumed to have impacts on output. Hence, their conclusions are not consistent with each other. One of the reasons is that these studies focus on one or several different channels that FDI can affect economy, but ignore the interaction between these variables and generate biased conclusion for the overall effects. Thus, a more comprehensive framework is still necessary to investigate the overview of relationships between economic development and FDI. This study gives an attempt to do so by including possible influence that FDI could impact into consideration of economic development and is expected to provide some evidence of economy growth in China from much broader scope.

In this chapter, we introduce the Vector Autoregression (VAR) methodology, following the work on APEC countries by Bende-Nabende *et al.* (2003), to undertake a time series analysis on the relationship between economic growth and FDI. As suggested by UNCTAD (1992), this model is founded on the consideration that the economic growth depends on those factors through the supply side, such as capital formation, human capital, employment, FDI, international openness and technology transfer. With all the variables treated as endogenous and no restrictions added, it is now only a consideration of the policy-neutral system to investigate economic growth and capture the integrations between elementary determinations according to the endogenous growth theory.

Based on the work of Sims (1980), The VAR model is frequently used for modelling multivariate relationships and multivariate version of the error correction model (ECM). The Sims methodology is based on a reaction against the traditional econometric approach to tackling multi-equation simultaneous equation models, which has to distinguish exogenous variables and endogenous variables precisely when imposing theoretical restrictions. The VAR approach abandons the division between endogenous and exogenous variables and treats all variables as endogenous. Furthermore, the VAR model is neutral to any of economic theories as no restrictions are placed on the parameters of equations in the model. Hence it could generate more prevailed conclusion based on the empirical analysis for economic reality. More importantly, it allows investigation through an error-correction model (ECM) to analyze the cointegration relationships or long-run effects among variables. With the VAR model, innovation analysis can be employed to capture the effects of various shocks on the variables in the model. In this case, impulse response functions can be estimated to capture the effects of a shock on output and other endogenous variables, and variance decompositions are applied to investigate how a future change in one variable is explained by others.

Basically, the model here described and estimated at least provides some new evidence on economic development that encompasses the FDI framework and attempts to answer questions such as whether FDI has a positive impact on output; how FDI affects its spillovers; whether these spillovers, like human capital and technology transfer have beneficial impacts on economic growth.

The rest of this chapter is divided into four sections. The overview of FDI in China is discussed in the next section. The second part describes the econometric methodology of the VAR system. The interpretation of the model and the empirical results are discussed in the third section. And conclusions are drawn in the last section.

3.2. FDI in China: policies, trend, and influence

Before we explore the trend and characters of FDI in China and evaluate its contribution to the Chinese economy, we need review the history of FDI policies of the Chinese government as they are the main internal impetus for the inflows of investment from outside the country.

3.2.1. FDI policies in China

When China started to reform its economic system in the late 1970s, the attitude toward foreign investment also changed. Foreign capital was more regarded as an impetus to rather than invasion of domestic economy. Attracting FDI has become the main policy and the major component of the reform. However, the strategy of openness is implemented with caution and consistency. From initially accepting foreign investors in 1979 till completely participating in international integration when China became a member the WTO in 2001, it took more than twenty years to convert the Chinese economy to be fully opened. Meanwhile, the Chinese government has developed the legislative framework related to FDI, including ownership legislations, property rights and contract laws, to improve investment conditions and the business environment in order to attract FDI. The details of the path of this progress can be found in Appendix A3.1.

From 1979 till 1983, the Chinese government adopted an experimental approach toward FDI. In 1979, the implementation of the Law of Joint Venture, which recognized the ownerships of foreign investors for the first time, symbolized the start of the opening-up process. FDI policies were basically formed with preferential policies, including tax concessions and privileges, for foreign investors in desired areas in the country. In 1981, Special Economic Zones (SEZs) were established in four cities in south coastal provinces, Guangdong and Fujian. These SEZs were designated for the absorption and utilization of foreign investment. But foreign capital in other areas was extremely restricted.

In 1984, the Chinese government took a further step to give FDI access to other fourteen coastal cities. Compared to SEZs, these cities enjoyed more autonomy in determining the FDI projects with capital investment up to certain level. They were also given the right to reserve and spend foreign exchange yielded by local FDI for their own growth. Published in 1986, The Law of People’s Republic of China on

Wholly Foreign-owned Enterprises (WFOEs) indicated the acceptance of fully foreign owned enterprises. In the same year, the Chinese government introduced the ‘Provision for the FDI Encouragement’ to stimulate FDI. These so-called ‘22 Article Provisions’ provided protection for the profits and interest of foreign investors when they founded WFOEs in China, which drove the promotional policy toward FDI to a new stage, A series of other laws and regulations further relaxed China’s restriction in promoting FDI with measurements for the limit of foreign shares in joint ventures, profit remittances, labour recruitment and land use. In December 1990, the central government issued “Detailed Rules and Regulations for the Implementation of the People’s Republic of China Concerning Joint Ventures with Chinese and Foreign Investment”, which aimed to encourage joint ventures that could introduce advanced technology, save energy and upgrade productivities.

Affected by Deng Xiaoping’s famous tour to the south of China, the encouragement to foreign capital reached its peak, when the commitments to economic reform and the opening-up policy were demonstrated by him. The market for foreign investors was deregulated. The process of FDI project application was simplified. A number of business sectors were opened to foreign investors including wholesaling and retailing, consultancy services, banking and insurance. The openness of the Pudong Area in Shanghai indicated that China expected to promote its industries with the help of foreign capital, while Hi-tech enterprises, capital-intensive manufacturers and financial companies were encouraged to set up their China operation in Pudong with various preferential treatments from the central and local governments.

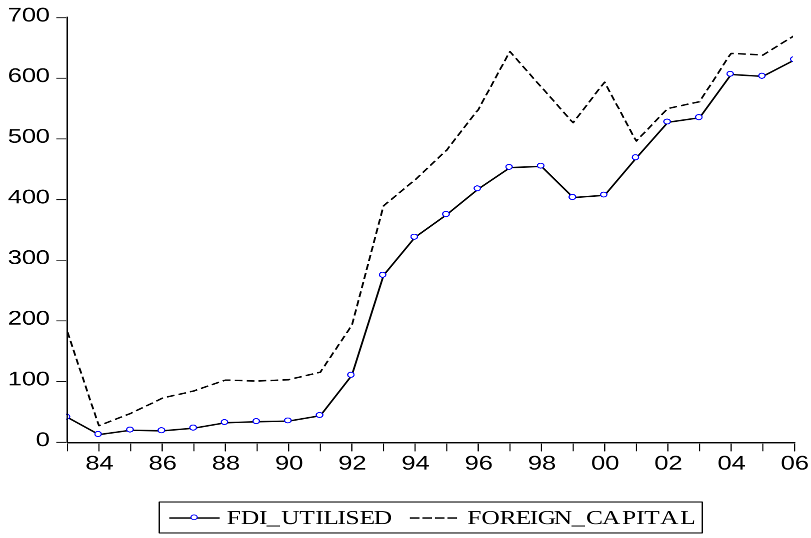
Since 1994, China began to guide FDI to meet its target of economic development. The Provisional Guidelines for Foreign Investment Projects in 1995 categorized the FDI projects into four types: encouraged, restricted, prohibited and permitted. Included in the 'encouraged' projects were those in infrastructure or underdeveloped agriculture; those with advanced technology, or manufacturing new equipment/materials to satisfy market demand; those which were export-oriented. Some projects were classified as 'restricted' such as those with low technologies, and those whose production exceeded domestic demand; and those under experiment or monopolized by the nation, and those engaged in the exploration of rare and valuable mineral resources. The 'prohibited' projects included those that jeopardized national security or harmed the public interest; those damaged the environment, natural resources or human health; those which used sizeable amounts of arable land. Projects that are not in any of the above groups are classified as 'permitted'.

When China joined the World Trade Organization (WTO) in 2001, it began to revise its regulations to meet its commitment of openness, especially in tertiary industry. Massive laws and regulations had been revised to follow rules of WTO for trade and investment during the transitional period ended in 2005. In the financial market, new regulations were applied in 2001 to allowed foreigners to control banks and insurance companies and run local-currency business. In 2004, foreigners were allowed to run business in whole and retails markets. For international trade, China had abolished most restrictions in trade and investment for foreigners by 2005. China's tariff for imports was reduced from an average 23% in 2001 to 9.4% in 2005 (Long (2005)). Quotas for most import productions were relaxed. Accession to the WTO attracted more export-oriented FDI to take advantage of China's lower labour cost, which contributed more and more to China's exports. It provided China with the opportunity to continue its economic reform and reconstruct its legal framework. This, in consequence, improved China's business environment and helped attract more foreign direct investment.

3.2.2. FDI trend and characteristics in China

The trend of actual utilized FDI inflows for the period from 1979 to 2006 is illustrated in Figure 3.1. As we can see, at the initial opening-up period, FDI inflows were quite small varying between US$ 0.17 billion and US$ 0.63 billion from 1979 to 1983. Between 1984 and the early 1990s, FDI increased with a remarkable growth rate of over 30% per annum. However, the total amount of FDI was still small and remained as low as US$ 4.36 billion in 1991. In 1992, a new relaxation of restriction caused by the decision of deepening the economic reform drove the growth of FDI inflows to a new stage. Compared with the value in 1991, The FDI inflow jumped to US$ 11 billion in 1992. The inflow value doubled again to US$ 27.5 billion in 1993, which placed China as the largest FDI host country in the developing world. This rapid growth continued until 1998, when the value reached US$ 45.4 billion. The boom was then interrupted by the Asian financial crisis, which caused FDI to decrease during the years 1999 and 2000. The growth then recovered and accelerated when China joined the World Trade Organization (WTO). In 2001, China's FDI inflows increased from US$ 40.71 billion in 2000 to US$ 46.88 billion with a growth rate 14.7% and in 2002 China became the largest FDI host country in the world with inflows of US$ 50.2 billion. From 2003 to 2006, FDI inflows continued to rise from US$ 53.7 billion to US$ 63.0 billion.

Figure 3.1. *Foreign capital and utilized FDI in China (US$100 million)*



Along with the FDI inflows, we can see the total foreign capital trend for the same period in Figure 3.1. Generally, there are mainly three forms of foreign capital inflow: foreign loans, direct foreign investment and other foreign investment. Between 1979 and 2006, China's actual usage of foreign capital summed to US$ 878.6 billion (see Table 3.1), of which more than two thirds were in the form of FDI. But the share of

FDI in foreign capital was not impressive during the initial stage. Between 1979 and 1983, FDI inflows accounted for only 12% of total actual foreign capital utilization. Between the mid-1980s and the early 1990s, FDI increased its share steadily and accounted for about one third of total foreign capital inflow in 1991. Since 1992, FDI has become the most important source of foreign capital inflow. After 2000, as China stopped accepting loans from overseas, FDI became the dominant component in total foreign capital inflows.

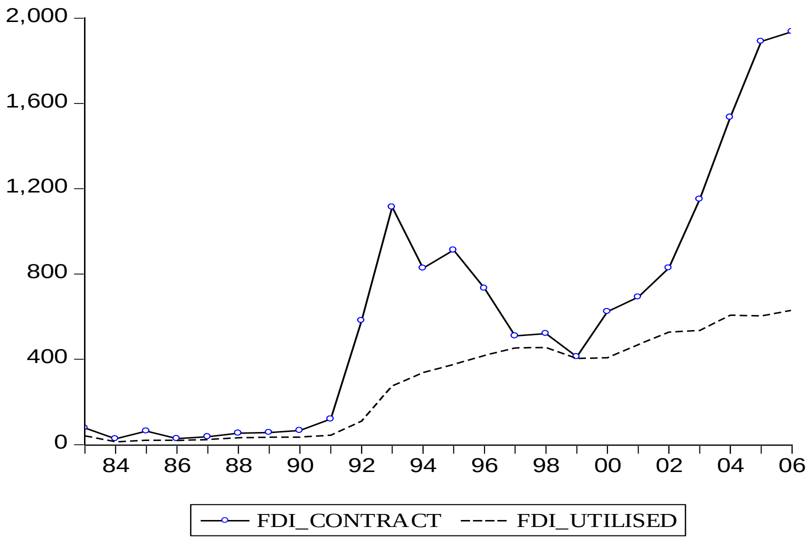
Table 3.1. *Utilization of foreign capital in China (US$ 100 million; unit)*

	Total Foreign Capital			Loans			FDI			
Year	Number of Projects	Contract Values	Utilized Value	Number of Projects	Contract Values	Utilized Value	Number of Projects	Contract Values	Utilized Value	Average investment
1979-8	1471	239.8	181.9	79	150.6	130.4	1392	77.4	41.0	5.6
1984	1894	47.9	27.1	38	19.2	12.9	1856.	26.5	12.6	1.4
1985	3145	102.7	47.6	72	35.3	25.1	3073	63.3	19.6	2.1
1986	1551	117.4	72.6	53	84.1	50.1	1498	28.3	18.7	1.9
1987	2289	121.4	84.5	56	78.2	58.1	2233	37.1	23.1	1.7
1988	6063	160.0	102.3	118	98.1	64.9	5945	53.0	31.9	0.9
1989	5909	114.8	100.6	130	51.9	62.9	5779	56.0	33.9	1.0
1990	7371	120.9	102.9	98	51.0	65.3	7273	66.0	34.9	0.9
1991	13086	195.8	115.5	108	71.6	68.9	12978	119.8	43.7	0.9
1992	48858	694.4	192.0	94	107.0	79.1	48764	581.2	110.1	1.2
1993	83595	1232.7	389.6	158	113.1	111.9	83437	1114.4	275.2	1.3
1994	47646	937.6	432.1	97	106.7	92.7	47549	826.8	337.7	1.7
1995	37184	1032.1	481.3	173	112.9	103.3	37011	912.8	375.2	2.5
1996	24673	816.1	548.1	117	79.6	126.7	24556	732.8	417.3	3.0
1997	21138	610.6	644.1	137	58.7	120.2	21001	510.0	452.6	2.4
1998	19850	632.0	585.6	51	83.9	110.0	19799	521.0	454.6	2.6
1999	17022	520.1	526.6	104	83.6	102.1	16918	412.2	403.2	2.4
2000	22347	711.3	593.6			100.0	22347	623.8	407.2	2.8
2001	26140	719.8	496.7				26140	692.0	468.8	2.6
2002	34171	847.5	550.1				34171	827.7	527.4	2.4
2003	41081	1169.0	561.4				41081	1150.7	535.1	2.8
2004	43664	1565.9	640.7				43664	1534.8	606.3	3.5
2005	44001	1925.93	638.05				44001	1890.65	603.25	
2006	41473	1982.16	670.76				41473	1937.27	630.21	
total	595622	16617.8	8785.71	1683	1385.5	1484.6	593939	14795.52	6863.56	

Source: China Statistical Yearbook

While FDI has increased dramatically in both amount and in its share of total foreign capital utilization, we notice that the trends of contractual and utilized FDI exhibited somewhat different patterns. Table 3.1 shows that contractual FDI, which is the value of FDI in agreement, increased sharply in the early 1990s. In 1993, both the number of projects and the total contractual amount reached their highest levels and declined tremendously thereafter until 1999. The actual utilized FDI, referring to those actually were undertaken, however, has grown more slowly and did not begin to decrease until 1999. After 2000, the gap has a tendency to increase, while contractual FDI reached about US$ 156 billion, and at the same time, utilized FDI flows was only US$ 60 billion.

Figure 3.2. *Contractual value and utilized value of FDI in China (US$ 100 million)*



At the early stage, part of the reason for this divergence is that foreign investors were uncertain about the policy environment during the early years of the reform. The percentage of utilization increased during the second half of 1980s due to improved business environment. Another reason could be that some of the contract FDI projects were actually established by domestic companies to take advantage of tax incentives and other privileges for foreign investors. The fabricated investment of foreign capitals in those projects inflated the contract value from the real FDI.

Likewise in Table 3.1, we can observe that the average size of FDI projects has experienced drastic changes over decades. In the early 1980s, the average size of FDI projects is quite large compared with that of the later years. Between 1979 and 1983, the average size of FDI projects, calculated using the contract amount was about US$5.6 million. The main reason is that during this period of time, a substantial portion of FDI is in the form of joint exploration where large projects were set up between foreign investors and the Chinese government. The average size of FDI projects began to fall in 1984 and continued to do so for most of the 1980s reaching its lowest level of US$ 0.9 million in 1988, and then maintained this level through the early 1990s. Encouraged by the government's promotional policies, large numbers of small firms, especially those from Hong Kong and Taiwan, established labour-intensive manufacturing operations in mainland China during this period, and brought down the average size of total FDI projects (China Investment Yearbook (2006)). The average size of FDI projects began to increase since 1992. Between 1992 and 1995, the average contract amount of FDI projects doubled from US$ 1.2 million to US$ 2.5 million. After 1995, the average size of an FDI project ranged between US$ 2.4 million and US$ 3 million. These latest figures reflect China's new emphasis on attracting capital intensive, high-tech and infrastructure investments. They also reflect the participation of large multinational enterprises (MNEs) from western developed world, particularly in infrastructure investment and other key industrial projects. Large market potential, favourable government policies and low labour cost attracted many large multinational into industries such as telecommunications, automobiles and petrochemicals recently (China Investment Yearbook (2006)).

Table 3.2. *Cumulated FDI in China by top 15 source countries from 1979 to 2006*

	Values (US$100 million)	Percentage (%)
Total	6863.56	100%
HongKong	2795.23	40.73%
Japan	578.02	8.42%
Virgin Islands	570.18	8.31%
United States	539.36	7.86%
Taiwan	430.49	6.27%
South Korea	349.99	5.10%
Singapore	299.94	4.37%
Germany	134.18	1.95%
United Kingdom	132.88	1.94%
Canada	102.70	1.50%
Netherland	77.79	1.13%
France	75.90	1.11%
Macau	67.46	0.98%
Australia	50.35	0.73%
Malaysia	40.94	0.60%

Source: Calculated from the China Statistical Yearbook of various years

When investigating the sources of FDI in China from Table 3.2, we can find that more than half of that were actually from overseas Chinese, especially from Hong Kong and Taiwan. Between 1979 and 2006, FDI from Hong Kong, Taiwan, Singapore and Macau, accounted for more than 50% of total FDI in China (mainland). Hong Kong itself took the first position in investing in China with US$ 279.5 billion investment, with a share of 40.73% of total FDI. Taiwan is another important origination for FDI in China. It contributed about US$ 43.05 billion investment in China and took the fifth place with 6.27% from the various sources. The other two Chinese economies, Singapore and Macau, contributed about 5% of total FDI.

If adding in Japan, South Korea and Malaysia, FDI from East Asian countries reached 66.5% in total. Japan took the second place by invested about US$ 57.8 billion with a share of 8.4% during the whole period; FDI from South Korea amounted to US$ 34.9 billion in total. Although FDI from Western developed countries was only in a minor position, the United States still ranked the forth important source of FDI in China. During 1979 to 2006, the United States invested about US$ 53 billion and accounted for 7.86% of the total amount. Apart from that, other countries from the developed world, like UK, Germany, and France shared about 6% of total investment. However, many MNEs from Western developed countries had a channel by investing in China through their branches in Hong Kong. This kind of FDI actually was categorized to the contribution from Hong Kong rather than their real original countries.

Since most of foreign capitals entered in China in the form of FDI, we could alternatively indicate FDI from registration status of total foreign investment as the status of total foreign investment could reasonably reflect characters of FDI. From Table 3.3, we found that the geographical distribution of foreign investment, as well as FDI, was unbalanced in China, while most of them located in the east coastal area.

At the end of 2006, twelve eastern coastal provinces, including Beijing and Shanghai, located 86.75% of total investment from overseas equivalent to US$ 642.5 billion. On the other hand, 20 inland provinces, whose population makes up almost two thirds of the national total, accounted for about 13.25% of foreign capital inflow.

Table 3.3. *Registration status of foreign funded enterprises in China by region at the year-end 2006 (US$ 100 million; unit)*

Region	Number of Enterprises (unit)	Total Investment (100 mn USD)	Registered Capital (100 mn USD)	Foreign Capital (100 mn USD)
National	274863	17075.6	9465	7406
Coastal 12 provinces	238712	14534	8039	6425
--Major city				
Beijing	12064	697	366	238.3
Tianjin	10753	686	363	268.6
Shanghai	31568	2255	1212	854.3
--Southern coastal provinces				
Fujian	18629	878	1805	442
Guangdong	61999	3143	500	1503
Inland 20 Provinces	36151	2541	1428	980

Sources: Calculated from China Statistical Yearbook

As shown in Table 3.3, southern costal provinces, Guangdong and Fujian registered about 26.26% of total cross-border investment at the end of 2006. Guangdong itself located US$ 150 billion investment from overseas, about 20.29% of total, which made this province the largest reception in China. There are mainly two reasons why Guangdong was so popular for foreign investors. First of all, as discussed earlier, Hong Kong is the most important source for FDI inflow in China. The contiguity between Hong Kong and Guangdong made the region the prior destination for FDI from Hong Kong. Second, Guangdong has the longest history in attracting foreign investment when counting the cumulated FDI. Among the first open area to foreign investment, three of the four SEZs are actually in Guangdong province. At the early stage, this region was the almost the only place permitted to have foreign investments. Meanwhile, its business environment and management were more relevant to foreign investors.

Fujian is another popular location for foreign investors, especially from its neighbour Taiwan. An influx of capital poured in this region during the 1990s when Taiwan's restriction of outward investment to mainland China was relaxed. At the end of 2006, total foreign investment in Fujian made up about 6% of all. During the 1990s, more investment moved up north along the coast to some major cities, especially Shanghai. This city registered about US$ 85.4 billion foreign investment by the end of 2006, which made it the second largest reception in China. Recently, the Chinese government is working to attract more FDI to the inland provinces by offering more preferential treatments.

As indicated in Appendix A3.3, investment in the manufacturing sector (or the industrial sector) dominated the composition of foreign capital measured in both the number of enterprises and the value of investment. At the end of 1991, the investment in the industrial sector (or manufacturing sector after 1996) took about 80% of the number of total foreign-invested enterprises and 72% of total investment value of

FIEs. Investment in manufacturing sectors rose dramatically both in numbers and in values in the first half of the 1990s, but the shares in total foreign-funded enterprises dropped to 70% in numbers and 55% in values respectively at the end of 1995. In the second half of the 1990s, the number of enterprises in the manufacturing sector decreased along with total number of FIEs, while the value of investment in manufacturing industry increased. After 2000, the number of foreign invested enterprises (FIEs) in the manufacturing sector increased with the total number of FIEs, its share in total foreign capital rose slightly to 60% at the end of 2006. Meanwhile, the speed of the growth in the value of investment exceeded that in total foreign capital and consequently boosted its share in the total to about 60% at the end of 2006. This characteristic of FIEs in China may suggest that FDI played a very important role in economic development and industry upgrading. As UNCTAD (1992) reported, FDI in the manufacturing sector is always seen as a benefit for host countries as it is expected to increase productivity, accelerate the industrialization process and upgrade the technology level in host countries. In addition, FDI in manufacturing sector can improve human capital quality through training and learning by doing.

The second most important sector for FIEs is the real estate related sector. Between 1991 and 1995, the share of the sector of “Real estate, public residential and consultancy services” increased from 5.5% to 12.8% by number of establishment and from 18.8% to 29.4% in terms of total investment. Between 1996 and 2000, the share of “real estate management” ranged between 5.9% and 6.3% in number of firms. Its share in the total amount of investment had, however, decreased slightly from 21% to about 18%[2]. After 2000, the share of “real estate management” in number of firms increased to 8% in 2004, but returned to about 5% at the end of 2006. The share in value of investment shrank slightly from 16% in 2001 to about 13% in 2006 despite of the increase of its actual value. Beside these two main sectors, investments in the transportation sector, particular in telecommunications, all increased their share in total FDI, where it rose from 1.6% in 1991 to 5.3% in 2006. Investments in electricity, gas and water production and supply, were relatively stable around 5% for the whole period.

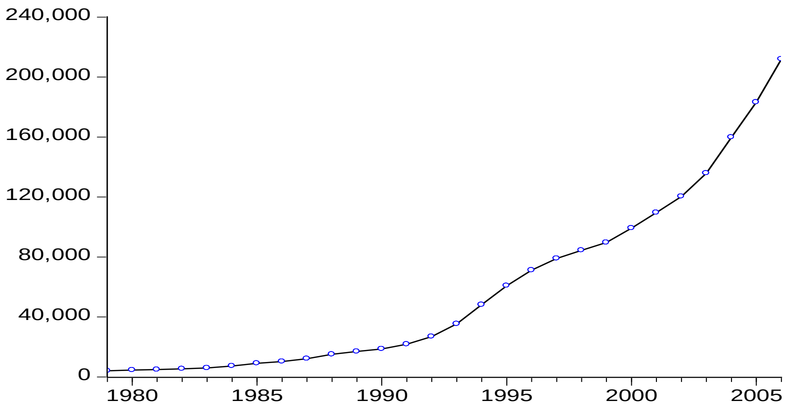
Generally, the consistent policy of attracting FDI successfully induced foreign investors to participate in the Chinese economy. Both the Chinese government and foreign investors were cautious and patient about this process. They witnessed the small stream at the initial stage and the large influx thereafter. Investment from newly industrialized economies in the neighbouring region has played a dominant role during their processes of industrialisation. These investments are mostly concentrated in the southeast provinces of Guangdong and Fujian, where numerous FIEs ran labour-intensive operations to save costs. As China is working to upgrade its economy to capital-intensive, investment from Western industrial countries is becoming more welcomed as they are always be expected to introduce new technology to accelerate the industry upgrading process. Therefore, the manufacturing sector with high-technology was the most expected and encouraged field for foreign investments.

Foreign investors also participated notably in other areas, like infrastructure and energy supply.

3.2.3. The influence of FDI on economic development in China.

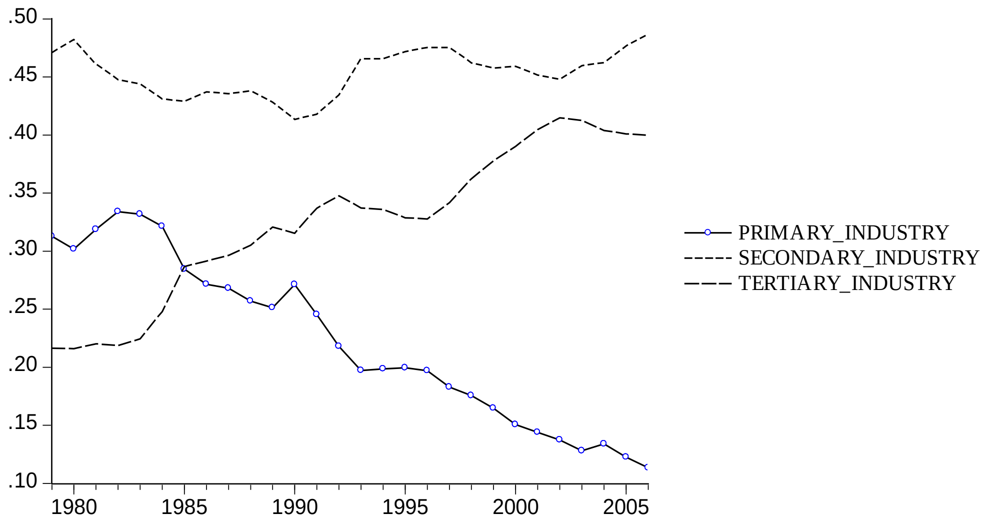
During the last 30 years, China has successfully transformed its economy from a typically Soviet planning-determined system to a market-oriented system and become one of the fastest growing economies of the world. Its output boomed from RMB 406.2 billion in 1979 to RMB 21192.3 billion at the end of 2006 (see Figure 3.3), with an average annual growth rate of 9%. Output per capita rose from RMB 419 in 1979 to RMB 16165 in 2006 at an annual growth rate of about 8% (Appendix A3.4).

Figure 3.3. *Gross Domestic Products in China (RMB 100 million)*



Meanwhile, the development of industrialization could be interpreted by the change in the composition of output. Highlighted by Figure 3.4, the secondary industry, which included the manufacturing sector, contributed most to output with about 48%. During the 1990s, its share declined slightly due to the rapid growth of the tertiary industry, which increased its share from 21% in 1979 to 40% at the end of 2006. The percentage of the primary industry, including agriculture and fishing, declined from 31% in 1979 to 11.3% in 2006. This change demonstrated the upgrading of Chinese industry. It would be expected that FDI played a major role in this process of economic development mainly through compensating domestic capital formation, promoting productivity and stimulating exports.

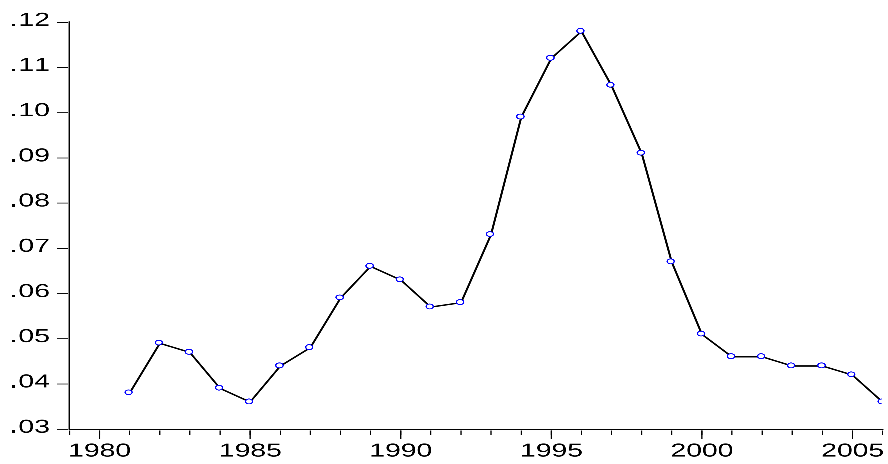
Figure3.4. *Percentage composition of output of China*



FDI and investment in fixed assets

One direct influence of foreign investment is that it did form an important part of capital accumulation. Figure 3.5 indicates that foreign investment has been an important element of China's total investment in fixed assets since the start of the economic reform. In the early 1980s, foreign investment made up less than 5% of total fixed assets investment. In the late 1980s and early 1990s, the share increased slightly and fluctuated around 6%. The share of foreign investment in total fixed assets investment reached its highest level of over 10% in the mid of the 1990s when FDI accelerated its flow into China. Affected by the Asian financial crisis, investment in fixed assets from foreign sources decreased continuously both in value and by share until 2001, when access to WTO increased the confidence of foreigners and initialized a new tide of investment in China. Despite the increase in value, its share in total fixed investment slightly dropped from 4.6 in 2001 to 3.6% in 2006.

Figure 3.5. *Share of investment from FIEs in fixed investment in China*



FDI and employment opportunities

As in most developing countries with abundant labour supply, FDI created employment opportunities either directly through FIEs or indirectly through suppliers in China. According to a report from the OECD (2000), total employment in FIEs increased significantly from 4.8 million (0.74% of total employment) in 1991 to 18.38 million (2.64% of China's total employment) in 1999. And the China Investment Report (2006) suggested that FIEs employed about 28 million employees in China, about 3.6% of total labour force, by the end of 2006. In urban areas, its percentage growth were higher with 1.65 million workers (0.97% of China's urban employment) in 1991 and 5.87 million (2.84%) in 1998. This also suggests that FDI absorbed millions of the labour forces released by the primary industry during the industrialization progress. Most people employed by FIEs were located in rural areas. FIEs are particularly important employers in the east coast regions (Tseng and Zebregs (2002)) and had over 6% of urban employment in the eastern region in 1998. They only contributed 1.14% to the central region and 0.63% to the western region in that year. This would suggest that FDI might have widened the regional income gap between the east coastal area and the west inland in China.

FDI and transfer of advanced technology

Getting access to modern technology is one of the most important reasons why China wished to attract foreign investment. As discussed before, the Chinese government continually encouraged high technology FDI to accelerate its industrialization progress. Generally FDI can promote the advanced technology capability of host countries through two channels. MNEs can introduce advanced technologies directly to their subsidiaries or indirectly through spillover effects to local firms. In China, initially, FIEs, especially from Hong Kong and Taiwan, were concentrated more in the labour-intensive, and export-oriented industries with relative low technological content, such as the garment industry. At this stage, MNEs regarded China as a place to digest out-dated technologies. Hence, the effect of technology transfer was limited (Chen *et al.* (1995)) either directly or indirectly. But as market competition intensified in China, many foreign firms have increasingly adopted new technologies to maintain their market shares (Long (2005)). A survey study by Jiang (2004) demonstrated this tendency. From Table 3.4, we observe that only 13% of FIEs in the survey introduced advanced technology in China in 1997 (technology at the same level as employed by their parent companies), while 54% adopted relatively new technology, which is one lagged by two or three years behind that of their parent companies. Outdated technology was found in 33% cases that the parent companies would like to discard. In 2002, FIEs with advanced technology reached 60%. The other 40% employed relative new technology; no company introduced outdated technology into China.

Table3.4. *Technological level of FIEs in China (percentage)*

	1997	2002
Technology at the same level as their parent company	13%	60%
Technology lagged 2-3 years behind their parent company	54%	40%
Technology that their parent company has washed out	33%	0

Source: Jiang (2004)

The number of patents registered by MNEs in China provided more evidence of technology transfer, which has been rising rapidly since the early 1990s, by an average annual growth rate of 30%, according to China Statistical Yearbook (2006). More recently, MNEs , especially from the developed world, see China as a new focus of their global strategy and have put more emphasis on the localization of their research and development (R&D) capacities. According to UNCTAD (2004), by the end of 2002, MNEs established more than 400 R&D centres in China. Most of them are located in Beijing, Shanghai and Guangzhou.

Another channel for FDI to stimulate technology in China is through spillovers. The spillover effects of technology transfer were mainly though training local staff and learning-by-doing by local firms. Local suppliers can get technology assistance when FIEs need them to meet the new technology requirement. Domestic partners of the FIEs can learn new technology in co-operation with MNEs. This indirect effect can be found in some industries, especially in the electricity industry and telecommunication industry where domestic competitors have now caught up with the FIEs who used to dominated the markets. In relation to the human capital sector, Long (2005) found that 85.4% of 442 FIEs engaged in the processing trade have trained their employees in China, 21.3% trained their staff abroad, and only 8.9% did not train their employees.

FDI and the economic reform

Foreign investors, in the last two decades, have witnessed and been involving in the transformation of the Chinese economy from a centralized planning system to an open market-oriented framework. During this transformation, Table 3.5 shows that the output of FIEs in the total industrial sector expanded more than twenty times from RMB 44.8 billion in 1990 to RMB 1007.6 billion in 2006. The percentage share in total industrial output increased significantly from 2% in 1990 to 31.6 % in 2006. The industrial value-added output by FIEs grew consistently from RMB 228 billion in 1995 to RMB 2554.6 billion in 2006. Its growth rate exceeded the growth of total industrial value-added output, thereby boosting its share from 15% to 28%. Although the value-added output by state-owned enterprises (SOEs) kept growing throughout, its share in the total declined from 54% in 1995 to 35.8% in 2006.

Table 3.5. *Contribution to industrial output and industrial value-added by FIEs of China (Value: RMB 100 million; share: percentage)*

Year	**Industrial outputs**			**Industrial value-added output**						
	Total	FIEs		Total	SOEs*		Collectives		FIEs	
	Value	Value	Share	Value	Value	Share	Value	Share	Value	Share
1990	19701.04	448.95	2.28%							
1991	23135.56	1223.32	5.29%							
1992	29149.25	2065.59	7.09%							
1993	40513.68	3704.35	9.14%							
1994	76867.25	8649.39	11.25%							
1995	91963.28	13154.16	14.30%	15446.12	8307.19	53.78%	3866.25	25.03%	2281.77	14.77%
1996	99595.55	15077.53	15.14%	18026.11	8742.42	48.50%	5162.95	28.64%	2853.58	15.83%
1997	56149.70	10427.00	18.57%	19835.18	9192.93	46.35%	5255.7	26.50%	3541.7	17.86%
1998	58195.23	14162.00	24.34%	19421.93	11076.9	57.03%	3302.21	17.00%	4055.06	20.88%
1999	63775.24	17696.00	27.75%	21564.74	12132.41	56.26%	1617.93	7.50%	4850.92	22.49%
2000	73964.94	23145.59	31.29%	25394.8	13777.68	54.25%	3071.58	12.10%	6090.35	23.98%
2001	94751.78	26515.66	27.98%	28329.4	14652.1	51.72%	2615.5	9.23%	7128.1	25.16%
2002	101119.87	33771.09	33.40%	32994.8	15935	48.30%	2552.5	7.74%	8573.1	25.98%
2003	128306.1	46019.55	35.87%	41990.2	18837.6	44.86%	2551.7	6.08%	11599.6	27.62%
2004	187220.6	58847.08	31.43%	54805.1	23213	42.36%	2877.4	5.25%	15240.5	27.81%
2005	249625.0	78399.40	31.41%	72186.99	27176.67	37.65%			20468.2	28.35%
2006	316588.9	100076.5	31.61%	91075.73	32588.81	35.78%			25545.8	28.05%

Note: 1.* SOEs include enterprises with controlling share hold by the state since 1998.

2. Non-state-owned industrial enterprises above designated size are those with annual revenue from principal business over 5 million RMB.

Source: China Statistical Yearbook

FDI and international trade

Participating in the international production process, and driving economic growth through exports, is one of the main components of the opening-up policy of China. Consequently, we can observe tremendous expansion of international trade by China. During the last 30 years, China's total external trade increased from US$ 38 billion in 1980 to more than US$ 1760.4 billion in 2006 (see Table 3.6). In 1980, China's exports and imports accounted for 0.9% and 1% of world total, respectively. In 2000, the figures rose to 3.9% and 3.5% of world trade. And globalization penetrated deeply into Chinese economy through international trade and investment. In 1980, the ratios of exports and imports in GDP were 6.0% and 6.6%, respectively. In 2006, the ratios rose to 38.2% and 30.7%.

China's expansion in trade can probably be attributed mostly to foreign investment. The data in Table 3.6 indicate that the contribution of foreign invested enterprises (FIEs) to external trade has been increasing rapidly since the early 1980s, especially in the 1990s. Between 1980 and 1985, trade by FIEs accounted for less than 0.6% of total exports and 2.1% of total imports. The shares increased to 7.3% and 12.8%, respectively, in the second half of the 1980s. In the 1990s, trade by FIEs accelerated and shares in total trade were enlarged to 31% of exports and 47% of imports for the years between 1991 and 1995, and further to 57% both exports and imports at the end of 2004. In 2006, the contribution of FIEs to international trade rose to 81.7% of total exports and 59.7% of total imports. The participation of FIEs in international trade may suggest that much FDI is motivated by saving production costs and may not be attracted by the market demand in China. Their products have to be traded back to their "own" market to sell, which enhance exports of China. According to China Investment Yearbook (2006), this kind of processing trade reached US$ 705.5 billion in 2006, and accounted for 68% of external trade by FIEs.

Table3.6. *International trade in goods by total and foreign funded enterprises in China*

Year	Total Trade		Trade by Foreign Funded Enterprises			
	Export Value (US$ 1 billion)	Import Value (US$ 1 billion)	Export		Import	
			Value (US$ 1 bn)	%	Value (US$ 1 bn)	%
1980	18.27	19.55	0.01	0.05%	0.03	0.15%
1981	20.89	19.48	0.03	0.14%	0.11	0.56%
1982	21.82	17.48	0.05	0.23%	0.28	1.60%
1983	22.2	18.53	0.33	1.49%	0.29	1.57%
1984	24.4	25.36	0.07	0.29%	0.4	1.58%
1985	27.35	42.25	0.3	1.10%	2.06	4.88%
1986	30.94	42.91	0.58	1.87%	2.43	5.66%
1987	39.44	43.21	1.21	3.07%	3.12	7.22%
1988	47.54	55.25	2.46	5.17%	5.75	10.41%
1989	52.54	59.14	4.91	9.35%	8.8	14.88%
1990	62.09	53.35	7.81	12.58%	12.31	23.07%
1991	71.91	63.79	12.05	16.76%	16.91	26.51%
1992	84.94	80.59	17.36	20.44%	26.37	32.72%
1993	91.74	103.96	25.24	27.51%	41.83	40.24%
1994	121.01	115.61	34.71	28.68%	52.93	45.78%
1995	148.78	132.08	46.88	31.51%	62.94	47.65%
1996	151.05	138.83	61.51	40.72%	75.6	54.46%
1997	182.79	142.37	74.9	40.98%	77.72	54.59%
1998	183.71	140.24	80.96	44.07%	76.72	54.71%
1999	194.93	165.7	88.63	45.47%	85.88	51.83%
2000	249.2	225.09	119.44	47.93%	117.27	52.10%
2001	266.1	243.55	133.21	50.06%	125.84	51.67%
2002	325.6	295.17	169.99	52.21%	160.25	54.29%
2003	438.23	412.76	240.31	54.84%	231.86	56.17%
2004	593.32	561.23	338.61	57.07%	324.57	57.83%
2005	761.95	659.95	444.18	86.61%	387.46	58.71%
2006	968.94	791.46	563.78	81.68%	472.49	59.70%

Source: China Statistical Yearbook

Above all, FDI has been deeply involved in the process of economic development in China and has become an important element in its economy. It has remarkable influence on capital formation, technology transfer and particularly on international trade; it also contributed to industrial modernization and economic transformation. Hence, the evaluation of the relationship between FDI and economic growth becomes important for those pursuing sustainable economic growth, as well as seeking to 'benefit' from international integration through trade and investment.

3.3. Econometric methodology approach

In recent years, vector autoregressive methods have become the favourable vehicle for empirical macro-econometrics. Despite having roots in the analysis of stationary data, their popularity is attributed to the theoretical developments in the analysis of non-stationary data exhibited by many economic time series. In particular, Johansen (1988), and Johansen and Juselius (1992) have developed multivariate methods that explicitly employ the VAR for the estimation of cointegration (or 'long-run' relationships) among non-stationary variables. As a tool for analysis, the VAR is tractable and can be interpreted as the reduced-form expression of a large class of dynamic structural models (see Hamilton (1994)). As such, it provides a useful framework for the investigation of both long-run (cointegration) relationships and short run dynamics (via an error-correction model) of the variables in the system. Furthermore, the VAR facilitates the dynamic simulation of variables within the system following a shock using impulse response analysis (Sims (1980), Lütkepohl and Reimers (1992)).

Given the familiarity of VAR methods, we merely give a broad outline here. The statistical analysis takes place in a VAR (p) model,

$$Y_t = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_p Y_{t-p} + BX_t + \varepsilon_t \qquad (3.1)$$

where Y_t is a ($m\times 1$) vector of jointly determined I(1) variables, X_t is a (q $\times$1) vector of deterministic variables. p is the lag of Y_t in the estimation. Each Φ_i (i = 1, …, p) are ($m\times m$) matrix of coefficients, and B is ($m\times q$) matrix, t = 1, …, T. ε_t is a ($m\times 1$) vector of disturbances with zero mean and non-diagonal covariance matrix Σ.

If each variable in Y_t is integrated with order one I(1) and cointegrated with others, equation (3.1) then can be expressed in an error-correction model (ECM) that is observationally equivalent with the original VAR. But the new form facilitates estimation and hypothesis. This representation is given by:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \ldots + BX_t + \varepsilon_t \qquad (3.2)$$

In the ECM model, attention focuses on the ($n\times r$) matrix of cointegrating vectors β, which quantify the 'long-run' relationships between variables in the system, and the ($n\times r$) matrix of error-correction adjustment coefficients α, which load deviations from the equilibrium (*i.e.* $\beta' Y_{t-k}$) to ΔY_t for correction. The Γ_i coefficients in (3.2) estimate the short-run effects of shocks on ΔY_t , and therefore allow the short-run and long-run responses to differ.

3.3.1. Estimation of VAR

Before we estimate a VAR system, all variable have to be tested to see if they are stationary and ensure that all variables that enter the VAR system are all integrated at the same order. The most popular stationary test is the Augmented Dickey-Fuller test (see Dickey and Fuller (1979), and Davidson and. MacKinnon (1993)), when the series y_t is estimated by:

$$\Delta y_t = c_0 + bt + cy_{t-1} + c_1 \Delta y_{t-1} + c_2 \Delta y_{t-2} + \ldots + c_p \Delta y_{t-p} + e_t \qquad (3.3)$$

where b, c_0, c, c_1, c_2, … , c_p are coefficients, e_t is residual term. The null hypothesis is H_0: c=0; and rejection of the null hypothesis suggests the series is stationary.

Another test for unit roots is the KPSS test (Kwiatkowski *et al*. (1992)). In this test the series is assumed to be (trend) stationary under the null. The KPSS statistic is based on the residuals from the OLS regression of the series y_t on the exogenous variables x_t :

$$y_t = x'_t z + w_t \qquad (3.4)$$

where z is coefficient and w_t is the residual term.

The LM statistic is defined as:

$$LM = \sum_t (V(t)^2)/(T^2 m_0) \qquad (3.5)$$

where $t=1,2, \ldots, T$; m_0 is an estimator of the residual spectrum at frequency zero and $V(t)$ is a cumulative residual function:

$$V(t) = \sum_{j=1}^{t} \hat{w}_j \qquad (3.6)$$

based on the residuals $\hat{w}_t = y_t - x'_t \hat{z}(0)$. To run the KPSS test, the set of exogenous regressors x_t and a method for estimating m_0 must be specified, for example, by a Kernel Sum-of-Covariances Estimation (see Andrews (1991)).

Another important condition for a valid VAR is that the system must be mathematically stable, which requires all the roots of the companion matrix to be less than one in absolute value. This requirement ensures that the system will always return to its long-run equilibrium regardless of any shock caused by a disturbance, which is an important reference for choosing lags in the system. Under this condition, several criteria can be taken into consideration for appropriate lags. The main method is the sequential modified likelihood ratio (LR) test from the maximum lags. Akaike information criterion (AIC) and Schwarz information criterion (SC) also can be used to test lag orders (see Lütkepohl (1991)).

A valid VAR model also requires its residuals to be white noise, which means residuals must follow a normal distribution with no autocorrelation, no Heteroskedasticity, and no ARCH. Accordingly, relative tests are needed to evaluate residuals. The multivariate Lagrange-Multiplier test is usually implemented for examining high order serial correlation among residuals. The test statistic for lag order is computed by running an auxiliary regression of the residuals on the original right-hand regressors and the lagged residual, where the missing first values of are filled with zeros (See Johansen(1995)) for the formula of the LM statistic. Under the null hypothesis of no serial correlation of order, the LM statistic is asymptotically distributed with k^2 degrees of freedom, where k is the number of variables in the original equation.

In another word, it tests the null hypothesis H_0: $\hat{p}_1 = \hat{p}_2 = \hat{p}_3 = \cdots = \hat{p}_q = 0$, follows a $\chi^2(k^2)$ distribution on a regression:

$$\hat{u}_t = \sum_{i=1}^{k} y_t \eta_i + \sum_{j=1}^{q} \hat{u}_{t-j} p_j + \varsigma_t \tag{3.7}$$

where $\hat{u}_t$ are residuals from the estimated model; y_t are variables in VAR; η_i and p_j are coefficients; k is the number of variables in the original VAR; q is lag order of residuals in test; ς_t is an error term that follows normal distribution.

The White test can be applied to test Heteroskedasticity of residuals, which requires estimating the squared residuals on all variables, their squares and their cross products. Any significant coefficients on this regression will indicate Heteroskedastic residuals. Normal distribution of residuals can be test by the Jarque-Bera (J_B) statistic. This statistic has a Chi-squared distribution and measures skewness and kurtosis of the residuals. Chow tests, including Breakpoint Chow and Forecast Chow, are implemented to test any structural change with respect to the VAR.

If all the variables are integrated of $I(1)$, it is possible that their combination is stationary, (Engle and Granger (1987)). If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is so called the cointegrating equation and can be interpreted as a long-run equilibrium relationship among the variables. The purpose of the cointegration test is to determine whether groups of non-stationary series are cointegrated or not. As explained below, the presence of a cointegrating relation forms the basis of the ECM specification. The main methodology of cointegration tests is developed by Johansen (1991, 1995).

Recall the structural VAR from (3.1) and its transformation (3.2), we have new expression for ΔY_t:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \ldots + BX_t + \varepsilon_t \qquad (3.8)$$

where $\Pi = \alpha\beta'$.

Given by Johansen and Juselius (1990), Trace statistics and Maximum eigenvalue statistics therefore can be calculated from the eigenvalues of the coefficient matrix Π of Y_{t-1},

Trace statistic is given by:

$$LR_{tr}(r \mid k) = -T \sum_{i=1}^{k} \log(1 - \lambda_i) \qquad (3.9)$$

Maximum statistic is given by:

$$LR_{max}(r \mid r+1) = -T \log(1 - \lambda_{r+1}) = LR_{tr}(r|k) - LR_{tr}(r+1 \mid k) \qquad (3.10)$$

for r= 0, 1, k–1; T is the number of observations; k is the number of endogenous variables and λ_i is the i^{th} largest estimated eigenvalue of long-run coefficient matrix.

The null hypothesis of the Trace statistics is that there are at most r cointegrating vectors while the alternative is that there are more than r cointegrating vectors, and the maximum eigenvalue statistics test the null that there are r coingegrating vectors against the alternative that there are r +1 cointegration relationship.

But the hypothesis is based on as many as five assumptions for different cases of deterministic trend. Then, the major problem when applying the Johansen test for cointegration is to determine where the trend is in the cointegration relationship. Johansen (1995) listed the five assumptions below and developed a likelihood ratio test for determining the trend.

1. The level data have no deterministic trends and the cointegrating equations do not have intercepts:

   $H_1(r)$: $\Pi y_{t-1}+Bx_t = \alpha\beta' y_{t-1}$ (3.11)

2. The level data have no deterministic trends and the cointegrating equations have intercepts:

   $H_2(r)$: $\Pi y_{t-1} +Bx_t =\alpha (\beta' y_{t-1}+\rho_0)$ (3.12)

3. The level data have linear trends but the cointegrating equations have only intercepts:

   $H_3(r)$: $\Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0)+ \alpha_\perp \gamma_0$ (3.13)

4. The level data and the cointegrating equations have linear trends:

$$H_4(r): \quad \Pi y_{t-1} + Bx_t = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0 \qquad (3.14)$$

5. The level data have quadratic trends and the cointegrating equations have linear trends:

$$H_5(r): \quad \Pi y_{t-1} + Bx_t + = \alpha(\beta' y_{t-1} + \rho_0 + \rho_1 t) + \alpha_\perp \gamma_0 + \gamma_1 t \qquad (3.15)$$

Whether the intercept only exists in the cointegrating equations (assumption 2) against an unrestricted drift (assumption 3), is based on a log-likelihood restriction test. It requires both two types of models to be estimated in order to calculate the eigenvalues (λ_{2i} and λ_{3i}) from the long-run coefficient matrices Π_2 and Π_3.

Then, the statistic

$$LN = -T \sum_{i=1+r}^{k} \ln[(1 - \lambda_{2i}) / (1 - \lambda_{3i})] \qquad (3.16)$$

follows an asymptotical χ^2 distribution with (k-r) degree of freedom if the restriction is valid. A similar test can be carried out to determine whether there are linear trends in the cointegration vector (assumption 4 against assumption 3), where the log likelihood statistic:

$$LR = -T \sum_{i=1}^{r} \ln[(1 - \lambda_{4i}) / (1 - \lambda_{3i})] \qquad (3.17)$$

also follows a χ^2 distribution with the null hypothesis of no linear trend existing in the cointegrating vector.

Once the number of cointegrated vectors is found, as $\Pi = \alpha\beta'$, the coefficient matrix of long-run relationship β' could be identified by adding restrictions based on both theoretical and empirical considerations. For each particular β', the adjustment coefficient α also could be specified. Whether restrictions added to β' or α are consistent with data can be tested by likelihood ratio test as the asymptotic distributions for hypotheses on either β' or α turn out to be χ^2 distributions (see Johansen (1995)).

3.3.2. Impulse response

Given the inter-relationships in economic systems, it is often more informative to undertake an impulse response analysis when short-run and long-run impacts are of key interest. As total derivatives, the coefficients of the impulse response function do not suffer from the *ceteris paribus* limitation that can confound the interpretation of (3.2) (Lütkepohl and Reimers (1992)). In cases where variables are interrelated, a shock to one variable may set off a chain reaction of knock-on and feedback effects as it permeates through the system. In such circumstances the partial derivatives of equation (3.2), which ignore these interactions by construction, may have limited appeal and may give a misleading impression of the short-run and long-run effects of such shocks. By contrast, impulse response analysis estimates the net effect of the direct and indirect effects of a shock, not only in the long-run but at all periods following the shock.

Consider the simplified VAR from equation (3.1):

$$Y_t = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_p Y_{t-p} + \varepsilon_t \qquad (3.18)$$

where Y_t is a $(m \times 1)$ vector of jointly determined I(1) variables; p is the lag of Y_t in the estimation; each Φ_i ($i = 1,\ldots, p$) are $(m \times m)$ matrix of coefficients, $t = 1, \ldots T$; ε_t is a $(m \times 1)$ vector of disturbances with zero mean and non-diagonal covariance matrix Σ.

The VAR then can be written as a vector moving average (VMA) by the moving average representation ε_t as:

$$Y_t = \varepsilon_t + A_1 \varepsilon_{t-1} + A_2 \varepsilon_{t-2} + A_2 \varepsilon_{t-2} + \ldots\ldots = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i} \qquad (3.19)$$

Where the $(m \times m)$ coefficient matrices A_i can be obtained according to:

$$A_i = \Phi_1 A_{i-1} + \Phi_2 A_{i-2} + \Phi_3 A_{i-3} + \ldots\ldots + \Phi_p A_{i-p} \qquad (3.20)$$

with $A_0 = I_m$, and $A_i = 0$ for $i < 0$.

If the innovations are contemporaneously uncorrelated, the interpretation of the impulse response is straightforward. The i^{th} innovation is simply a shock to the i^{th} endogenous variable. Innovations, however, are usually correlated, and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation to the innovations so that they become uncorrelated. This transformation is so called the Cholesky decomposition. In this case, we decompose the residual covariance matrix Σ into a lower triangular matrix and its transpose:

$$\Sigma = PP^T \qquad (3.21)$$

where $EP = Z^{\frac{1}{2}}$

As E is a lower triangular matrix with 1 along the principal diagonal and Z is a unique diagonal matrix where its (j, j) element is the standard deviation of residual j, we have uncorrelated residuals

$$\sigma_t = P^{-1}\, \varepsilon_t \qquad (3.22)$$

Substitute (3.22) into equation (3.19), we have

$$Y_t = P\ \sigma_t + A_1 P\ \sigma_{t-1} + A_2 P\ \sigma_{t-2} + \ldots + A_q P\ \sigma_{t-q} + \ldots = \sum_{i=0}^{\infty} A_i P\ \sigma_{t-i} \qquad (3.23)$$

Thus, the impulse response is the effect of one standard error shock to the j^{th} equation at time t on Y_{t+n} given by

$$H_j^g(\mathrm{n}) = A_n\, P\ \sigma_j \qquad (3.24)$$

Where σ_j is an $m\times 1$ selection vector that identifies the source of the shock (hence unity is its j^{th} element with zeros elsewhere).

However, the Cholesky decomposition imposes an ordering of the variables in the VAR and provides responses that depend upon this ordering. Responses can change dramatically if the ordering of the variables is changed. Pesaran and Shin (1998) constructed an orthogonal set of innovations, so called generalized impulse responses, that does not depend on the VAR ordering. The generalized impulse responses from an innovation to the j-th variable are derived by applying a variable specific Cholesky factor computed with the j-th variable at the top of the Cholesky ordering.

3.3.3. Variance decomposition

While impulse response functions tracing the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR. With the moving average representation used by impulse response analysis in equation (3.14) and equation (3.18), we have:

$$Y_{t+n} = c + \sum_{i=0}^{\infty} A_i \varepsilon_{t+n-i} = c + \sum_{i=0}^{\infty} A_i P \, \sigma_{t+n-i} \qquad (3.25)$$

By introducing $B_i = A_i P$, we rewrite the equation 3.25 as:

$$Y_{t+n} = c + \sum_{i=0}^{\infty} B_i \sigma_{t+n-i} \qquad (3.26)$$

The n-period forecast error is equal to the difference between the realization of Y_t and its conditional expectation after n time:

$$Y_{t+n} - E_t(Y_{t+n}) = \sum_{i=0}^{n-1} B_i \sigma_{t+n-I} \qquad (3.27)$$

The variance of the n-step ahead forecast error $\rho^2_{yt}(n)$, for each variable in the vector $Y_t = (Y_{1t}, Y_{2t}, \ldots, Y_{nt})'$ is equal to:

$$\rho^2_{y_t}(n) = \rho^2_{y_{1t}}\left[\sum_{i=0}^{n-1} B_i^2\right] + \rho^2_{y_{2t}}\left[\sum_{i=0}^{n-1} B_i^2\right] + \cdots + \rho^2_{y_{nt}}\left[\sum_{i=0}^{n-1} B_i^2\right] \qquad (3.28)$$

It is possible to decompose the variance of the forecast error and isolate the different shocks, especially we can separate the different proportions of the variance due to shocks in the sequence $\{\sigma_{t+n-i}\}$.

3.4. Model specifications and empirical results

The framework in this chapter follows the work by UNCTAD (1992), and Bende-Nabende *et al.* (2003). As indicated by the new endogenous growth theory, from the supply side, output is considered to be determined by physical capital, improvement of technology, labour quality and quantity. The new growth theory also considers the international trade as a stimulus factor for economic growth in the host country. Hence, it is hypothesised that output is affected by FDI and spillovers like: capital formation, employment, labour quality, international trade and technology transfer. Thus, the output is to be estimated as a function combining these variables and it is expected to exhibit positive correlations with these variables.

In the VAR model, as all variables are treated as endogenous, we would try to explain the direct and indirect relationships between output, FDI and spillovers. Other impacts which are usually treated as exogenous in the production function, such as interest rate, exchange rate and instruments of government policies, are not considered at this stage.

The main difficulty faced by the VAR analysis in economic growth is that the degree of freedom is restricted by the small sample size, as observations may be probably new and not available for previous time. Recalling from the previous content, the involvement of FDI in the Chinese economy is started from 1979. If only considering their impacts afterwards, there are as only as 27 annual observations for each variable until 2006. To tackle this problem, it is necessary to enhance the sample by including previous time into observation when only FDI variable was absent in the economy. Though the previous economy is considered different from the latter, the consistency of the system could still be achieved by adding a dummy variable to capture the opening process in China after 1979 if it exists. By adding previous time series from the year of 1979 to 1970 into the sample, enough observations then could be obtained to estimate the VAR.

3.4.1. Definitions and measurements of variables

The definitions and measurements of all our variables are discussed in the following paragraph:

Output (GDP): real Gross Domestic Production would be introduced to capture the total output of economic activities in China. From the other side, this variable is used as the income level, which is considered as the main resource of technology development, human capital improvement. Also MNEs would consider this variable to measure the potential market size when decide their FDI location, especially those who target to enhance their market share in the host country.

Employment (EM)**:** Annual average employment is considered to measure the labour force participating in economic activities. Employment increases personal income which may lead to higher consumption and hence demand, generating skills in the process of learning by doing, and improvement of the diffusion of technology which promotes productivity. Hence, we consider it as a stimulus of output.

Human capital (HK)**:** the school enrolment ratio is usually considered to measure the stock of human capital. We estimate this variable as the ratio of enrolment students in secondary education of the population in appropriate age cohort. The latter variable is calculated as multiplication of total population and birth rate of the relative year. The implicated assumption is that the secondary school education would provide people essential capability to grasp new skills and knowledge required in work. Therefore, more percentage of people involve in secondary school indicates higher accumulation of human skills in the future, which would lead to higher productivity, hence results in stimulating economic growth.

International openness (OPEN): this variable is measured as total annual imports and exports as a percentage of GDP, which indicates how internationalization involves in the host economy. International trade can promote competition and innovation, since an open economy is more exposed to competition and is therefore less likely for firms to undertake inefficient investment. All of these would suggest that openness would be in favour of economy growth. This variable is also can be seen as an attraction for efficiency-seeking FDI, as those usually are in favour of a location that is convenient to import original material and export final product.

***New technology transfer* (*TTECH*):** Import value of machinery and transports as a percentage of GDP is introduced to capture the development of technology introduced from overseas. As China is still in the developing world, the technology imported from outside could be considered as more advanced than the domestic level and be taken as a promotion of total technology level. The higher the ratio usually indicates the higher utilization of new technology in production, hence increases productivity and stimulates economic development.

***Capital formation (KAP) and FDI* (*FDI*):** the system measures capital formation by annual domestic capital formation and FDI by utilized value of FDI inflow. This system introduces these two variables as the capital inputs in the production process. From the supply side, along with technology progress, human capital and labour quantity, capital stocks both from domestic side and foreign side are usually considered as determinants in the output production function (see Solow (1970), Lucas (1988), and Romer (1990)). But this system uses annual inflows to measure FDI and capital in the production process, as the preferred proxy for these variables like domestic and foreign capital stocks are not available for China.

Although the stocks of domestic capital and FDI could be estimated, such estimations would be more imprecise. For example, there are many researches use the ratio of investment of output as the approximate growth of the capital stock when estimating the growth of output (for example see Balasubramanyam *et al.* (1996a), Li and Liu (2005), and Greenaway *et al.* (2007)). However, when applying this estimation to construct the capital stock values of China, it turns out that the change of capital stock from 1970 to 2006 was about 100 times than the total investment during the same period even we choose a very small initial value. The estimation of foreign capital stock diverged from the true cumulative FDI too. Therefore, we are not convinced to use capital stocks estimated by this approximation to estimate output and other variables in their levels.

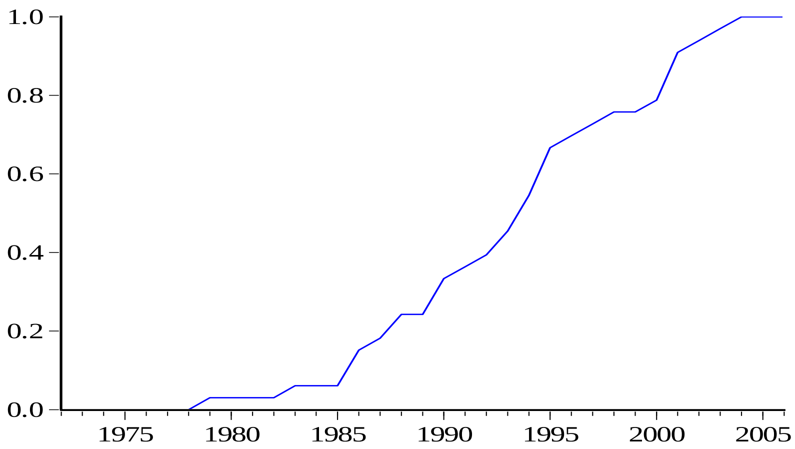
Based on Jorgenson (1973, 1980), another attempt has been tried formulating an arbitrary capital stock series by capital flows, which captures the enhancement in the stock of capital in each year. And we find that the arbitrary capital stocks both domestic and foreign one can be explained by their inflows. Details can be found in Appendix A3.11. In addition, the results from the model based on this arbitrary data, are similar with those from the model with capital formation (see Appendix A3.6). These results convince us to use the actual data on domestic capital formation and FDI inflow rather than the arbitrary data on capital stocks in our estimation. Thus, even the use of the stocks of both domestic capital and FDI is theoretically desirable, it is still consistent to use flow data related to both of those variables as did by UNCTAD (1992).

Utilized value of annual FDI inflow refers to investment that was actually undertaken in China each year. As it takes time for transferring capital and shipping equipment, the utilized FDI may not be the same as the amount in the agreement, and should be more precise than the contracted value of FDI to be used in estimating the effect on the economy. FDI is assumed to benefit the host economy through the creation of dynamic comparative advantages that lead to new technology transfer, capital formation, human resources development and expanded international trade.

Liberalization (libdummy): a dummy variable is introduced to capture the economic reform process started from the late 1970s. Since our sample includes the pre-reform period, the liberalization factor should not be ignored as it may cause a structure change in economy at the end of the 1970s. The main idea of the reform is to release restrictions and liberalize both private business from domestic side, and international trade and investment from foreign side. Recalling the openness process of Chinese economy in the second section (Section 3.2), the economic reform and open-up is a very cautious and gradual process over last 30 years, which including legislation innovation, policy and strategy change. Although it is difficult to measure precisely this reference, the development of legislation related to FDI can be considered to capture the main liberalization progress. We construct the dummy variable as the percentage of legislations employed in each year to the total liberalization legislations made during 1970 to 2006. The data of this liberalization dummy is illustrated in Figure 3.6 and details could be found in Appendix A3.2. Thus, this estimation of liberalization process imply that every law related to FDI has same and constant effect on economy, the liberalization process then depends on the frequency of establishment of new legislations.

The liberalization process is assumed to start in 1979 when China adopted the opening-up policy and terminate at the end of 2004 as no more relative contents about legislation change for 2005 and 2006. We can regard 2004 as a finishing line for the legislation process and the liberalization process. One reason is that, when China joined WTO in 1999, it has been allowed five years transaction time till the beginning of 2005 toward fully opening-up, especially for tertiary industry, after that any change should follow the rules of WTO. That could also explain the jump of the libdummy variable in 2001, while most regulations were modified at that time to associate with the rules of WTO before the deadline of 2005.

Figure 3.6. *Values of the liberalization variable*



Data

The annual data are collected from China Statistical Yearbook (FDI, Human Capital, Employment, and Technology Transfer) and UNSTATS database (GDP, Capital Formation, and Openness). The time series sample covers from 1970 till 2006. Variables as GDP, capital formation are measured in domestic currency at constant prices of 1990 to eliminate the influence of price change. FDI are originally in current US Dollars. It is converted to the same constant level as GDP and other variables by multiplying the average exchange rate and GDP deflator in domestic currency of each year. Openness is calculated as the share of total exports and imports as a percentage of GDP. Technology transfer is calculated as import value of machinery and transport as a share of GDP. The values of total international trade and import of machinery and transport are actually in current US Dollars and are treated the same way as FDI before calculated its percentage share of GDP. All these variables are taken into their logarithms in estimation.

3.4.2. The empirical results of unrestricted VAR

If all variables are treated as endogenous, the original VAR will be estimated as:

$$Y_t = C+\sum_{i=1}^{p} A_i Y_{t-i}+B\,D_t+\varepsilon_t \qquad (3.29)$$

where the vector variable Y can be set as $Y' = (GDP, KAP, EM, HK, OPEN, FDI, TTECH)$.

The exogenous variables, such as dummy and linear trend, are included in D_t. If there are any cointegration relationships among levels of these variables, then the ECM model can be transformed from the VAR system:

$$\Delta Y_t = C + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta Y_{t-i} + \ldots + BD_t + \varepsilon_t \quad (3.30)$$

Thus, the long-run relationships between output, FDI and other spillover variables can be investigated from the cointegration relationships. The short-run effects, as how each variable reacts to the disequilibrium can also be captured by the error-correction terms. In addition, impulse response and variance decomposition would be calculated to analyze how variables react to shocks from others.

Unit roots

As there is a clear upward trend in each of the variables, some variables could be non stationary. The results of augmented Dickey-Fuller (ADF) tests show that output, with test-statistic of -3.1193 and probability of 11.77%, capital formation (-2.74725, 22.52%), employment (6.081321, 100.00%), human capital (-1.83672, 66.52%), FDI (-1.76655, 39.03%), and new technology (-3.43851, 6.25%) all have unit roots in their levels. Although the ADF test indicates that the variable openness (-2.156478, 3.17%) does not have unit roots in its level, the KPSS test gives a test statistic of 0.236281 for openness and rejects the null hypothesis of no unit roots with 5% significant level (5% critical value is 0.146). So openness is still non-stationary based on the result of KPSS test. In the first difference terms, both the ADF test and the KPSS test indicate that all variables have no unit root, which confirms that all our variables are actually I(1). All the results are reported in Appendix A3.6.1.

The Unrestricted VAR

The optimal lag length for the VAR is tested with the log-likelihood ratio test. Table 3.7 shows that three lags are optimal for the unrestricted VAR. However, due to the restriction of the sample size, the unrestricted VAR has been regressed with 2 lags, which is just enough to enable us to run cointegration test and the ECM model. The LR test is also applied to decide whether the dummy variable or the trend is significant. According to Table 3.8, both the liberalization dummy and the linear trend are significant from zero, and should be included in the system. As mentioned previously, the presence of the linear trend indicates that, in our system, the Johansen test for cointegration would be undertaken between Model 4 and Model 3.

Table 3.7. *VAR lag order selection criteria*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	154.6628	NA	9.11e-13	-7.862518	-6.919766	-7.541013
1	305.8332	213.4171	2.53e-15	-13.87254	-10.73004	-12.80086
2	403.5353	97.70208	2.53e-16	-16.73737	-11.39511	-14.91551
3	570.4490	98.18451*	1.39e-18*	-23.67347*	-16.13145*	-21.10143*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

According to the F-test for significance, variables are significant both in lag one and lag two. And we observe a significant trend and an intercept in the system. All these results confirm the choice of the model with 2 lags, as well as a trend and a liberalization dummy, is appropriate. The F-test also rejects the hypothesis that all variables are insignificant (see Appendix A3.6.3).

Table 3.8. *LR test for dummy variable and trend*

Excluded variable	Chi-square value	Critical statist	Degree of freedo	Probability
Libdummy	14.7644	14.06714	7	0.03914
Trend	46.5872	14.06714	7	6.7184E-08

Table 3.9. *Roots of the companion matrix*

Root	Modulus
0.977491	0.977491
0.633600 - 0.539238i	0.832002
0.633600 + 0.539238i	0.832002
0.367192 - 0.694500i	0.785595
0.367192 + 0.694500i	0.785595
0.679506 - 0.274995i	0.733042
0.679506 + 0.274995i	0.733042
-0.667461	0.667461
0.648019	0.648019
-0.060977 - 0.641280i	0.644172
-0.060977 + 0.641280i	0.644172
-0.163132 - 0.265646i	0.311737
-0.163132 + 0.265646i	0.311737
-0.066671	0.066671

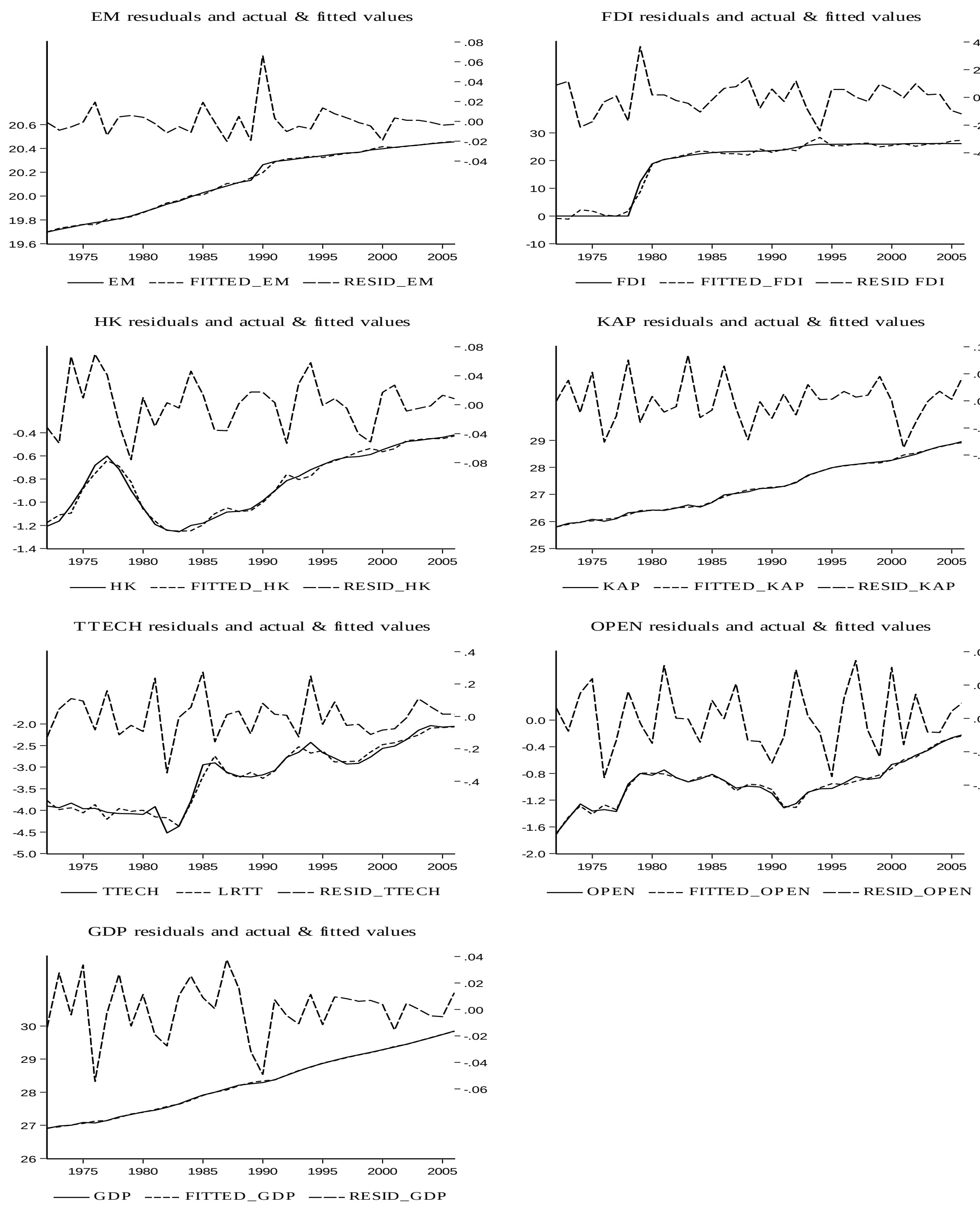
Table 3.9 lists all the eigenvalues of the companion matrix, which meet the mathematical stability condition as all of them are obviously less than one in absolute value. All the residuals and the actual-fitted values are displayed in Figure 3.7, which

indicates that our estimation has high power in explaining the actual variables. We also find that all of the residuals are stationary as expected. The covariance matrix shows that the residuals' covariances of all variables are small (see Appendix A3.6.6). But some of the residuals are notably correlated with each other according to the correlation Matrix in Appendix A3.6.5.

Residuals are also tested for Autocorrelation, Normality distribution, Heteroskedasticity, and ARCH. The results are given in the Appendix A3.6.8 and A3.6.9. We can observe that all variables passed the ARCH test. But the system, as well as the variables like employment and FDI failed to pass the normality distribution test. The residuals of technology transfer suffered Autocorrelation problem. All of the residuals are not significant for Heteroskedasticity test with no cross terms. We do not have enough observation for the Heteroskedasticity test with cross terms. In a summary, the total results are acceptable when compromising for some violence from non-normality distribution and autocorrelation.

Recursive estimation is introduced to evaluate the consistency of coefficient parameters of the system by 1-step Chow tests and break-point Chow tests. From Appendix A3.6.11 and A3.6.12, the results suggest that the system is consistent as a whole with no break-down during the recursive period. For individual variables, all of them are consistent except capital formation, which has a break point in 2001. Despite this, most of the results suggest that our VAR system is consistent and efficient.

Figures 3.7. *Residuals and actual-fitted values of the unrestricted VAR*



Cointegration

Cointegration in variables would enable us to evaluate the long-run equilibrium relationships from the original VAR. The cointegration Trace test is implemented by the methodology developed by Johansen (1991, 1995) to investigate whether there is any long-run equilibrium relationship among all these variables. The critical values for the Trace test are taken from Osterwald-Lenum (1992). We also take into account the simulative critical values generated by the Monte-Carlo method (developed by Bagus (2002)) to consider the adjustment needed for the small sample size in our model.

Table 3.10. *The unrestricted cointegration rank test (Trace)*

Hypothesized	Eigenvalue	Trace Statistic	Critical Value by Osterwald-Lenum		Critical Value by Monte-Carlo simulation	
No. of CE(s)			CV of 5%	Prob.**	CV of 10%	CV of 5%
None *	0.886509	259.6934	150.5585	0	229.0889	239.5666
At most 1 *	0.851734	183.5324	117.7082	0	156.7124	163.4152
At most 2 *	0.669006	116.7263	88.8038	0.0001	106.0923	111.1555
At most 3 *	0.615965	78.02837	63.8761	0.0021	68.62894	72.34891
At most 4 *	0.539418	44.53262	42.91525	0.0341	41.37006	43.76723
At most 5	0.339743	17.39837	25.87211	0.3858	21.74721	23.43954
At most 6	0.0787	2.868951	12.51798	0.8917	8.472492	9.400085

**MacKinnon-Haug-Michelis (1999) p-values

Recalling that we have a trend in our unrestricted VAR system, we can assume that there exists a linear trend in the cointegration relationship, and hence, the Johansen test for cointegration can be implemented by the model with assumption 4 (see Equation (3.14)). The rank of cointegration result is represented in Table 3.10. It shows that the null hypothesis of rank ≤ 4 can be rejected by both critical values of 5% significant level. As the null hypothesis of at least 5 cointegrating vectors can not be rejected, we tend to accept that there are 5 cointegrating vectors in the VAR.

As mentioned before, according to Johansen (1995), we also need to investigate whether we choose the appropriate model when applying the Johansen test. The log-likelihood ratio test is implemented to test whether the linear trend and the intercept exist in the cointegrating vectors. We firstly test the existence of a linear trend, if the hypothesis of no liner trend is not rejected, we would undertake the Johansen test with the model 3, and then test against model 2 that the intercept is limited only in the cointegrating vectors. Provided with the eigenvalues from both the models, as shown in Table 3.11, the test for only an intercept in the cointegrating vectors against a linear trend gives a log likelihood statistic of 35.13986353. As 5% of χ^2 (5) distribution statistic is 11.07, the null hypothesis of no trend in the cointegrating vectors is rejected. Hence, the model 4 that a linear trend is restricted in the cointegration relationship is appropriate for our system, and hence, the system has five cointegration relationships is recognized.

Table 3.11. The t*est for trend in cointegration relationships*

Roots with linear trend λ_{4i} (Model 4)	roots without trend λ_{3i} (Model3)
0.886509	0.862541
0.851734	0.814541
0.669006	0.647143
0.615965	0.54392
0.539418	0.344655
0.339743	0.099745
0.0787	0.062878
$LR = -T \sum_{i=1}^{r} \ln[(1-\lambda_{4i})/(1-\lambda_{3i})] = 35.13986$	

3.4.3. Innovation accounting

Innovation accounting, including variance decomposition and impulse response, is carried out to analyze the correlation between each variable: the forecast error variance decomposition explains all the forecast error variance effects on each endogenous variable; while the impulse response function analysis traces out the time path of the effects of the various shocks on each endogenous variable to determine how each endogenous variable responds over time to a shock in that variable and in every other endogenous variable. Applying by this technique would allow us to investigate the independent effects of each variable on others.

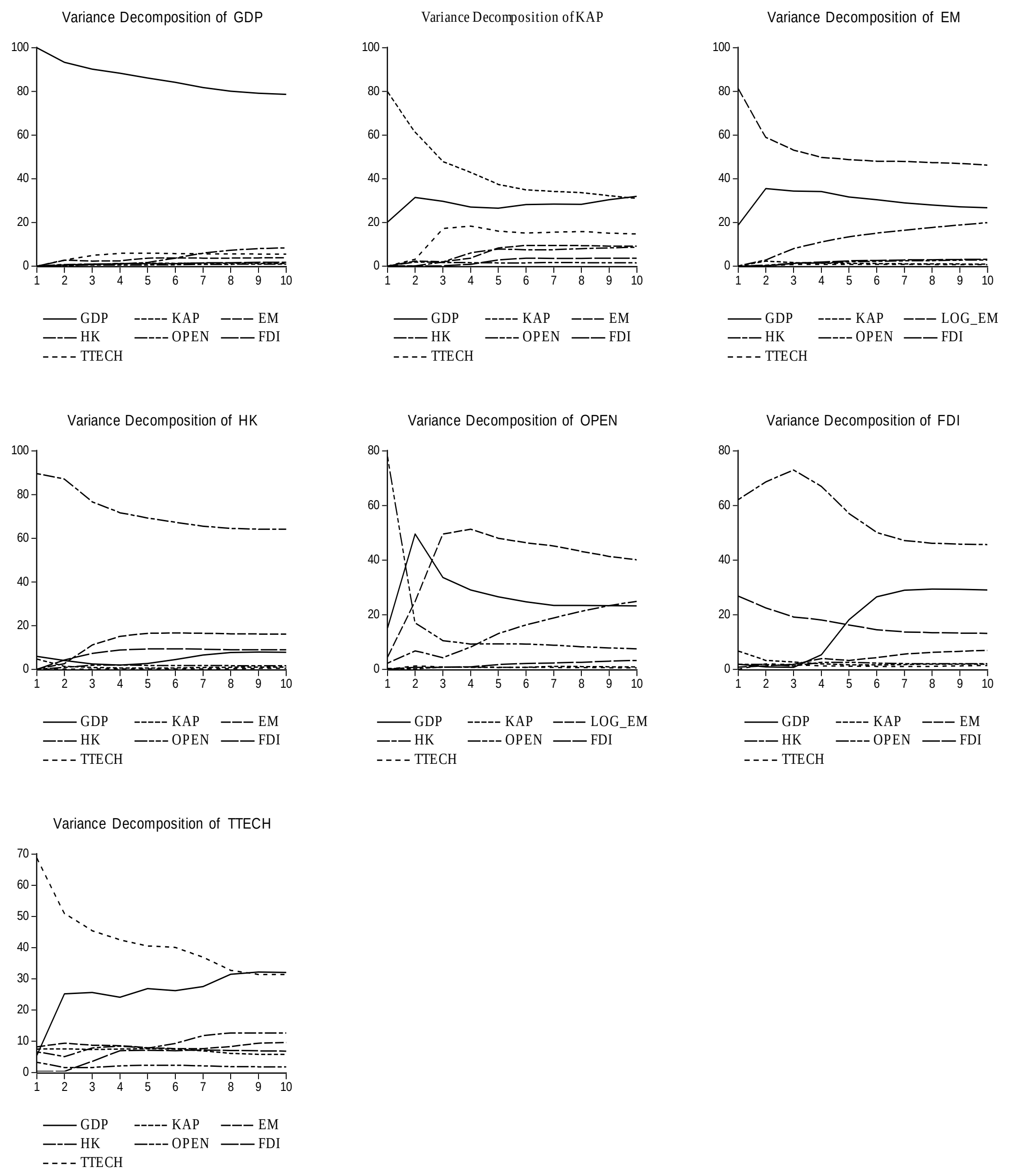
Variance decomposition

The forecast error variance decomposition allows inference over the proportion of the movements in a time series due to its own shocks versus shocks to the other variables in the system. With a ten-year forecasting horizon adopted, the variance decompositions are implemented on all variables by the Cholesky decomposition method in the order of GDP, KAP, EM, HK, OPEN, FDI and TTECH. All the results are reported in Appendix A3.7.

The results illustrated in Figure 3.8 indicate that GDP (82%) itself can explain most of its own forecast error during the observed period. Capital formation, employment and FDI, as well as openness, don’t have significant effects on the decomposition of forecast error of output. A small part of output can be explained by human capital

(8.26%) and technology import (5.49%). On the other side, output itself, as the main source of national income and the measurement of domestic market size, is more powerful in explaining spillover variables and FDI. It accounts for over 20% of variance decompositions of all variables except human capital, where employment (16%) and FDI (8.8%) have more impacts than output (7.8%).

Figure 3.8. *Variance decomposition of the unrestricted VAR*



Our results suggest that output and human capital are the main determinants of FDI. They imply that FDI, especially market-seeking investment, may need time to adapt domestic market as output has more power in explaining FDI in the long-run (29%). Human capital is the most important issue for FDI with 62% of decomposition share in the short-run diminishing to 45% in the long-run. The results do not give strong evidence of FDI impact in explaining the future shocks of spillovers variables. It only has notable effects on human capital (8.8%) and technology transfer (6.8%) in the long-run. It suggests that economy of China is still driven by domestic sectors; the role of FDI is actually limited on output but can affect human capital and technology imports in a certain level.

Impulse Responses

The impulse response analysis provides a practical vision to interpret the behaviour of a time series in response to the various shocks in the system. Since all the variables are endogenous in the VAR, any shock in one equation's innovation is transmitted to the rest of the system. The impulse response analysis therefore provides an opportunity to investigate the response of one variable to an impulse in another variable in a system that involves a set of other variables as well.

The impulse response functions of all variables to all kinds of shocks are evaluate by the Cholesky impulses decomposition method, which is implemented, in this case, in the order of GDP, KAP, EM, HK, OPEN, FDI and TTECH. The Cholesky decomposition provides responses that depend upon the ordering of the variables in the VAR. If residuals across equations are seriously related, different order of the Cholesky decomposition may affect the results of impulse responses. Recall from the residual correlation matrix for the VAR in the Appendix A3.6, we find that correlations between residuals are reasonable for most links across the equations, but there are some with remarkable value over 0.40. Thus, we could not rule out the possible effect by the Cholesky ordering on impulse responses. Hence, we also provide the generalised impulse responses in order to generate more robust results through comparing the implications of these two. In fact, results indicate that two of them are similar in several instances, especially in cyclical terms, which implies that the impulse responses by the Cholesky decomposition are convincible. All results can be found in Appendix A3.8.

Figure 3.9 and Figure 3.10 represent the dynamic responses of GDP to one standard deviation impulse of FDI and other spillovers. Similar to the result from variance decomposition, these results indicate that responses of GDP are very limited to shocks of other variables, for both Cholesky and generalized innovations. They are less than 0.01 in most of the cases. The largest response of GDP is caused by its own shocks. A shock in FDI can have positive responses from output in the long-run reversing from short-run negative effects, which may demonstrate its expected positive effect on the long-run economic growth. But the dynamic responses of output to human capital, technology transfer and openness are opposed to the cycle of FDI with long-run negative effects and short-run positive effects. It indicates that the benefits from one time shoot in human capital, technology, as well as learning from openness, could die out by depreciation, but the effect from FDI could be sustainable as it not only brings skills and technology but also brings advanced methods of research and management that the host economy could continuously gain from. Unlike the variance decomposition results, impulse response analysis could not capture the effects of output on spillovers, as responses of spillovers to impulses of output are insignificant for both the Cholesky and generalized innovations.

Figure3.9. *Impulse responses of GDP to Cholesky one S.D. innovation*

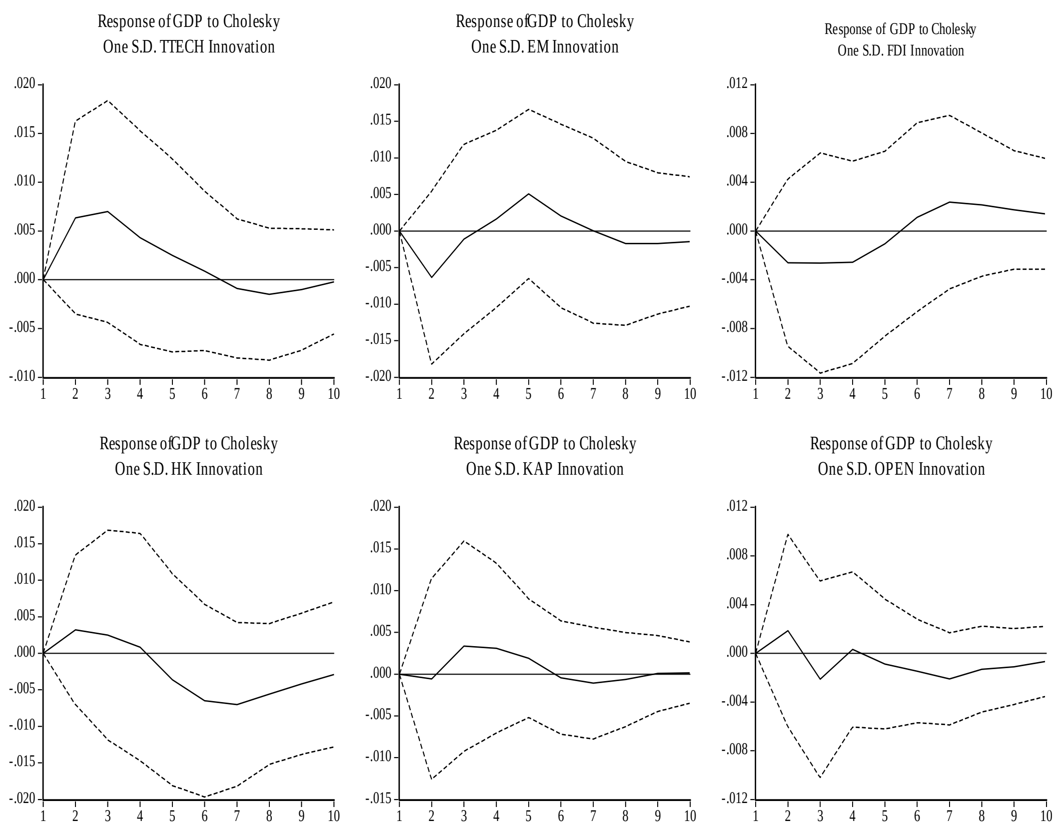


Figure3.10. *Impulse responses of GDP to generalized one S.D. innovation*

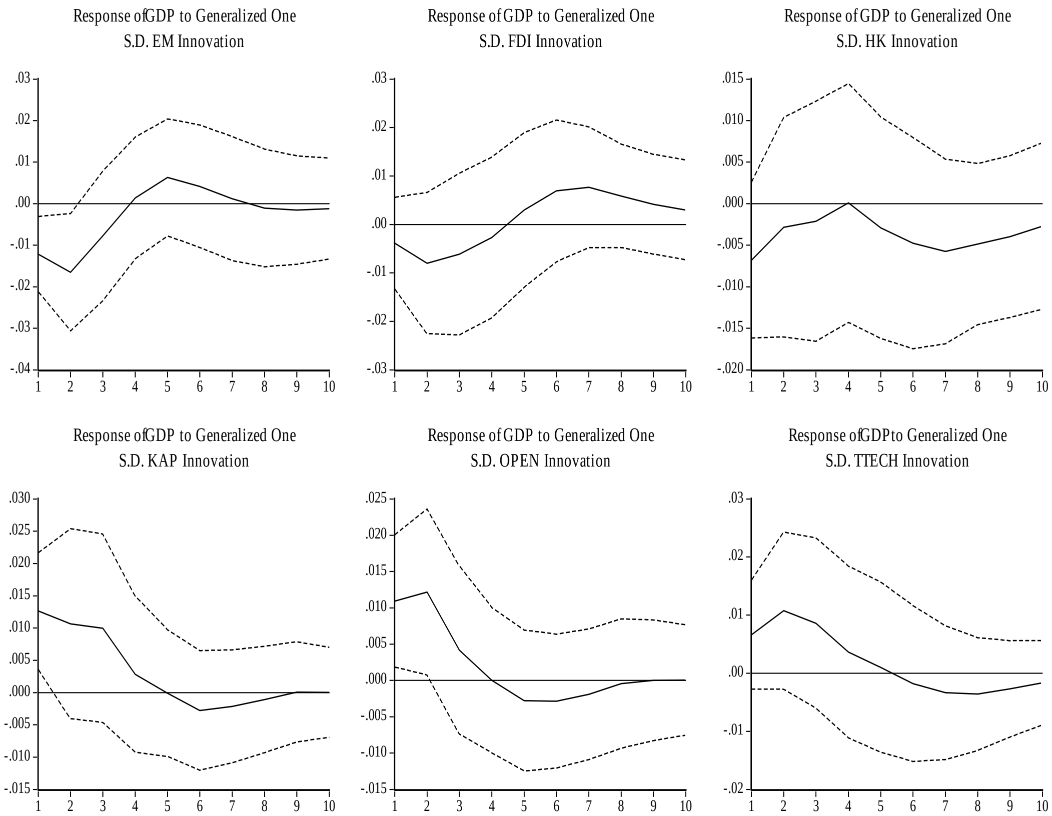


Figure 3.11 and Figure 3.12 illustrate that FDI responds significantly to the innovation of each variable. Despite the immediate negative responds, FDI would be attracted from a sudden increase in output by taking advantage of improved economic environment and enhanced domestic market size in the mid-term. After competitive capability from domestic business is improved by following-up and learning-by-doing from FIEs, FDI would respond the initial output impulse negatively in the long-run. FDI responses to capital formation and openness follow the similar cycle with long-run negative responses to their impulses, which reflects its competitive relationship with domestic business both in the domestic market and in the international market.

Figure3.11. *Impulse responses of FDI to Cholesky one S.D. innovation*

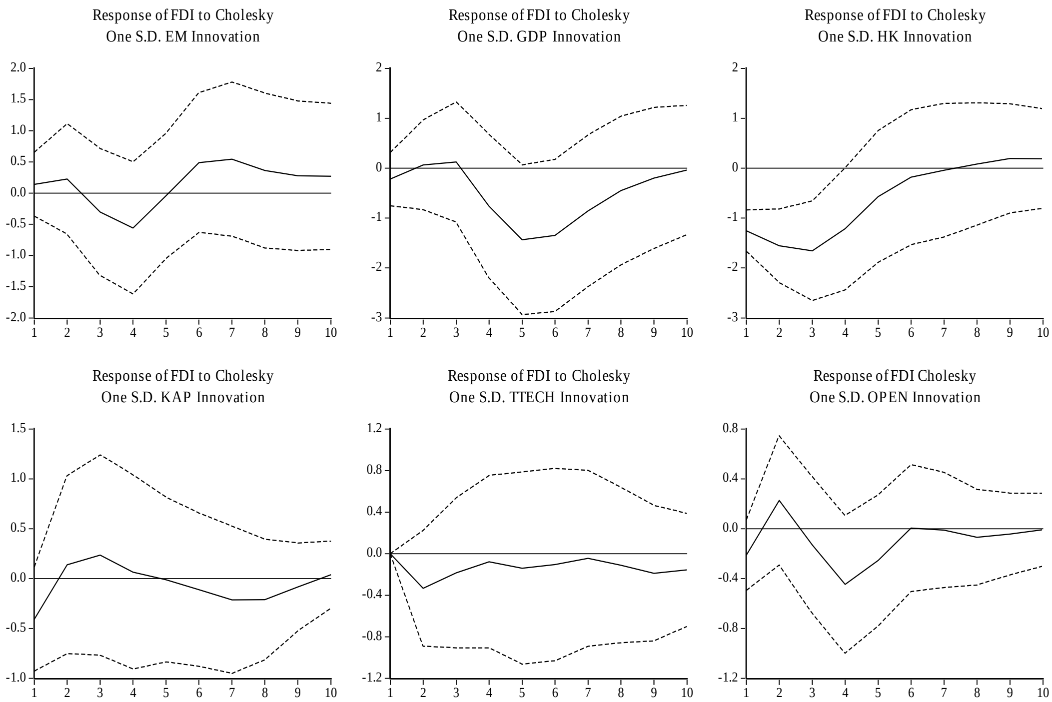
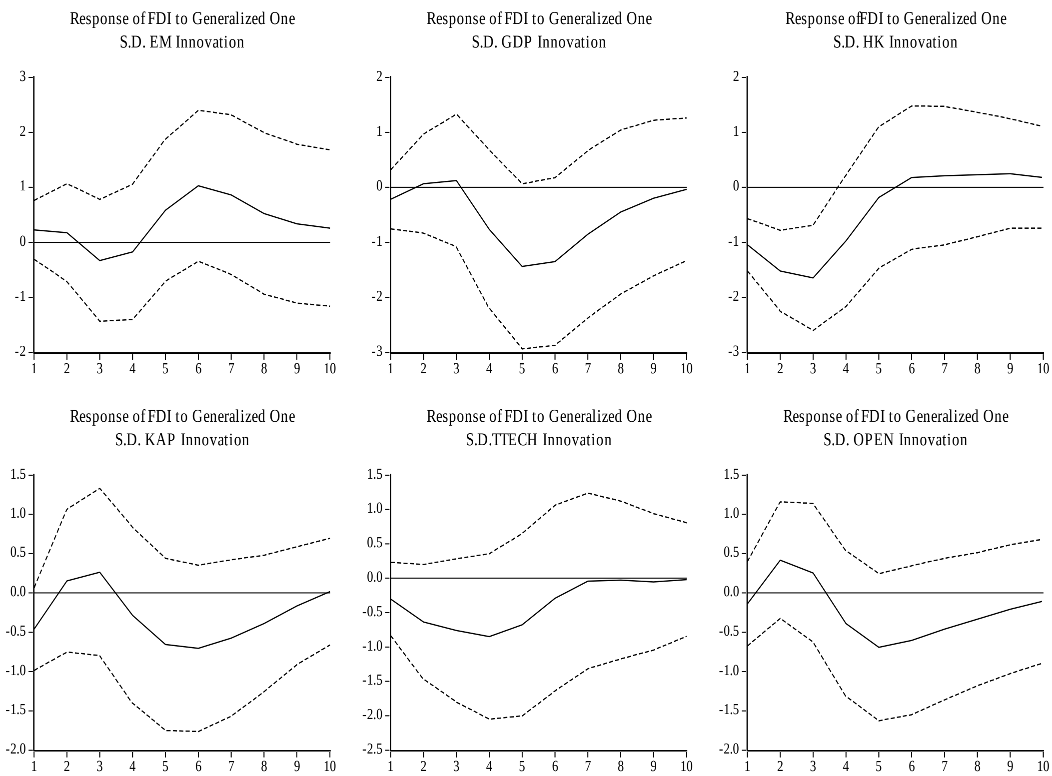
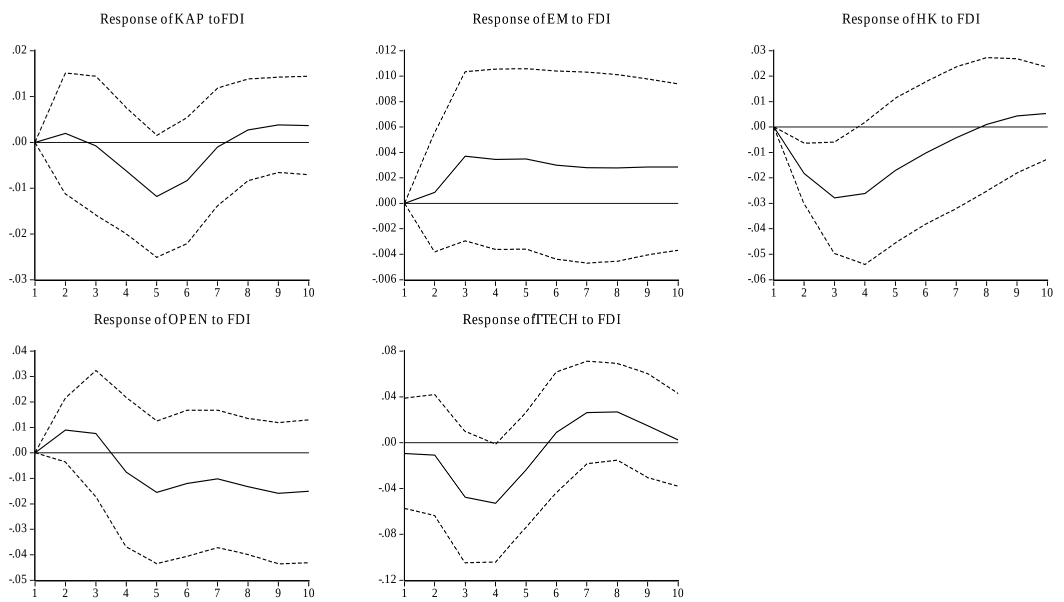


Figure3.12. *Impulse responses of FDI to generalized one S.D. innovation*



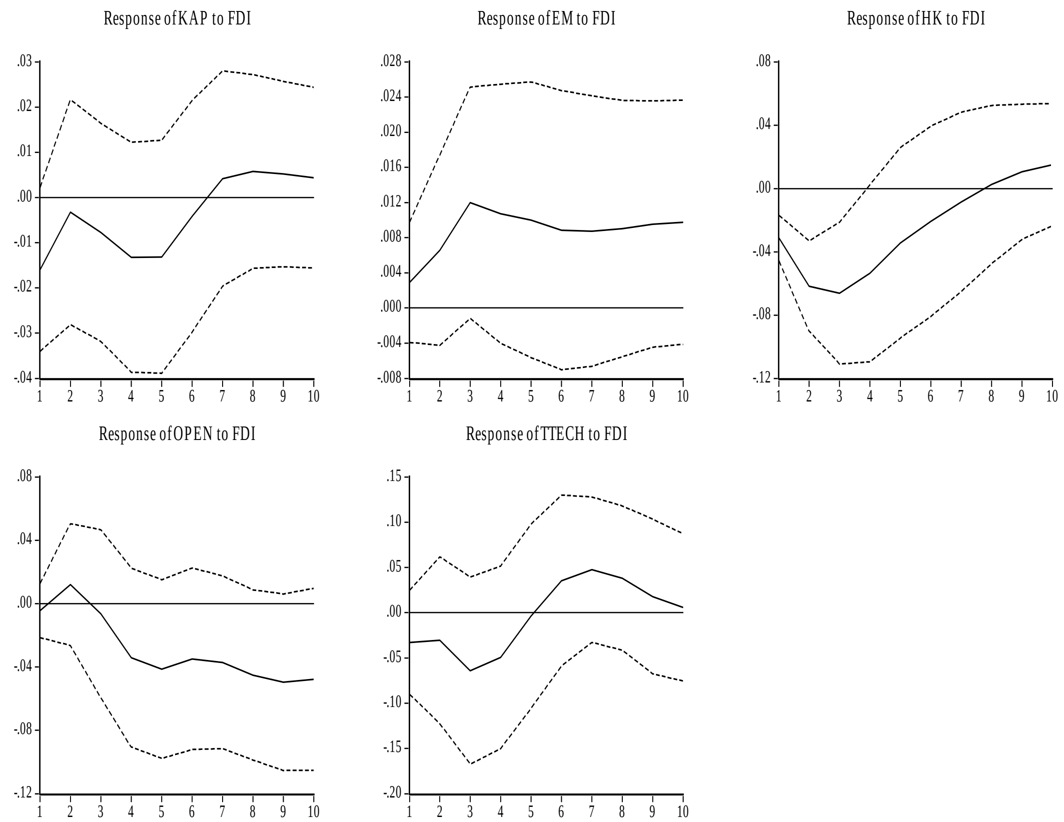
FDI responds to the impulses of human capital and technology transfer negatively in the short-run, but the negative reactions diminish after a few period. We can observe the tendency more obviously from generalized innovations than the Cholesky innovations, where responses to technology close to zero and responses to human capital turns to positive after several years. These reactions may suggest that those FDI intend to seek efficiency to save cost, particular those with labour-intensive and low technology would be more sensible to the increase in labour cost and be washed out quickly by the domestic business with development of human capital and technology. But those with more technology advantage would benefit from labour quality improvement and enhanced absorptive capability of new technology. Hence, responds of FDI would positively react to impulses from these variables in the long-run as they attract more capital and technology intensive FDI.

Figure3.13. *Impulse responses to Cholesky one S.D. FDI innovation*



As illustrated in Figure 3.13 and Figure 3.14, responses from other variables to innovations of FDI are insignificant. It indicates that, in the short-run, capital formation, human capital and new technology, are actually negatively responding to FDI innovation. But their responses turn to positive in the long-run. This gives some support that FDI has limited beneficial effect on the Chinese economy in the long-run.

Figure3.14. *Impulse responses to generalized one S.D. FDI innovation*



3.4.4. The long-run relationships and the ECM model

Recalling from equation 3.29 and 3.30 that the unrestricted VAR can be re-estimated by the error-correction model:

$$\Delta Y_t = C + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta Y_{t-i} + \ldots + BD_t + \varepsilon_t \qquad (3.30')$$

where $\Pi = \alpha\beta'$

together with the information of cointegration test, the ECM model then can be specified if the long-run relationships, or cointegrating vectors, $\beta' Y$ is identified, which then enable us to investigate the long-run relationships between variables in the equilibrium and the short-run correction from one variable to the equilibrium.

Identification of cointegration relationships

Identification of cointegration relationships is to distinguish cointegrating vectors empirically from each other. Restrictions then can be imposed on the cointegrating vector (elements of the matrix β) and on the adjustment coefficients (elements of the matrix α). One restriction of particular interest is whether the *i*-th row of the matrix is all zero. If this is the case, then the *i*-th endogenous variable is said to be weakly exogenous with respect to the parameters (See Johansen (1995)).

Firstly, we need test on β to confirm if one particular variable is in the long-run equilibrium and test on α to find if any variables are weakly exogenous. From Table 3.12, it confirms that all variables are significant in the cointegrating vectors and enable us to normalize those we have chosen. And the results of the test on α indicate that employment is likely to be weakly exogenous (see Table 3.13). According to Johansen (1995), the interpretation of the weak exogeneity is that some rows of α are zero, but that means that the corresponding unit vectors are contained in $\alpha_{\perp}$, indicating that the cumulated residuals from these equations are common trend. Also this does not mean that these variables cannot cointegrate in the long-run equilibrium. Because given the number of cointegrating vectors is determined, the test for weak exogeneity rests on the assumption that the model actually fitted the data. So we can still continue the analysis given current value of those 'exogenous' variables, under the assumption that the corresponding rows of α are zero.

Table 3.12. *LR test on cointegrating coefficients Matrix* β

Null H_0	Hypothesized No. of CE(s)	Restricted Log-likehood	LR Statistic	Degrees of Freedom	Probability
$\beta_{i1}=0$	5	376.9528	22.69873	5	0.000385
$\beta_{i2}=0$	5	375.0245	26.55519	5	0.00007
$\beta_{i3}=0$	5	362.9412	50.72191	5	0
$\beta_{i4}=0$	5	375.713	25.17834	5	0.000129
$\beta_{i5}=0$	5	363.5477	49.50884	5	0
$\beta_{i6}=0$	5	366.8785	42.84732	5	0
$\beta_{i7}=0$	5	376.2837	24.03696	5	0.000214

Table 3.13. *LR test on Adjustment coefficients Matrix* α

Null H_0	Hypothesized No. of CE(s)	Restricted Log-likelihood	LR Statistic	Degrees of Freedom	Probability
$\alpha_{1i}=0$	5	380.3949	15.81456	5	0.007394
$\alpha_{2i}=0$	5	375.9189	24.76641	5	0.000155
$\alpha_{3i}=0$	5	386.4129	3.778466	5	0.581732
$\alpha_{4i}=0$	5	380.6663	15.27175	5	0.009262
$\alpha_{5i}=0$	5	359.4367	57.73089	5	0
$\alpha_{6i}=0$	5	383.1853	10.23359	5	0.068881
$\alpha_{7i}=0$	5	377.5316	21.54104	5	0.00064

The estimated cointegrating vectors given by the various software packages are not unique and are derived from a variety of normalisation procedures. The only requirement is to ensure the model be consistent. Otherwise, it would generate spurious regression. The ideal is to be able to impose constraints on the coefficients in the cointegrating vectors and/or the adjustment coefficients, so that both the restrictions hold statistically by the Chi-squared test and they do identify the vectors. Occasionally, attempts at identification can be made easier by the nature of the variables in the potential relationships and the form of those relationships suggested by economic theory: as in the classic example of links between money, an interest rate and national income. Here, in our endeavours to identify the vectors, we focused on exploring these kind of issues: (1) the long-run links between GDP and FDI and vice-versa; (2) the possibility that spill-over effects from FDI might affect GDP and employment, such effects arising from the use of more advanced technology in production, either directly or indirectly through imports of technological products; and, (3) the possibility of identifying a long-run aggregated production function.

The identified cointegrating coefficient matrix β and their adjusted coefficient matrix α can be found in Table 3.14 and Table 3.15. The LR test indicates that the null hypothesis that these restrictions are insignificant could not be rejected. Hence, the identification of the long-run relationships is valid and consistent with the original data. The graphs of the cointegrating vectors are given in Figure 3.15. All vectors are I(0); though at first appearance that looks not to be so. Thus, the relevant statistics are as follows: for CV1, with statistically significant intercept and trend, the ADF t-statistic is -3.558 [0.0008]; for CV2, with an intercept and a trend, the KPSS test produces an LM statistic of 0.0905, which is not only under the 5% critical value (of

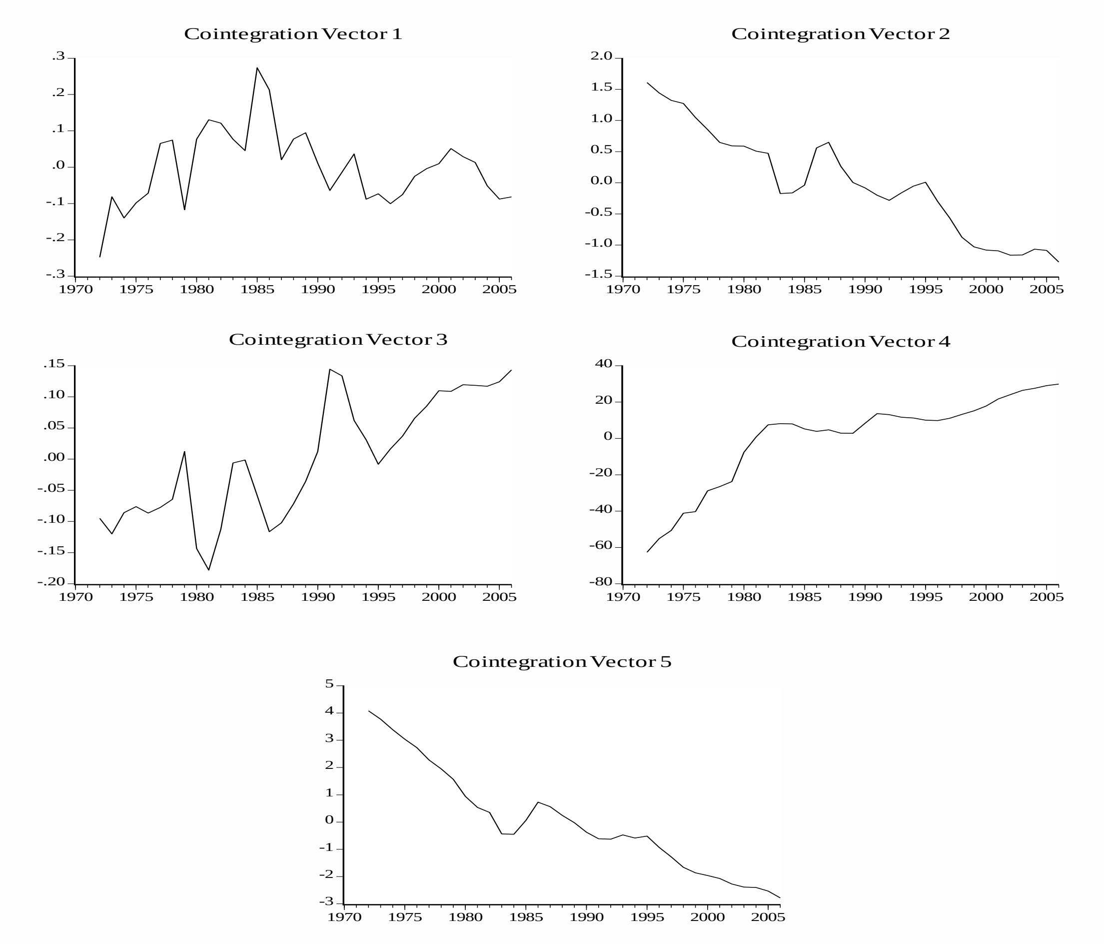
0.146) but is lower than that at the 10% level (0.119); for CV3, with a statistically significant intercept and trend, the ADF t-statistic is -4.3607 [0.0078]; for CV4, with neither intercept nor trend, the PP adjusted t-statistic is -2.412 [0.0174]; and, for CV5, with both intercept and trend, the KPSS LM statistic is 0.12298, which is below the 5% critical value as required.

Table 3.14. *Cointegrating coefficients Matrix* β

Cointegration Restrictions:					
β(1,1)=1, β(1,2)=1, β(1,3)=1, β(1,5)=0, β(1,7)=0, β(2,1)=1, β(2,2)=1, β(2,3)=0,					
Convergence achieved after 2482 iterations.					
Restrictions identify all cointegrating vectors					
LR test for binding restrictions (rank = 5):					
$\chi^2(7)$	2.404213				
Probability	0.934136				
Cointegrating Eq:	CointEq1	CointEq2	CointEq3	CointEq4	CointEq5
GDP(-1)	1.000000	-1.000000	-0.466180	-94.10783	2.559329
			(0.10125)	(21.0802)	(0.76346)
			[-4.60447]	[-4.46428]	[3.35228]
KAP(-1)	-1.000000	1.000000	0.000000	0.000000	-0.158321
					(0.01786)
					[-8.86580]
EM(-1)	-1.000000	0.000000	1.000000	0.000000	0.000000
HK(-1)	0.512763	0.000000	-0.365955	1.558056	0.000000
	(0.10411)		(0.05770)	(3.10442)	
	[4.92516]		[-6.34278]	[0.50188]	
OPEN(-1)	0.000000	0.000000	0.022789	9.541357	-0.435986
			(0.01797)	(4.52260)	(0.16196)
			[1.26810]	[2.10971]	[-2.69188]
FDI(-1)	0.022288	0.014723	-0.021840	1.000000	-0.025605
	(0.00423)	(0.00840)	(0.00261)		(0.01134)
	[5.26849]	[1.75220]	[-8.35699]		[-2.25847]
TTECH(-1)	0.000000	0.828260	-0.087335	0.000000	1.000000
		(0.02580)	(0.01658)		
		[32.1015]	[-5.26654]		
TREND	-0.000143	-0.146551	0.054961	9.418907	-0.420107
	(0.01024)	(0.03506)	(0.01008)	(1.84910)	(0.08982)
	[-0.01399]	[-4.18000]	[5.45072]	[5.09379]	[-4.67695]
Constant	19.12930	6.217832	-8.183219	2466.676	-56.58195

Standard errors in ( ) & t-statistics in [ ]

Figure 3.15. *Cointegrating vectors*



The long-run relationships

By omitting the trend and drift terms, and rounding up the coefficients in Table 3.14, we have these long-run relationships:

$$GDP= 1*KAP + 1*EM - 0.518* HK - 0.022*FDI \tag{3.31}$$

$$KAP=1*GDP - 0.015*FDI - 0.828*TTECH \tag{3.32}$$

$$EM=0.0466*GDP+0.366*HK-0.023*OPEN+0.022*FDI+0.087*TTECH \tag{3.33}$$

$$FDI= 94.108*GDP-1.558*HK-9.541*OPEN \tag{3.34}$$

$$\mathrm{TTECH}= -2.559*GDP+0.158*KAP +0.436*OPEN + 0.026*FDI \tag{3.35}$$

The conclusions that we can extract from these long-run relationships give some possible indications of the answers to the issues posed in our introduction especially those related to the links between economic development and FDI. Recalling the measurement of our variables in Section 3.4, equation (3.31) suggests that in the long-run FDI statistically significantly inhibits GDP or growth in FDI is inimical to the growth in GDP (Table 3.14). If think of equation (3.31) as the logarithmic transformation of a multiplicative aggregate production function, then the elasticities of aggregate output with respect to the domestic capital stock and to the surrogate for the labour supply are one. Although FDI seemingly impress growth, we find adverse long-run effect that could mainly due to two aspects. Firstly, FDI was spatially concentrated in south coastal region as mentioned in section 3.2. Whilst FDI contributes to rapid growth in the coastal region, it is responsible for the widen development gap between coastal region and inland region, and worsen of the income distribution, which result in damaging long-run national output consequently (see Bramall (2000) and Sun (1998)). Secondly, FDI figures involved were simply far too small before 1990s compared with the scale of economy. It is hard to believe that FDI on the very limited scale of the 1980s could promote the economy into achieving very fast growth at that time (Bramall (2000)). Equation (3.31) also suggests that output responds negatively in the long-run to changes in human capital and not just to FDI. It reflects that: firstly, the ‘fruits of growth’ might not be used to fund improvements in educational quality; secondly, skills gained from education might not be associated with the demand of the economic reform. Hence, to follow the path taken by East

Asian economies such as Japan, Taiwan, and South Korea and update industries, China need create a highly skilled and educated workforce, and that could hardly be accomplished overnight. The state of technology, for which a surrogate might be the imports of technology, has no impact in the long run on economic growth, that finding being accepted statistically under our restrictions on the coefficients.

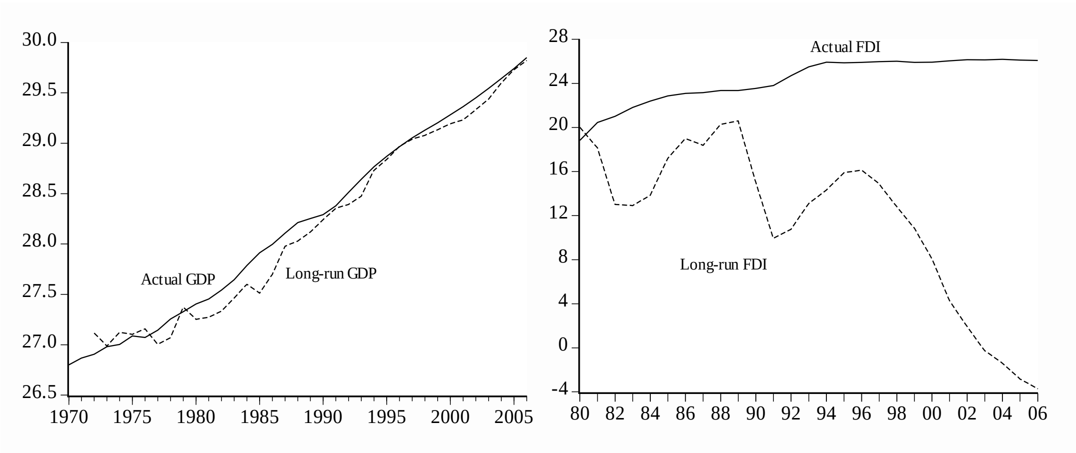
Equation (3.32) provides another feasible explanation for the negative response of long-run output to FDI. The latter tends to reduce domestic capital formation in the long-run and so works against the tendency of that capital formation to enhance long-run growth. The impact of the technology variable on the long-run stock of domestic capital is also negative, which perhaps reflects the application of imported technology by foreign firms that, as a consequence, domestic capital formation is being crowded out by multi-national enterprises.

So, we turn now to equation (3.34) for FDI before extracting some implications of the long-run equations for employment and imports of technology. Over the long-run no other variables could be found to produce an identified long-run relationship for FDI, besides GDP, openness and human capital. The latter's impact is not statistically significant, but like openness in the long-run equation for employment, it could not be omitted without rendering most other coefficients in the system statistically insignificant and preventing identification of the vectors. However, whilst the degree of openness seems to hamper long-run FDI, we observe that GDP is a positive and substantial attractor of FDI (with an elasticity of 94). So, FDI might not impact on long-term economic growth, but economic growth is its main attractor in the long-run.

Finally, we consider equations (3.33) and (3.35). Long-run employment increases with GDP, human capital and FDI, which would probably be generally consistent with priori expectations. The positive impact from FDI implies that whilst FDI might not be a direct influence on long-run economic growth it has a positive indirect influence via its employment generating activities. In China, whilst huge amount of labour surplus need shift from primary industry sector to manufacturing industry sector and service industry sector, improvements in human capital and technology could be beneficial to employment via its indirect impetus to labour productivity. Technological development itself is increased in the long-run by increased FDI and openness; as well as by higher domestic capital formation.

The long-run time paths of GDP and of FDI are portrayed in Figure 3.16. These time series are, of course, dependent upon the cointegration vectors 1 and 4 graphed earlier. The first graph suggests that GDP is now nearer to its long-run level. For FDI, its current path is running ahead of its long-run under current links between the (indeed, conventional) variables in our framework (recall that FDI also is measured in logs: hence the negative values; and the graph is drawn from 1979/1980 when FDI commenced).

Figure 3.16. *The long-run time paths of GDP and FDI*



These long-run relationships that highlight the role of the traditional fundamentals in economy, capital and labour, therefore may suggest that fundamental factors are still important for developing countries to promote their economies. Actually relative evidence that fundamental factors matter for countries at early stage of development is very strong (see Lau (1996)), including the developed countries, such as Japan (Minami (1986)) and USA (Jorgenson (1995)). The new industrialized East Asian countries also share similar experience. In the earlier growth-accounting work on Hong Kong, South Korea, Singapore, and Taiwan, Young (1992) found that the total productivity growth had played only a small role in the economic miracles of those countries, investment is still crucial in stimulating economic growth. Hence, he concluded that accumulations of traditional factors in the neoclassic theory are more convincible in explaining the experience of the East Asian countries. Krugman (1996) drew the same conclusion, but he argued that these Asian countries therefore could not sustain their growth. However, DeLong and Summers (1992) argued that investment in equipment could generate externalities, therefore could be endogenous, which overturns the assumption by neoclassic model that capital could have only diminishing returns. Thus, the long-run growth (per capita) can be sustained by capital accumulation. They found strong evidence that even countries with limited human capital could benefit from higher equipment investment. Based on this belief, we suggest that capital formation and employment could be the main reasons to explain the sustainable economic growth in China as they contain endogenous elements of accumulation.

The ECM model

We now supply some of the key features of the ECM model itself. In Table 3.15, we report the impact on the changes in the variables of the error correction terms. The unrestricted, non-zero, values of the adjustment coefficients are all statistically significantly different from zero, except for one of them. We see that only one variable employment comes to be a “weakly exogenous” variable as tested before. Despite this, all variables react significantly to the long-run disequilibrium that may be caused by any one of them.

Table 3.15 also include some overall statistics for the ECM model. It is apparent that the goodness-of-fit for these equations is particularly good for such modelling. But the adjusted value is very low for the change in employment (EM). That could be rationalised by noting that this variable is almost a “weakly exogenous” variable so that its first-difference equation is likely to be "weak", with only a set of one-period first differences of the variables to influence the change in (EM). In Table 3.15, we also provide the coefficients on the Libdummy variable, since this is a potentially important component of our study. Of particular note is the fact that the Libdummy is statistically significant in the majority of the equations and should be a retained regressor.

Table 3.15. *The results of the ECM model: Adjustment matrix α, Libdummy's coefficients and overall statistics*

	D(GDP)	D(KAP)	D(EM)	D(HK)	D(OPEN)	D(FDI)	D(TTECH)
CEq1	-1.803737 (0.81690) [-2.20803]	0.000000	0.000000	6.834144 (1.01561) [6.72911]	-17.12682 (1.78141) [-9.61420]	0.000000	0.000000
CEq2	-1.456663 (0.70050) [-2.07946]	-0.724592 (0.14178) [-5.11057]	0.000000	6.128162 (0.87220) [7.02611]	-15.19331 (1.52601) [-9.95622]	0.000000	-0.849224 (0.14931) [-5.68761]
CEq3	-2.045544 (1.08363) [-1.88768]	0.000000	0.000000	9.330099 (1.35598) [6.88069]	-22.61393 (2.36291) [-9.57036]	19.60258 (6.09680) [3.21522]	0.000000
CEq4	0.043173 (0.01876) [2.30143]	0.032299 (0.00497) [6.50002]	0.000000	-0.164383 (0.02338) [-7.02985]	0.396037 (0.04084) [9.69768]	0.000000	-0.014975 (0.00444) [-3.37056]
CEq5	1.065976 (0.49354) [2.15984]	0.793605 (0.12889) [6.15713]	-0.011459 (0.00772) [-1.48518]	-4.315349 (0.61517) [-7.01485]	10.65575 (1.07449) [9.91707]	0.000000	0.000000
	D(GDP)	D(KAP)	D(EM)	D(HK)	D(OPEN)	D(FDI)	D(TTECH)
Libdummy	-0.041070 (0.05828) [-0.70465]	0.450157 (0.11045) [4.07555]	-0.064393 (0.04651) [-1.38443]	-0.098142 (0.10519) [-0.93295]	0.452999 (0.10253) [4.41816]	-5.850617 (3.46756) [-1.68725]	-0.994961 (0.35953) [-2.76738]
R^2	0.588737	0.753330	0.361296	0.782946	0.904289	0.702850	0.692853
Adjust R^2	0.334146	0.600629	-0.034093	0.648579	0.845040	0.518901	0.502715
S.E. eq.	0.026870	0.050922	0.021443	0.048498	0.047269	1.598632	0.165753
F-stat.	2.312482	4.933370	0.913774	5.826921	15.26237	3.820883	3.643941

Standard errors in ( ) & t-statistics in [ ]

The ECM model confirms that liberalization could improve changes in capital formation and openness significantly. But it plays a significantly negative role in the change of FDI and technology import in the short-run. These negative effects may indicate that, as suggested by (Fujita and Hu (2001)), economic liberalization may increase regional disparity, and cause agglomerations of human capital and technology diffusion in eastern coastal region, which can only benefit agents with new production function but worse those contain low value-added producing activities, especially those of labour intensive FDI from Taiwan and Hong Kong, which once was in a majority of total FDI inflows in China, could be worse off. Another explanation is that, as suggested by Hymer (1960) and Dunning (1981), it implies that MNEs, which participate in the Chinese economy, have an incentive to prevent spillovers of technology to other firms through intellectual protections of their brands and patents, since MNEs are dependent on its firm-specific advantage (in the form of technology) for profitable business operations in a certain time. Hence, all the results suggest that economy liberalization does not necessarily stimulate FDI and technology transfer, but hampers them in the short-run. Its positive role is mainly in domestic sectors as it releases constrains from the state government on domestic business, especially private business, then, stimulates investment and trade.

3.5. Conclusion

Our purpose of this chapter is to investigate the relationships between economic growth and FDI as well as its spillovers in China. Through the VAR model and the

ECM model, the relationships then have been investigated by the long-run relationships in the cointegrating vectors and the short-run effects from the ECM model. The dynamic correlations of variables have been captured by the analysis of variance decomposition and impulse response.

From the cointegration analysis, we find that Chinese economy lies in the early stage of development level. Its economic growth is still determined by traditional fundamentals, such as physical capital and employment. The sustainable elements, human capital and technology transfer, suggested by new growth theories, could have negative influence on output through affecting capital formation and employment. FDI, in the long-run equilibrium, could hamper economic development and capital formation significantly. But it owns positive impacts on employment and technology transfer. The long-run relationships also suggest that, though FDI might not stimulate economic growth, it is contrarily attracted mainly by the rapid economic growth.

The innovation analysis, including variance decomposition and impulse response, indicates the character of labour-intensive FDI in China. The results suggests that FDI and its effects are associated with the initial conditions of host economies, that economies with low levels of initial human capital would attract less technology-intensive FDI, and this type of FDI would play a smaller role in the development of these economies. The innovation analysis also suggests that FDI could have negative effects on economy in the short-run, but the long-run effects could be positive, though all of them are not significant.

The results, as well as those from the ECM model, suggest that, FDI and economic liberalization, does not voluntarily improve economic growth and technology development in the short-run. They only provide an access for the development. Efforts should be made by developing countries to invest in appropriate technology and labour force for sustainable economic growth. Both innovation analysis and the cointegration analysis suggest that economic growth is the main attractor for huge accumulation of FDI in China.

Contrary to the highly involvement of FDI in China, our results don't support that FDI can stimulate the economic growth. One explanation is that: the huge increase of FDI in China is actually a relative new phenomenon since the late 1990s, it then could not account the rapid growth during the 1980s. Further more, the geographical distribution of FDI is unbalanced in China and agglomerated in the coastal region of China. It did contribute to economic growth in this area. However, since one of the main features of post-1979 growth was countrywide, FDI is by no means a necessary condition for achieving rapid growth for the whole country. And we should not ignore the important role played by the state government through its planning system, though this role is becoming weaker along with the economic reform process. Hence, more efforts from different perspectives should be considered to investigate precisely the effect of FDI on the economy and the sustainable components of the economic growth in China. On the one hand, regional analysis could be considered to capture the different effects on the coastal region and the inland region; or more elements should be included in the time series analysis, particularly the role of the central government should be taken into account in explaining the economic growth in China and the effects of FDI.

NOTE:

1. Foreign loans include loans from foreign government and from international financial organizations, buyers' credits, commercial loans from foreign banks, and bonds issued to foreign countries. FDI are in five major forms: equity joint ventures, contractual joint ventures, wholly foreign-owned enterprises, share-holding companies, and joint explorations. Other foreign investment includes shares issued to foreigners, international leasing, compensation trade and processing assembly.

2. "Real estate, public residential and consultancy services" may include activities not included in "real estate management". The absolute numbers are, therefore, not comparable.

CHAPTER FOUR

THE VAR ANALYSES ON FDI AND ECONOMIC DEVELOPMENT OF TAIWAN AND SOUTH KOREA

4.1. Introduction

The East Asian region, represented by Japan, South Korea**,** Taiwan, all experienced rapid economic growth. From the 1950s, the process of industrialization that started from Japan has been the engine of growth of East Asia. In the 1970s, after reconstructed from the Second World War, the Japanese export industry started to conquer the world, especially the consumer electronics and automotive industries. Since 1960, industrialization occurred rapidly in what are now known as the Asian Newly Industrialized Countries: Hong Kong, Singapore, Taiwan and South Korea. And since late the 1980s, the regional pattern has been evolving rapidly, due to the performance of a new generation of economies as 'global export manufacturing platforms' (see Xu and Song (2000)). These include countries from the Association of Southeast Asian Nations (ASEAN) like Malaysia and Thailand, and later the mainland of China in the 1990s. All their development models are affected by Japan's export-oriented industrialization (see Grunsven (1998)).

Along with international trade, economic development in East Asia can also be caused by trends in foreign direct investment. According to UNCTAD, the share of developing countries in world wide FDI increased from a 21% annual average in the 1980s to 32% in the mid 1990s, and about 25% in the early 2000s to 36% in 2004 and 29% in 2006. Concerning the East Asian region, its share in FDI in developing countries increased from 37% in 1980s to over 60% in 1995, 45% in 2004 and down to 31% in 2006 (UNCTAD (1996, 2007)). Although China took the largest share of the FDI since the 1990s, FDI to other countries was also remarkable compared to the size of their economies. Given the many similarities between the Chinese economy and other countries in the East Asian region, we are interested to exam whether FDI play a similar role in those economies as in China or whether its effect on economic development is just peculiar for China. Particularly, we are interested in the roles of FDI played in the newly industrialized economies, like South Korea and Taiwan, as China follows the similar path of modernization that those countries experienced. Their lessons would be helpful for future development in China's economy. In addition, we would like to verify the 'geese style' story (see Pearson (1994), Xu and Song (2000)), which suggests that the effect of FDI on output might be different according to the development level attended**.** Hence, with the investigations in Taiwan and South Korea, we would like to obtain more information to understand the relationships between FDI and economic growth.

With respect to the endogenous economic growth theories mentioned in the previous chapter, FDI can affect output either directly through the increase of investment or through other spillovers like new technology, labour resources improvement, international integration, which are all assumed to have positive effects on output. Based on this hypothesis, investigations between FDI, output and its spillover effects will be conducted in South Korea and Taiwan. Through this evaluation, with compared to the case in China, some common and different characteristics of FDI on economic development can be discerned. Before doing so, we would like to start with a review on the economic development and FDI trends in these two economies.

4.2. Economic growth and FDI trends in Taiwan and South Korea

4.2.1. Export-oriented industrialization in Taiwan and South Korea

Earlier than China, Taiwan and South Korea pioneered the export-oriented industrialisation since the 1960s. Both of their economic growth strategies were influenced by the example of Japan, which had promoted industries through international trade by encouraging exports. In about 30 years, both South Korea and Taiwan obtained tremendous achievements with rapid growth and upgraded economies. According to Table 4.1, the average annual growth rate was over 9.5% in Taiwan and 8.5% in South Korea during the takeoff period in the 1960s and 1970s. Along with the rapid output growth, exports rose more quickly. Since 1990, as their economies became mature, the average GDP growth rate fell to about 6.4% and 5.7% per year respectively, but the growth rate of exports were still higher than that of output.

Table 4.1. *Average growth rates of output and exports in Taiwan and South Korea (Unit %)*

	Taiwan		South Korea	
Year	GDP	Exports	GDP	Exports
1960-1970	9.6	24.6	8.6	34.7
1970-1980	9.7	16.5	10.1	22.7
1980-1990	7.9	9.7	12	12
1990-2000	6.4	9.9	5.7	15.6

Source: Council for Economic Planning & Development of Taipei, 2001

The fundamental change in Taiwan's growth policy was outlined in 1960, including encouraging private sector business, promoting domestic savings and investment, reforming the banking system, de-valuing the exchange rate and promoting exports, which provided the foundations for Taiwan's rapid growth in four decades based upon export-oriented industrialization. At the same time, the Taiwanese economy experienced significant structural change. The share of manufacturing in GDP rose from 19.1% to 29.2% in this period while manufactured exports grew at an average annual rate of 36.2%, (Council for Economic Planning & Development of Taipei (2001)). These exports mainly comprised textiles, consumer electronics and agricultural products.

In the 1970s, Taiwan successfully promoted its economy from labour-intensive industries to capital-intensive industries with the development in industries of steel, petrochemicals and shipbuilding. There was a shift of the labour-intensive industries to new generation of Southeast Asian developing economies, like Thailand, Indonesia, and the mainland of China. The focus on the development policy of Taiwan therefore shifted to upgrade technology to promote the growth of technology-intensive industries. Since the 1980s, investment in R&D was steadily expanded with the government financing more than half of this expenditure until the early 1990s. The information technology sector was specifically identified as a strategic industry. The establishments of several large semiconductor manufacturers, together with the Hsinchu Science-Based Industrial Park created to attract foreign electronics firms, led to the rapid growth of the domestic computer and electronics sectors. Those products attributed to 71.6% of total exports in 2000 compared to 38.1% in 1991.

The progress of industrialization in South Korea told a similar story. The modernization started with the promotion of light industry such as oil-refining, fertilisers and agricultural machinery, along with textiles in the 1960s. In the 1970s, the development strategy shifted to stimulate heavy industries and chemical sectors to provide downstream inputs for domestic manufacturing. Also another emphasis at this stage was to expand and upgrade South Korea's human capital through education and vocational training in science and technology as well as increased government funding of R&D in these areas. Unlike Taiwan who encouraged private sector, South Korea focused more on the development of big firms by providing them financial support and privilege treatment.

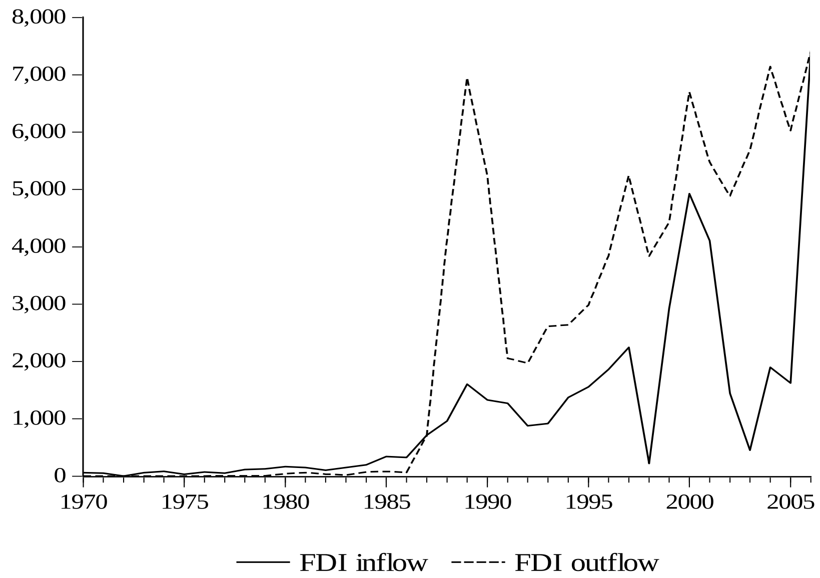
The downturn of economy in early 1980s forced the South Korea government to make more efforts to renew its export-led growth. This new export strategy involved greater incentives for the private sectors and continued promotion of science and technology to facilities industrial restructuring and upgrading as well as further liberalization of imports. Restrictions on foreign investment, primarily FDI, were also liberalized. This move enhanced Korean competitiveness by improving access to the 'leading-edge' technology of foreign MNEs in key high-tech industries and reduced its dependence upon technology transfer, technological agreements and mature technology. Since the late 1980s, South Korea started its second round of industrialization toward establishing high technology-intensive industries. In the 1990s, the boom of exports reflected the success of industrial restructuring and upgrading into increasingly technology-intensive manufactured goods, including televisions, electrical goods and electronic components. It was fuelled further by measurements to improve domestic competitiveness, including regulatory liberalization, privatization, and liberalization of the financial system and international trade. However, the South Korea economy was hit heavily by the 1997 Asian Financial Crisis due to the lack regulation in the financial sector, and did not recover until 2000.

As their economies approached maturity in the 1990s, both the strategies of South Korea and Taiwan were altered to encourage liberalization, including protecting small businesses, releasing restrictions on international trade and investment, and opening financial market. All of these innovations enable these two economies more and more integrating into globalization.

4.2.2. FDI in Taiwan and South Korea

At the initial stage of the industrialization, both countries employed strict restriction on foreign investment. Inflows of FDI to Taiwan until liberalization in the mid-1980s were highly constrained by controls on entries to reserved economic activities, ownership restrictions, and foreign exchange controls over remittances of profit. Annual inflows varied between US$100 million and US$300 million per annum between 1970 and 1980. A significant proportion of FDI inflows up to 1980 was consisted of investment from overseas Chinese, primarily in the basic labour-intensive manufacturing industries, such as textiles and clothing. Taiwan's liberalization of FDI restrictions in 1985 led to an immediate surge in the magnitude of FDI inflows. Total inflows doubled from US$ 700.4 million in 1986 to US$1.4 billion in 1987 and these inflows have, in general, continued to rise, reaching US$ 7.6 billion in 2000, but dropped to US$ 0.45 billion in 2003 and rose rapidly in 2006 to US$ 7.4 billion (see Figure 4.1).

Figure 4.1. *FDI in Taiwan (US$ 1 million)*



Inflows of FDI to Taiwan up to the mid-1970s were mainly in basic labour-intensive manufacturing industries, textile and clothing. Subsequently, there was a marked shift into the chemical and electronic sectors from the 1970s onwards, and more recently, FDI has flowed into the non-traditional sectors of Food and Metals & Machinery. Of aggregate FDI inflows over the period from 1952 to 2000, some as US$ 10.5 billion (23.6%) was in electronics and electrical products; US$ 6.8 billion (15.3%) was in Banking and Insurance-sensitive sectors; and US$ 4.9 billion (11.0 %) was in other services (Council for Economic Planning & Development (2001)).

The trace of FDI outflows from Taiwan is also illustrated in Figure 4.1, while FDI outflows did not reach a significant level until the liberalization in 1986. Since 1990, however, Taiwan has consistently been the source of considerable outflows with the value rising from US$ 1.6 billion in 1986 to US$ 7.4 billion in 2006. Permitted since 1991, the outflows to the mainland of China rose dramatically. Table 4.2 provides a review of Taiwan's FDI in the mainland of China from 1991 to 2000. This rapid growth of FDI to China can be explained as a combination of two factors. As the international competitiveness of many relatively labour-intensive industries in Taiwan has declined, they have been impelled to move offshore to lower labour cost locations. The mainland of China has been proven to be a particularly attractive location for Taiwanese FDI. China's opening-up policy since 1978 has been targeted at attracting inflows of FDI based upon its plentiful supplies of low-cost labour. The proximity of the mainland of China to Taiwan, however, is misled in that it is the proximity of both to Hong Kong. Given the absence of direct links, Hong Kong has been the primary transmission mechanism for both trade and FDI. A critical feature of Taiwanese FDI in the mainland of China is its low quality, as indicated in the final column in Table 4.2, much of this FDI appeared to be in small-scaled enterprises with low technology.

Table 4.2. *Taiwan's trade balance and FDI outflows to the mainland of China*

	trade balance	FDI	FDI projects	average FDI
	US$ 1m	US$ 1m	unit	US$ 1m
1991	3,541.30	174.2	237	0.735
1992	5,169.00	247	264	0.936
1993	6,481.80	3,168.00	9,329	0.34
1994	7,224.90	962.2	934	1.03
1995	8,308.60	1,092.70	490	2.23
1996	8,135.20	1,229.20	383	3.209
1997	7,971.30	4,334.30	8,725	0.497
1998	6,709.20	2,034.60	1,284	1.585
1999	6,546.80	1,252.80	488	2.567
2000	7,612.60	2,607.10	840	3.104

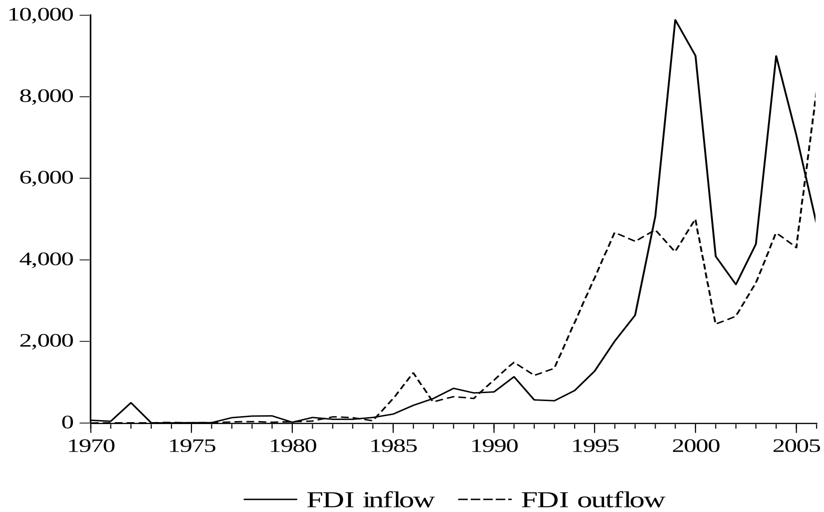
Source: Council for Economic Planning & Development of Taipei (2001), Statistical Data Book of Taipei (2001).

Note: FDI data are for approved/reported investments.

At the initial stage of industrialization before the 1980s, South Korea's policy toward FDI was conservative. South Korea preferred heavy foreign borrowing over substantial inflows of FDI. Instead of FDI, South Korea engaged in promoting technology transfer through licensing and other technological agreements. Such arrangements relied upon the repayment of technical fees, rather than the repatriation of profits and royalties on technology. The justification for this strategy was to retain domestic ownership of South Korean industry, as well as enhancing domestic wealth. Technological agreements and technology transfer provided a means for South Korea to acquire important technology that could be modified and utilized to promote the domestic economy. It also encouraged targeted R&D to modify and develop new indigenous technologies, and increase the likelihood of positive domestic technological spill-over effects (Read (2002)). This inward-looking strategy towards

FDI has been modified as the mature of South Korean economy, which forced South Korea to open itself to foreign investors. Especially, after the 1997 Asian Financial Crisis, when South Korea was heavily in debt, FDI then was regarded as a main source of capital instead of international borrowing. Hence, it can be observed a huge increase of FDI inflows after 1998, while most of them were from developed countries like Japan and the United States.

Figure 4.2. *FDI in South Korea (US$ 1 million)*



The path of FDI outflows from South Korea is illustrated in Figure 4.2. The outflows were relatively small until 1987. The two main destinations for Korean outflows of FDI are the United States and China. The United States has been the principal target for FDI outflows since the early 1980s, while the importance of China increased rapidly after domestic liberalization and the subsequent normalization of relations in 1990. Outflows to China are likely to target on export-oriented labour-intensive manufacturing industries (Lin (2005)).

4.3. The specifications and empirical results of the VAR estimations

As in the previous chapter, the methodology follows the work of Bende-Nabende *et al.* (2003), while the VAR technique would be implemented to interpret the relationship between FDI and economic growth. The system focuses on the supply side and follows UNCTAD (1992), in which it hypothesized that FDI can stimulate economic growth through the creation of dynamic comparative advantages that lead to new technology transfer, capital formation enhancement, human resources development and international trade expansion. Thus, the output is to be estimated as a function combining these variables and it is expected to exhibit positive correlations with these variables. The mechanism can be represented by:

$$GDP = f(KAP, EM, FDI, HK, TTECH, OPEN). \qquad (4.1)$$

Where *GDP=output, KAP=capital formation, EM =employment, FDI= foreign direct investment, HK=human capital, TTECH= new technology,* and *OPEN=international openness*.

Also recalling from Equation 3.29 and Equation 3.30 in the previous chapter, we rewrite the general unrestricted VAR in our regression as:

$$Y_t = C + \sum_{i=1}^{p} A_i Y_{t-i} + B\, D_t + \varepsilon_t \qquad (4.2)$$

where the vector variable Y can be set as Y'= (GDP, KAP, EM, HK, OPEN, FDI, TTECH). Exogenous variables such as the dummy and the linear trend are included in

D_t. Innovation analysis, including impulse response and variance decomposition, is employed to capture the total effects of shocks in FDI and spillovers on economic growth. If there exist a cointegration relationship, an ECM model could be estimated to investigate the long-run relationships from the transformation of the unrestricted VAR:

$$\Delta Y_t = C + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta Y_{t-i} + \ldots + BD_t + \varepsilon_t \qquad (4.3)$$

4.3.1. Definitions and measurements of variables in each VAR model

In the system of each country, the seven endogenous variables: output, capital formation, employment, human capital, international openness, FDI and technology transfer, are defined as the same as the case of China in the previous chapter, where output refers to GDP; capital formation is domestic capital formation; employment is the number of people employed in the economy; human capital refers to the student enrolment ratio in the secondary education; international openness is the ratio of total international trade in GDP; FDI is actually utilized FDI inflow; technology transfer is the ratio of imports of machinery and transport products in total output.

The measurements of variables are almost the same as those in the previous chapter, where output, capital formation, international trade, and imports of technology are measured in domestic currency at constant prices of 1990 of each country; employment is the average annual number of people employed in each country;

human capital is measured as the ratio of the student enrolled in the secondary education in the ageing population. However, in order to achieve a stable system, FDI in Taiwan is measured as the value of FDI inflow in 10 billion in domestic currency at constant prices of 1990; FDI in South Korea, is measured as FDI inflow in 1 billion in domestic currency at constant prices of 1990.

The annual data in the estimation are available from 1970 to 2006, and are collected from the National Statistic Yearbooks of these two countries, UNCTAD database and the database of Asia Development Bank (ADB). A dummy variable is introduced in the model for each country to capture the shock caused by the financial crisis in Asia in 1998. As the case discussed in China in the previous chapter, it is still justifiable to implement capital formation variables, domestic capital formation and FDI inflow, instead of arbitrary variables of capital stocks in our systems for both the two countries. The experiments of comparison can be found in Appendix A4. In the model of Taiwan, output, capital formation, employment and human capital are in logarithm, while FDI is in its level, and openness (OPENTW) and technology transfer (TTECHTW) are in their ratios. In the model of South Korea, all variables are in logarithm except FDI in its level, and technology transfer (TTECHK) in the form of a ratio. So variables in estimation could be in the same order of integration.

4.3.2. Specifications of the unrestricted VAR models

Firstly, ADF test and KPSS test are introduced to investigate if variables in estimation have unit roots. The results indicate that all variables could be treated as I(1) variables for both of the two cases. Details can be found in the Appendix A4.1. Therefore, we initially estimate the unrestricted VAR for each country, and then, test cointegration. If there is any long-run relationship or cointegration among variables, an Error-Correction Model would be introduced to investigate the long-run relationships for each country.

Table 4.3. *VAR lag order selection criteria for Taiwan and South Korea*

Taiwan						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	304.6359	NA	1.34e-16	-16.68447	-15.74171	-16.36296
1	467.9482	230.5585	1.82e-19	-23.40871	-20.26621	-22.33703
2	536.8176	68.86940	9.97e-20	-24.57750	-19.23524	-22.75564
3	678.7735	83.50351*	2.38e-21*	-30.04550*	-22.50348*	-27.47346*
South Korea						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	226.2220	NA	1.35e-14	-12.07188	-11.12913	-11.75038
1	371.7956	205.5156	5.21e-17	-17.75268	-14.61017	-16.68100
2	469.1852	97.38963*	5.33e-18	-20.59913	-15.25687	-18.77726
3	575.0458	62.27097	1.06e-18*	-23.94387*	-16.40186*	-21.37183*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error; AIC: Akaike information criterion;

SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Results of log-likelihood ratio tests in Table 4.3 suggest that unrestricted VAR of both countries should have 3 lags in their optimal situations. However, we do not have enough observations to estimate the cointegration relationships in the VARs with three lags. One lag could be the second choice for both cases accordingly. In addition, the companion matrices from both the systems are tested and none of the eigenvalues is greater than one in absolute value, which ensure that the systems are mathematically stable (see Appendix A4.2.2 and Appendix A4.3.2).

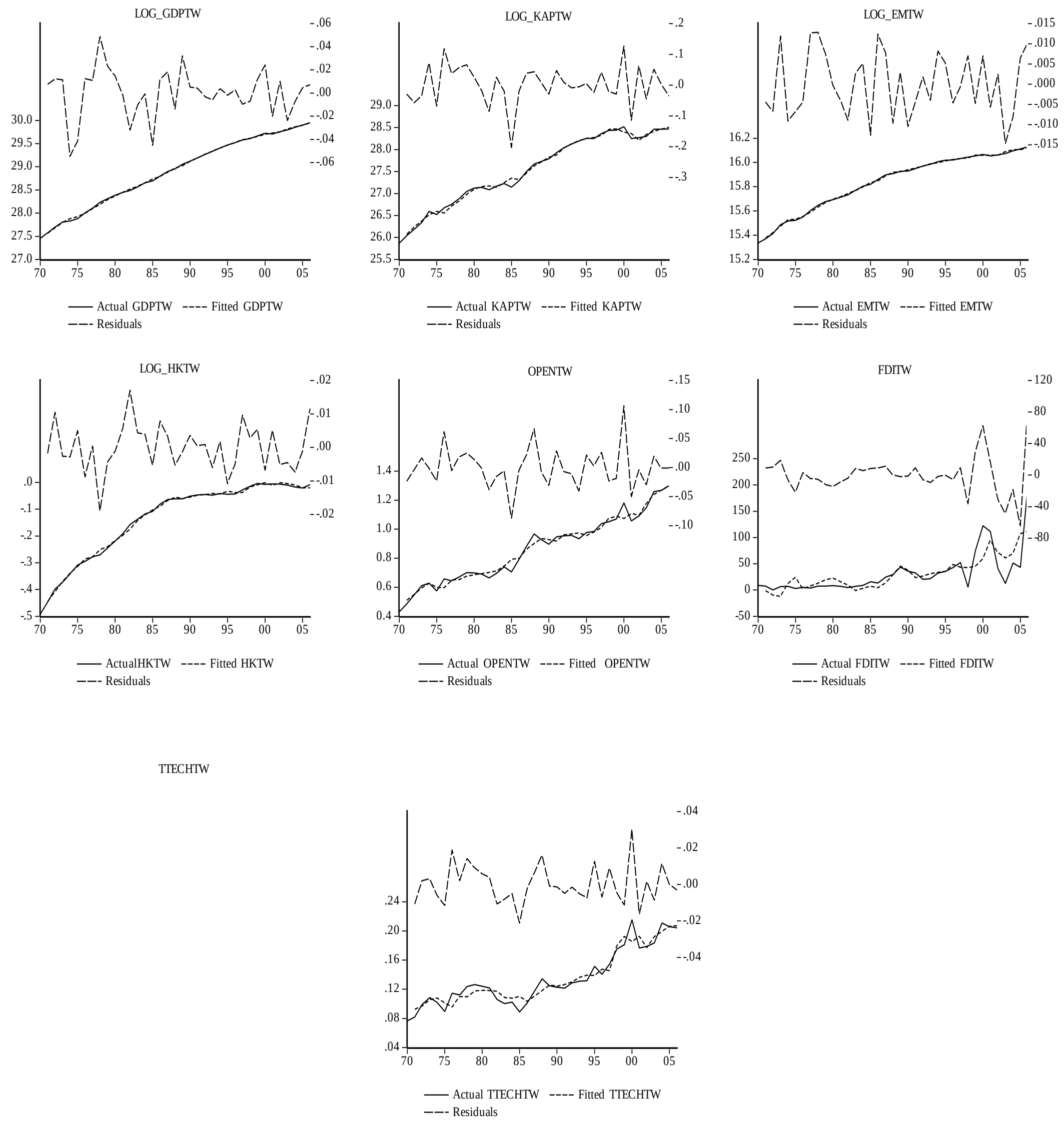
From the results of F-tests in Table 4.4, we find that the linear trend is significant in the VAR model for each country. As the financial crisis in 1998 deeply damaged these two countries, the results indicate the significance of the dummy variable in each VAR model. Consequently, our unrestricted system for each country is estimated by the seven endogenous variables with one lag, one dummy variable and a linear trend.

Table 4.4. *F-test for significance*

Taiwan		South Korea	
F-test	t-stats [prob.]	F-test	t-stats[prob.]
F (7,20) on retained regressors		*F (7,20) on retained regressors*	
GDPTW (-1)	3.61890 [0.011]*	GDPK (-1)	6.57713 [0.000]**
KAPTW (-1)	13.4650[0.000]**	KAPK (-1)	3.82556 [0.009]**
EMTW (-1)	1.78076 [0.147]	EMK (-1)	5.79179 [0.001]**
HKTW (-1)	9.05313 [0.000]**	HKK (-1)	49.6595 [0.000]**
OPENTW (-1)	9.91807 [0.000]**	OPENK (-1)	6.33521 [0.001]**
TTECHTW (-1)	5.93850[0.001]**	FDIK (-1)	1.31830 [0.293]
FDITW (-1)	2.01443 [0.104]	TTECHK (-1)	1.87484 [0.128]
Trend	3.52142 [0.013]*	Trend	3.41732 [0.014]*
Constant	3.35711 [0.016]*	Constant	1.91144 [0.121]
dummy98	2.99855[0.025]*	dummy	5.19475 [0.002]**
F(56,113) on regressors except	32.8036 [0.0000] **	*F(56,113) on regressors except*	30.4478 [0.0000] **

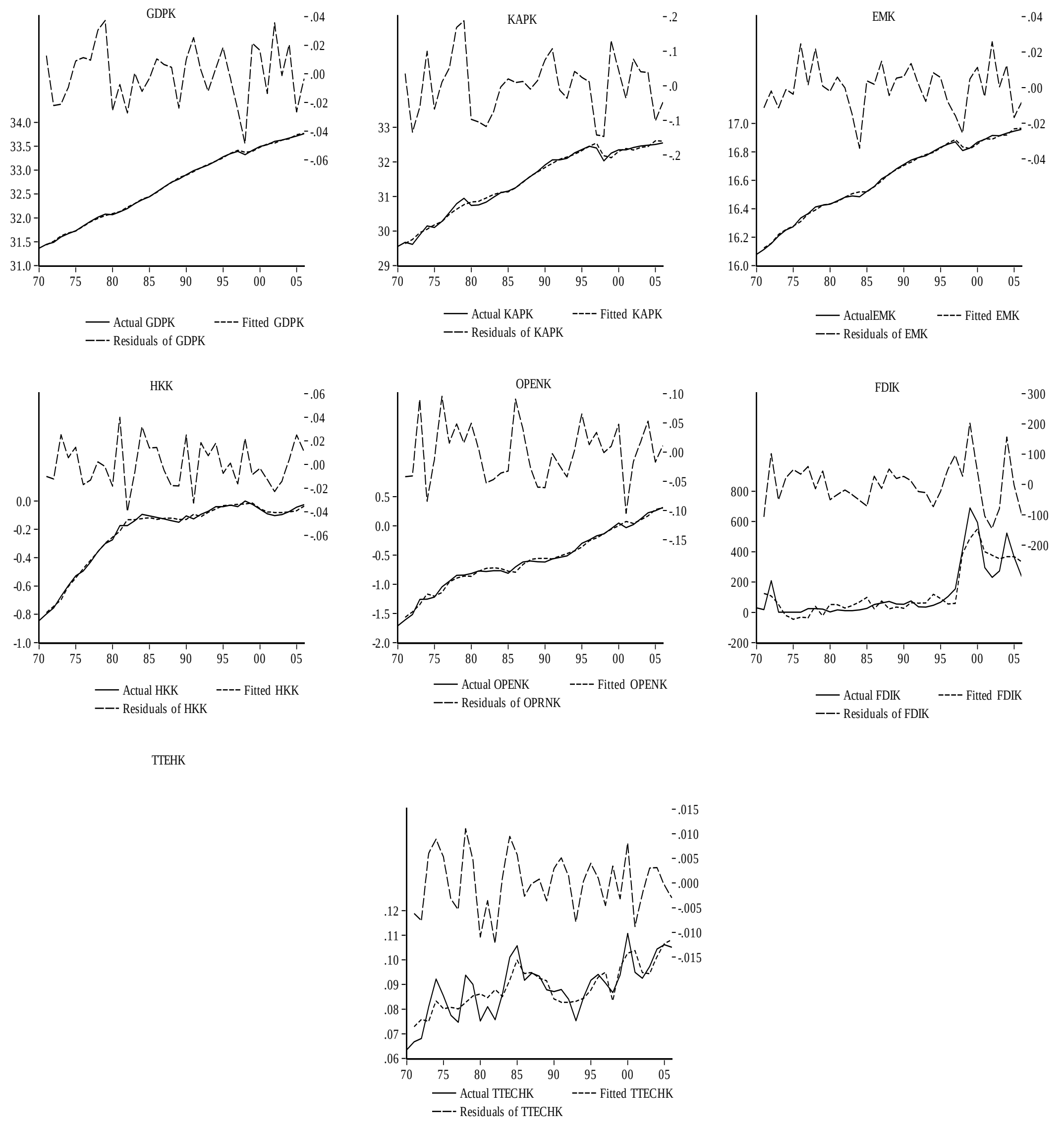
The residuals of the unrestricted VAR of each country, as well as actual and fitted values of all variables, are illustrated in Figure 4.3 and Figure 4.4 respectively. The virtual coincidence between the actual and fitted values is apparent for all equations of each VAR. The residuals also are stationary under the ADF-test for both of the VARs (see Appendix A4.2.8 and Appendix A4.3.8).

Figure 4.3. *Residuals and actual-fitted values of the VAR of Taiwan*



For both the VARs, the standard diagnostic tests indicate that there is no ARCH, no Heteroskedasticity, and no Autocorrelation among residuals (see Appendix A4.2.9, Appendix A4.3.9). But residuals from the VAR of Taiwan are not following Normality distribution for the equations of openness and FDI. However, Johansen (1995) pointed out that the normality assumption might not be important for the cointegration test, and Juselius (2006) noteed that the absence of normality is of no import provided it is due to excess kurtosis. Thus, the whole results are still acceptable for the evaluation of the existence of cointegrating vectors in the systems.

Figure 4.4. *Residuals and actual-fitted values of the VAR of South Korea*



4.3.3. The cointegration test

As in the previous chapter, the cointegration Trace test is undertaken, by the methodology developed by Johansen (1991, 1995), to investigate whether there is any long-run equilibrium relationship among all these variables in the VAR of each country. The critical values for the Trace test are taken from Osterwald-Lenum (1992). We also take into account the adjustment needed for the small sample size in our models by considering the simulative critical values generated by the Monte-Carlo method (developed by Bagus-Santoso (2002)).

Since a linear trend is in both the VARs, we can assume that there exists a linear trend in the cointegrating vectors according to the rationale of Johansen test described in the previous chapter. Hence, the Johansen test for cointegration can be estimated by the model with assumption 4 (see Equation (3.14)) for both countries. The test results are reported in Table 4.5 and Table 4.6 respectively. In both cases, results based on different critical values are incongruous. However, we noticed that the Trace-test values of the rank ≤ 3 for both cases are rejected according to the Bagus (2002) critical values by very small margins at the 5% significant level. Considering the critical values may not be so precise for the small sample-size VAR, it is possible that the hypothesis of the rank ≤ 3 might actually not be rejected. Hence, we tend to accept the results suggested by the Osterwald-Lenum (1992) critical values that there are 3 cointegrating vectors in each VAR.

Table 4.5. The u*nrestricted cointegration rank test (Trace) for Taiwan*

Hypothesized	Eigenvalue	Trace Statistic	Critical Value by Osterwald-Lenum		Critical Value by Monte-Carlo simulation	
No. of CE(s)			CV of 5%	Prob.**	CV of 5%	CV of 10%
None *	0.859939	216.0082	150.5585	0	184.5822	177.4296
At most 1 *	0.75243	145.2439	117.7082	0.0003	128.0127	122.7998
At most 2 *	0.646685	94.98569	88.8038	0.0166	87.64295	83.6293
At most 3	0.418955	57.53142	63.8761	0.1522	57.42634	54.41521
At most 4	0.389052	37.98605	42.91525	0.1427	34.91508	32.75754
At most 5	0.330652	20.24728	25.87211	0.2137	18.6708	17.17359
At most 6	0.148685	5.795041	12.51798	0.4868	7.440238	6.626578

Table 4.6. *The unrestricted cointegration rank test (Trace) for South Korea*

Hypothesized	Eigenvalue	Trace Statistic	Critical Value by Osterwald-Lenum		Critical Value by Monte-Carlo simulation	
No. of CE(s)			CV of 5%	Prob.**	CV of 5%	CV of 10%
None *	0.79781	203.3124	150.5585	0	184.5822	177.4296
At most 1 *	0.76012	145.7647	117.7082	0.0003	128.0127	122.7998
At most 2 *	0.618905	94.37047	88.8038	0.0187	87.64295	83.6293
At most 3	0.497131	59.64107	63.8761	0.1079	57.42634	54.41521
At most 4	0.394914	34.89374	42.91525	0.2495	34.91508	32.75754
At most 5	0.242185	16.80787	25.87211	0.4294	18.6708	17.17359
At most 6	0.172685	6.824498	12.51798	0.3632	7.440238	6.626578

According to Johansen (1995), we also need to demonstrate whether we choose the appropriate model when conducting the Johansen test. The log-likelihood ratio test is introduced to test whether the liner trend and the intercept exist in the cointegrating vector. We firstly test the existence of a linear trend, if the hypothesis of no liner trend is not rejected, we would undertake the Johansen test with the model 3, and test against model 2 that intercept is only limited to the cointegrating vectors. Table 4.7 provides eigenvalues from both the cases of mode 3 and model 4 for each VAR. The tests for only intercept in the cointegrating vectors against a linear trend give log-likelihood statistics of 13.67025 for Taiwan and 11.597379 for South Korea. As 5% of χ^2 (3) distribution statistic is 7.81472776, the null hypothesis of no trend in the cointegrating vectors is rejected for the VAR of each country. Hence, the model 4 that a linear trend is restricted in the cointegration relationships is appropriate for our systems, so are both the results of three cointegrating vectors associated with this assumption.

Table 4.7. *LR test for linear trend in cointegration relationships*

Taiwan		South Korea	
Roots with linear trend λ_{4i} (Model 4)	roots without trend λ_{3i} (Model3)	Roots with linear trend λ_{4i} (Model 4)	roots without trend λ_{3i} (Model3)
0.859939	0.856556	0.79781	0.781182
0.75243	0.734228	0.76012	0.714104
0.646685	0.530214	0.618905	0.592241
0.418955	0.412135	0.497131	0.495952
0.389052	0.37491	0.394914	0.244642
0.330652	0.156113	0.242185	0.172686
0.148685	0.003842	0.172685	0.036235
$LR= -T\sum_{i=1}^{r}\ln[(1-\lambda_{4i})/(1-\lambda_{3i})]$ =13.67025 [prob: 0.00339]		$LR= -T\sum_{i=1}^{r}\ln[(1-\lambda_{4i})/(1-\lambda_{3i})]$ = 11.597379 [prob: 0.00889]	

4.4. Innovation accounting of the VAR models

In the following section, we would discuss the relationships between economic growth, FDI and spillovers through the innovation analyses based on the results from the VAR model of each country. The variance innovation analyses capture the total effects of each variable by the applications of impulse response and variance composition.

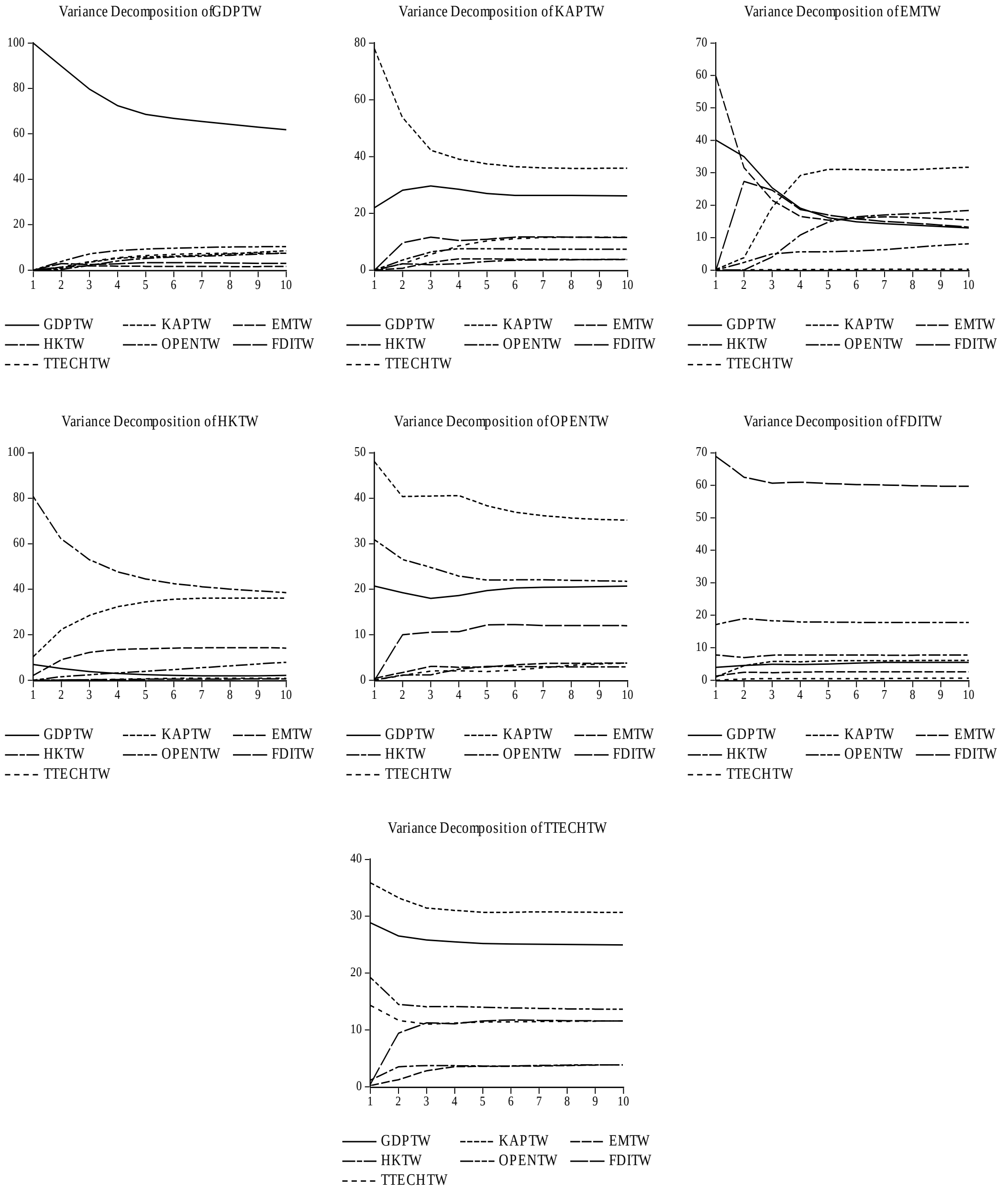
4.4.1. Variance decomposition

Variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR. With a ten-year forecasting horizon adopted, the variance decomposition is undertaken on all variables by the Cholesky decomposition method in the order of output, capital formation, employment, human capital, openness, FDI and technology transfer. All the results for Taiwan can be seen in Appendix A4.2.10, and those for South Korea can be found in Appendix A4.3.10.

Variance decomposition of Taiwan

As illustrated in Figure 4.5, our results suggest that GDP is largely influenced by its own fluctuations. Capital formation, human capital, openness and technology transfer, have some increasing contributions in explaining the forecast variance of GDP during the observed period. Employment and FDI can only explain the fluctuations of GDP by a small margin of 1.5 % and 3.0% respectively. In explaining the variation of FDI, FDI itself makes the most contribution by about 60%, while openness takes about 17% through out the observed period. Output and capital formation have increasing effects with compositions of 5.5% and 6% respectively by the end of the observed period. The composition of human capital and employment are relatively stable around 2.6% and 7.7% respectively. Technology transfer does not show significant influence on the fluctuations of FDI.

Figure 4.5. *Variance decomposition of the VAR of Taiwan*



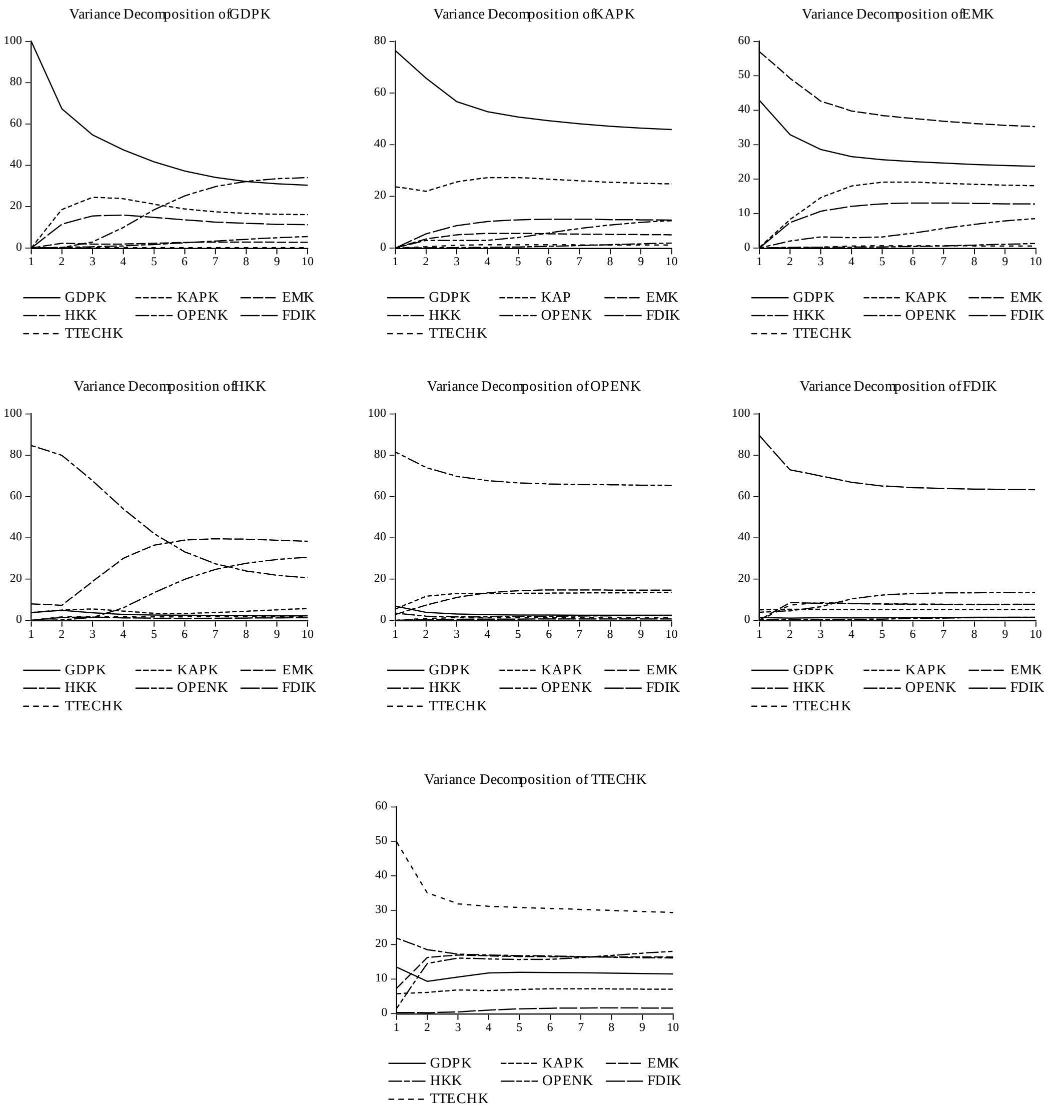
For variance decompositions of spillovers, we find that FDI play notable roles in explaining all these spillovers except human capital. It can only explain the fluctuations of human capital by less than 1%. Its impacts on capital formation and openness are relatively stable throughout the period by about 11% and 12% respectively, while the impact on employment drops from 27% to 13% in about 10 years, the impact on technology transfer increases rapidly from 0.4% to 11.5% in the end (see Appendix 4.2.10).

Variance decomposition of South Korea

Compared with the case of Taiwan, the contribution of FDI to the fluctuations of output is much greater for South Korea, by about 11% explanatory power throughout the observed period. Our results are illuminated in Figure 4.6, where openness plays the most important role in explaining the variation of economic growth after 10 years, while output explains its own deviation decreasingly from the initial 67% to the final 30%. Capital formation and human capital make their considerable contributions by about 16% and 5% respectively. Like the case of Taiwan, we have not found significant role of technology transfer in accounting for the variance decomposition of output.

From Figure 4.6, the contributions from all variables to explain the variation of FDI are not impressive, as FDI itself (63%) contributes most of its own variation. Only openness plays a considerable role by explaining about 13% of the FDI variation. Attributed to the FDI in capital-intensive industry, we find some influence from technology transfer, which explains about 7% of the variation of FDI. The expectation that FDI improves spillovers can be confirmed by its roles in explaining the variations of capital formation and employment, where its contributions are about 10% for both of them. The expected impacts on sustainable factors of economic growth, such as human capital and new technology, are not supported by the variance decomposition analysis (see Appendix 4.3.10).

Figure 4.6. *Variance decomposition of the VAR of South Korea*

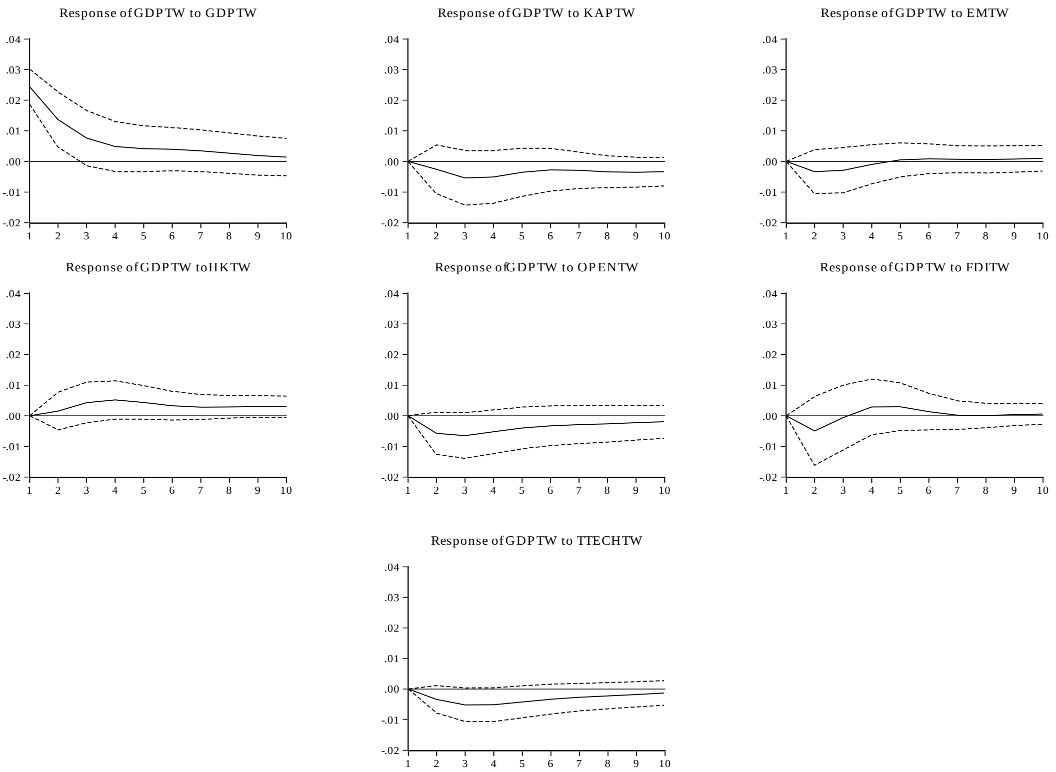


4.4.2. Impulse response

The impulse response analysis traces out the time path of the effects of the various shocks to each endogenous variable to determine how each endogenous variable responds over time to a shock to that variable and in every other endogenous variable.

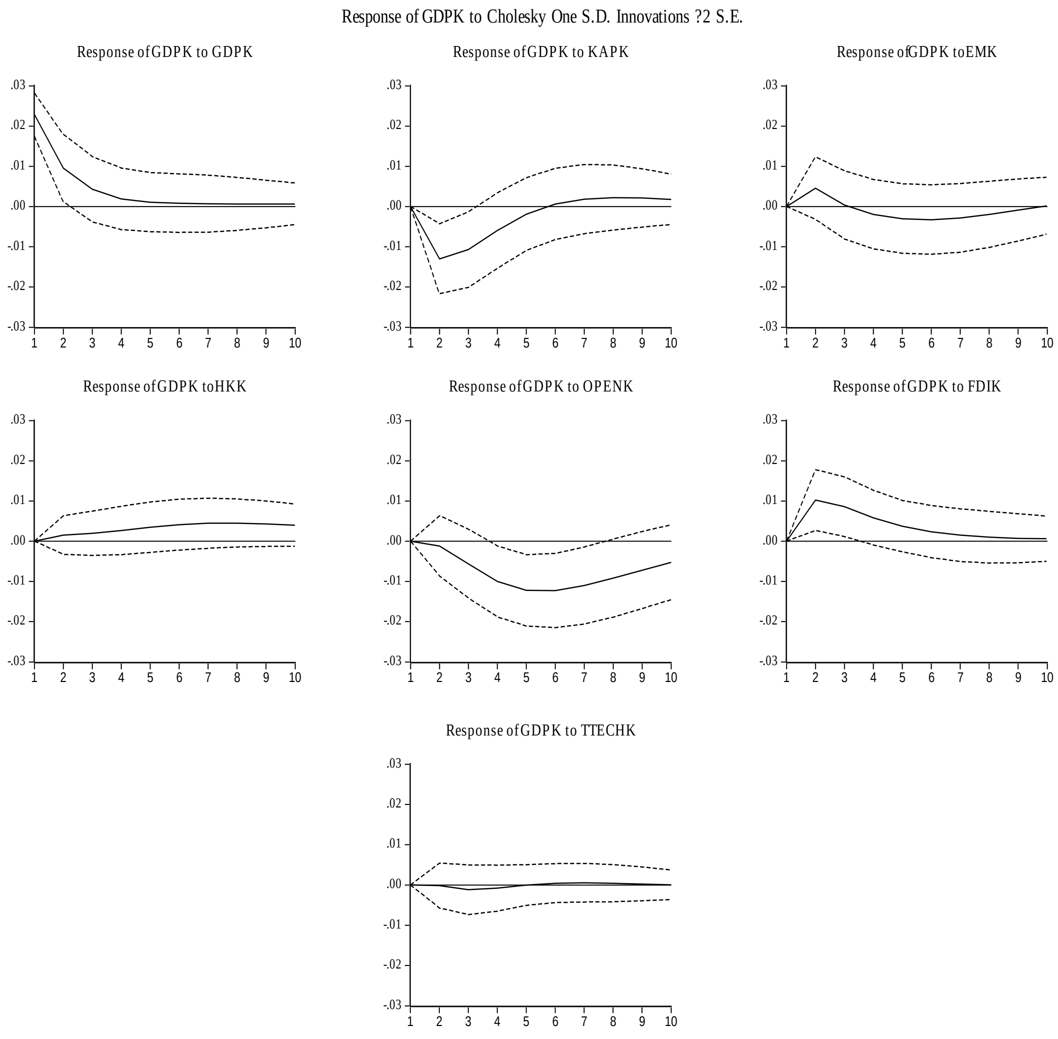
The shock refers to one standard deviation innovation derived from the Cholesky decomposition on the covariance matrix of the residuals. Because that the impulse response with Cholesky decomposition method could vary by different decomposition orders if some pairs of residuals are highly correlated, generalized impulse response (Pesaran and Shin (1998)) is also employed for both countries to generate more robust conclusions through comparing with the Cholesky impulses. Our results indicate that two of them are similar in most of the cases for each country, which implies that the impulse responses by Cholesky decomposition are convincible to be used in analysing the relationships of output, FDI and spillovers. All the results could be found in Appendix A4.2.11-12 and Appendix A4.3.11-12.

Figure 4.7. *Responses of GDP to Cholesky one S.D. innovation in Taiwan*



According to the results illustrated in Figure 4.7 and Figure 4.8, though we find positive effects from FDI on GDP for most of time, our results are not helpful in interpreting output, as its responses to either Cholesky impulses or generalized impulses of all variables, are merely exiguous for the two countries. Hence, we focus on the responses and impulses of FDI.

Figure 4.8. *Responses of GDP to Cholesky one S.D. innovation in South Korea*



Impulse response analysis on FDI in Taiwan

The results in Figure 4.9 suggest that FDI in Taiwan can be affected by all variables involved. FDI would increase with the enhancements of openness and new technology through the whole period; and react positively in the short-run and over time to higher employment and capital formation. Country to the initial positive effects, GDP and human capital would damage FDI in the long-run. Reactions of spillovers to the innovation of FDI are quite limited, as we can only capture a small negative effect on capital formation in the short-run as shown in Figure 4.10.

Figure 4.9. *Responses of FDI to Cholesky one S.D. innovation in Taiwan*

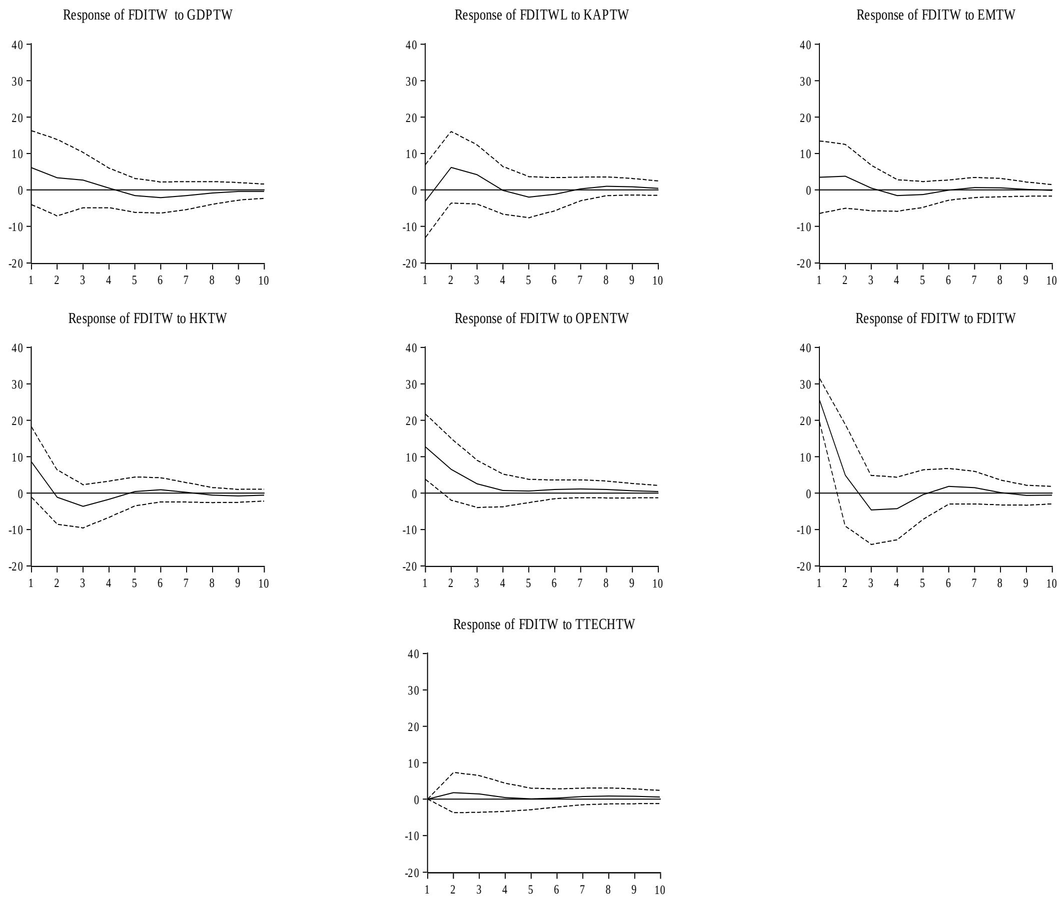
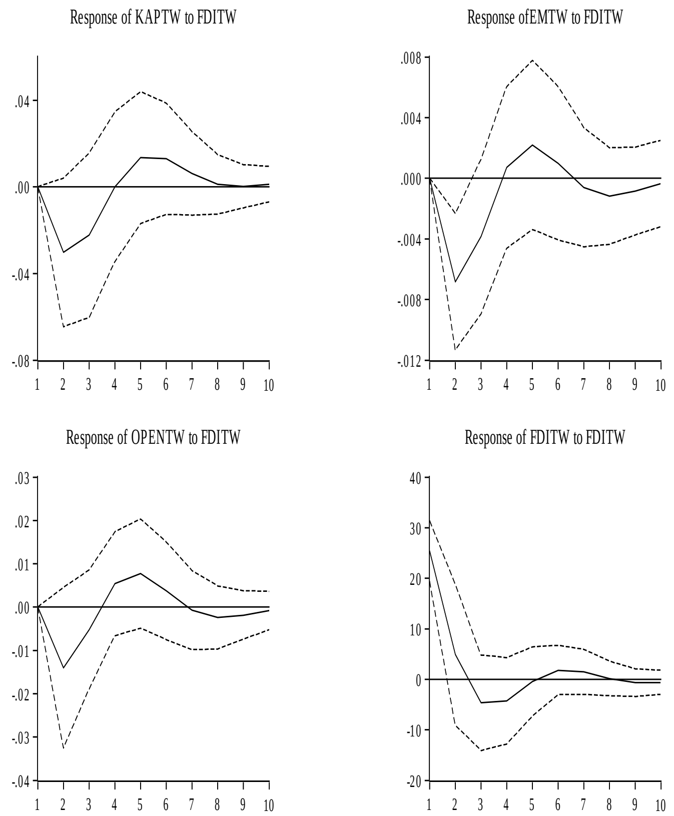


Figure 4.10. *Responses of spillovers to Cholesky one S.D. innovation of FDI in Taiwan*



Impulse response analysis on FDI in South Korea

From Figure 4.11, we find that output and human capital would positively affect FDI at most of the time. FDI would respond to the innovations of capital formation and employment negatively in the short-run, but positively in the long-run. Contrarily, openness has the inverse pattern in affecting FDI with the positive influence in the short-run and the negative influence in the long-run. Technology transfer would damage FDI in the short-run and overtime. Similar to the case of Taiwan, FDI only has a small but positive impact on capital formation in the short-run.

Figure 4.11. *Responses of FDI to Cholesky one S.D. innovation in South Korea*

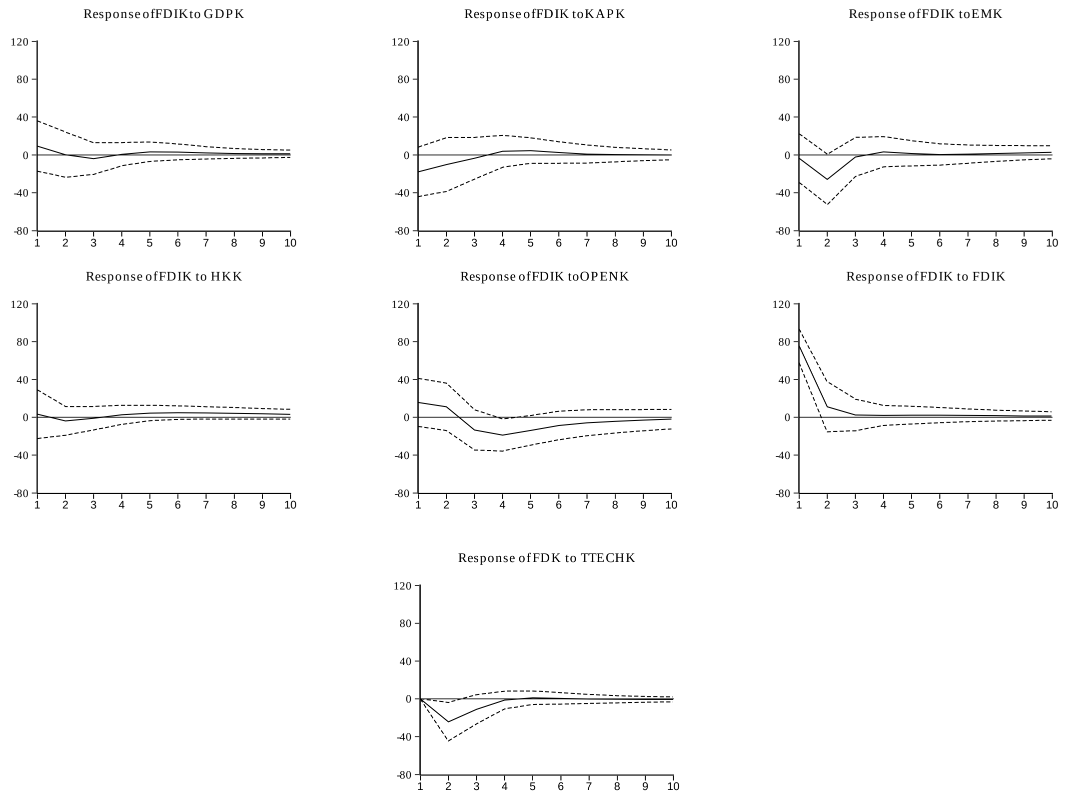
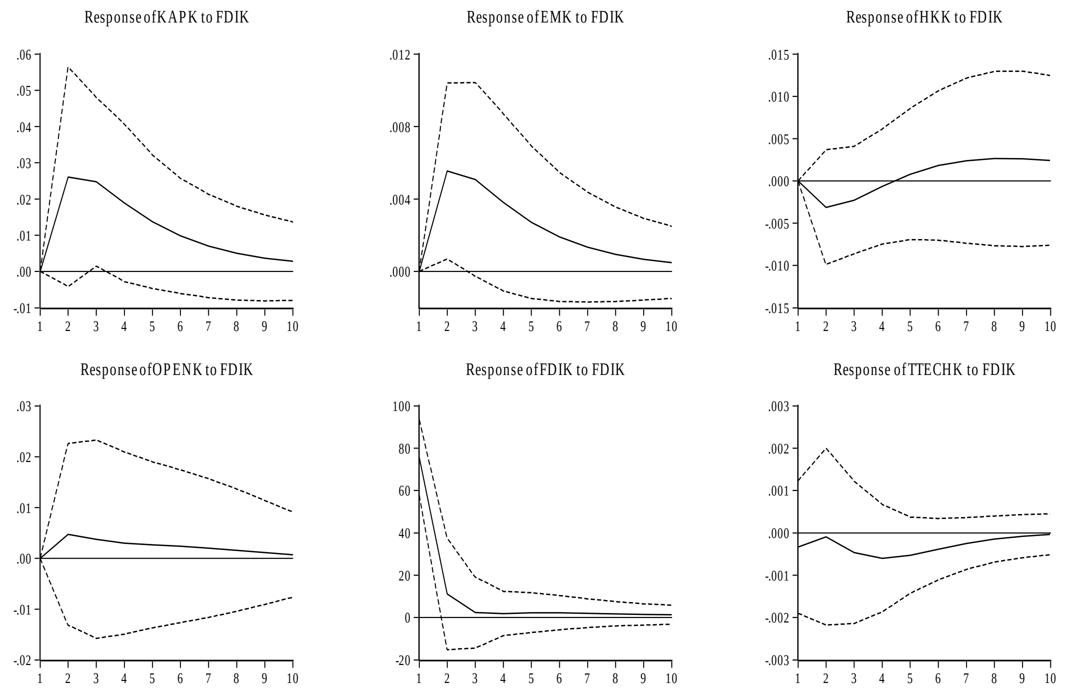


Figure 4.12. *Response of spillovers to Cholesky one S.D. innovation of FDI in South Korea*



Comparing the effects on FDI of these two countries, it suggests that, FDI in Taiwan is possibly oriented by saving efficiency and regard Taiwan as a platform to export their high-technology products, especially in the semi-conductor industry. Hence, FDI would be affected negatively by output and positively by openness; whilst FDI in South Korea is mostly driven by market-seeking motivation and would be attracted by enhanced market size, and be substituted by international trade when the country becomes more open to the world. The different effects of technology transfer on FDI may reflect the different technology development strategies of these two countries: Taiwan focuses on encouraging high-technology FDI and R&D from MNEs to stimulate its technology development, so that new technology introduced is dominated by MNEs and has positive correlation with FDI; whilst South Korea introduces new technology by buying patents and signing licence agreements for domestic companies, therefore, technology imported is led by the government and domestic companies, hence, would crowd out FDI by competition.

4.5. The ECM models and the long-run relationships

Since we find the existence of cointegrating vectors, the unrestricted VAR of each country thereby could be re-estimated by the error-correction model as represented by equation 4.2:

$$\Delta Y_t = C + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Pi_i \Delta Y_{t-i} + \ldots + BD_t + \varepsilon_t \qquad (4.3')$$

where $\Pi = \alpha\beta'$

With the information of cointegration test, the ECM model can be specified when the long-run relationships, or cointegrating vectors, $\beta'Y$ is identified for each country, which then enable us to investigate the long-run equilibrium relationships between variables and the correction from variables to the short-run disequilibrium.

4.5.1. Identification of cointegrating vectors of each country

Identification of cointegration relationships is to distinguish cointegrating vectors empirically from each other. The ideal is to be able to impose constraints on the coefficients in the cointegrating vectors (elements of the matrix β) and/or the adjustment coefficients (elements of the matrix α), so that both the restrictions hold statistically by the Chi-squared test. These attempts of adding restrictions are based on economic theories, as well as empirical experiments. As in Chapter Three, our endeavours to identify the cointegrating vectors are focused on exploring these kind of issues: (1) the long-run links between GDP and FDI and vice-versa; (2) the possibility that spill-over effects from FDI might affect GDP and employment, such effects arising from the use of more advanced technology in production, either directly or indirectly through imports of technological products; and, (3) the possibility of identifying a long-run aggregated production function.

Results of the identified cointegrating coefficient matrices β for both countries are reported in Table 4.8, and their adjusted coefficient matrices α, are given in Table 4.9 and Table 4.10 respectively, where the cointegrating vectors are identified.

Accordingly, the LR tests indicate that the null hypothesis that these restrictions are insignificant is not rejected for both of them. Hence, the identification of the long-run relationships for each country is valid and consistent with the original VAR.

Table 4.8. *Cointegrating coefficients matrices β of South Korea and Taiwan*

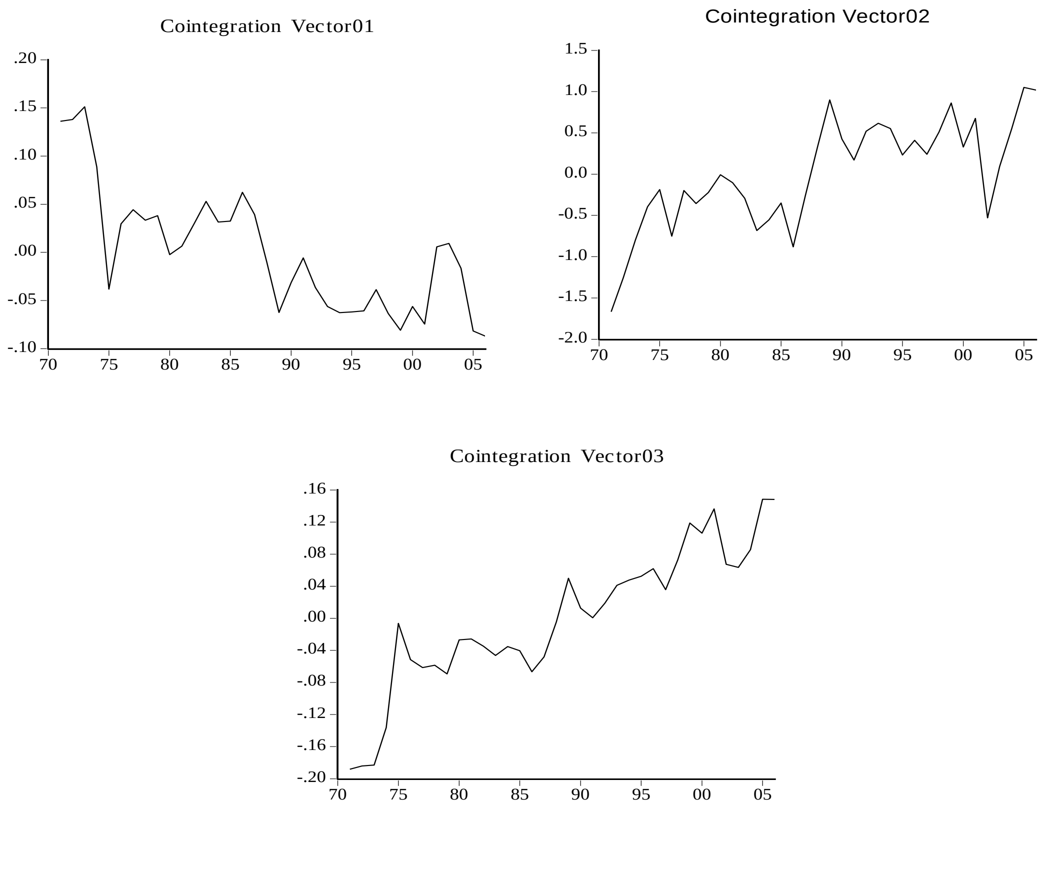
Standard errors in ( ) & t-statistics in [ ]

South Korea				**Taiwan**			
Cointegration Restrictions: β(1,6)=1, β(2,1)=1, β(3,2)=1, β(2,2)=-1, β(2,3)=-1, β(3,1)=-1, β(1,3)=0, β(1,4)=0, β(1,5)=0, β(3,5)=0 α (1,1)=0, α (3,1)=0, α(5,3)=0, α (5,1)=0 α (4,1)=0, α (1,2)=0				Cointegration Restrictions: β(1,1)=1, β(2,2)=1, β(3,3)=1, β(1,6)=0, β(3,6)=0 β(2,4)=0, β(3,4)=0 , β(3,5)=0, β(2,3)=0, β(2,1)=0, β(2,7)=0 α (7,1)=0, α (7,2)=0, α (7,3)=0 , α (6,1)=0, α (6,3)=0 α (1,1)=0, α (1,3)=0, α (5,2)=0, α (3,3)=0, α (2,3)=0			
Convergence achieved after 1299 iterations Restrictions identify all cointegrating vectors LR test for binding restrictions (rank = 3): Chi-square(7)= 2.44065; Probability: 0.9315				Convergence achieved after 578 iterations; Restrictions identify all cointegrating vectors LR test for binding restrictions (rank = 3): Chi-square(12)= 9.393985; Probability: 0.668961.			
Coint Eq:	*CointEq1*	*CointEq2*	*CointEq3*	*Coint Eq:*	*CointEq1*	*CointEq2*	*CointEq3*
GDPK(-1)	-98.46702	1	-1	GDPTW(-1)	1.000000	0.000000	-1.096142
	-80.3925						(0.07517)
	[-1.22483]						[-14.5820]
KAPK(-1)	-436.9603	-1	1	KAPTW(-1)	-0.368336	1.000000	0.346313
	-27.9943				(0.02645)		(0.03845)
	[-15.6089]				[-13.9264]		[9.00788]
EMK(-1)	0	-1	2.941169	EMTW(-1)	-1.340825	0.000000	1.000000
			-0.36171		(0.14544)		
			[8.13129]		[-9.21887]		
HKK(-1)	0	-1.644595	-0.838896	HKTW(-1)	0.544182	0.000000	0.000000
		-0.26418	-0.09739		(0.10499)		
		[-6.22526]	[-8.61417]		[5.18341]		
OPENK(-1)	0	1.478753	0	OPENTW(-1)	-0.191559	6.973336	0.000000
		-0.20098			(0.04435)	(0.88643)	
		[7.35778]			[-4.31911]	[7.86679]	
FDIK(-1)	1	0.001473	-0.002294	FDITW(-1)	0.000000	-0.007255	0.000000
		-0.00025	-9.20E-05			(0.00179)	
		[5.78049]	[-24.8233]			[-4.04968]	
TTECHK(-1)	-682.7964	-8.2889	4.365825	TTECHTW(-1)	0.491037	0.000000	0.489131
	-1717.29	-4.8198	-4.11636		(0.30492)		(0.34497)
	[-0.39760]	[-1.71976]	[1.06060]		[1.61040]		[1.41789]
TREND	52.23943	0.018962	-0.096019	@TREND(70)	-0.023770	-0.156982	0.036519
	-5.14816	-0.01048	-0.011		(0.00232)	(0.01921)	(0.00432)
	[10.1472]	[1.80907]	[-8.72785]		[-10.2337]	[-8.17360]	[8.44779]
C	15888.6	16.06069	-46.04927	C	3.109487	-30.32100	5.537911

(β_{ij} denotes the coefficient on the j^{th} variable in equation *i*; and α_{ij} denotes the coefficient on the j^{th} error correction term in the first difference equation of variable *i*).

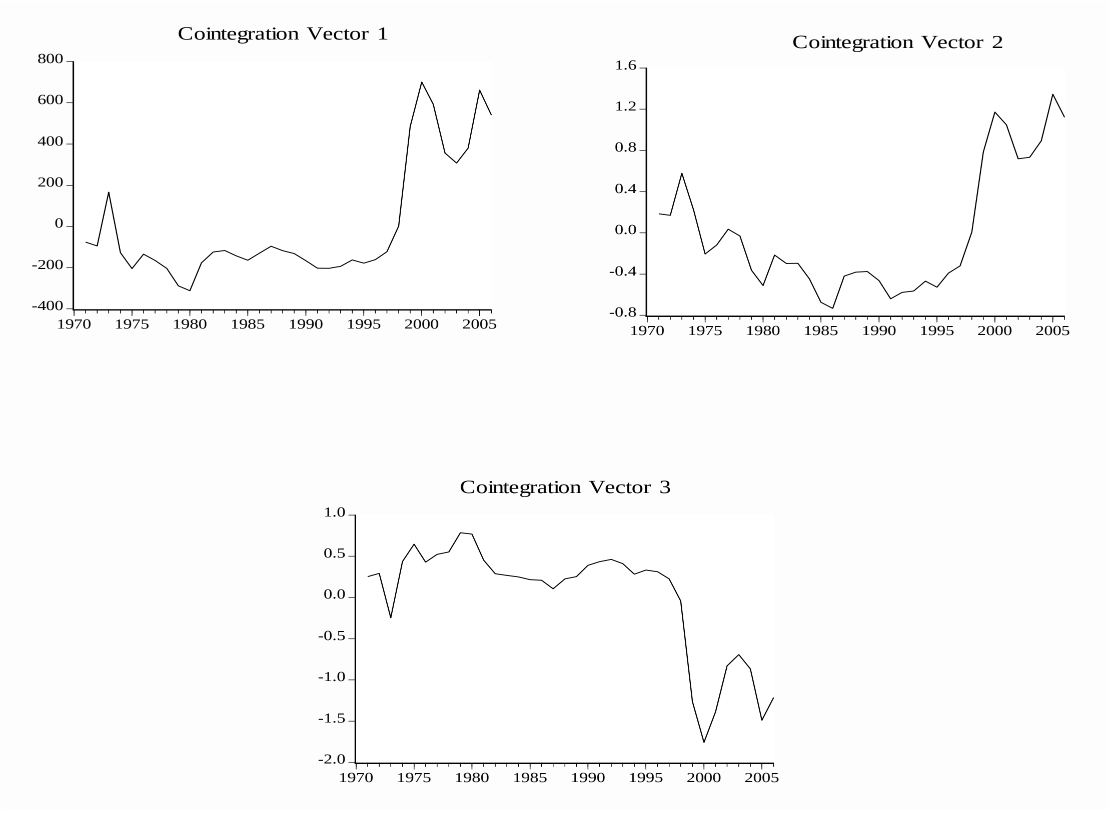
The graphs of the cointegrating vectors for each country are given in Figure 4.13 and Figure 4.14. For the case of Taiwan, all vectors are I(0) as they appeared with the relevant statistics being as follows: for CV1, with statistically significant intercept and trend, the ADF t-statistic is -3.983088 [0.0190]; for CV2, with an intercept and a trend, the ADF test produces a test statistic of -3.899099 [0.0227]; For CV3, with a statistically significant intercept and trend, the ADF t-statistic is -4.415494 [0.0067].

Figure 4.13. *Cointegration relationships of Taiwan*



The cointegrating vectors identified for South Korea, do not look to be I(0) but they are: for CV1, KPSS test with a constant and a trend, using the Bartlett Kernel and Andrews Bandwidth, gives an LM statistic of 0.1438 which is below the 5% critical value of 0.1460; CV2, with just a constant has an LM statistic of 0.40767 under the KPSS test, which is below the 5% critical value of 0.460; and, CV3 has an LM statistic of 0.3479, with a constant in the test equation. This is even almost below the 10% test value of 0.347. Additionally, by the Perron (1997) break test, CV1 and CV3 are I(0) with a trend break in 1997: which is relevant in terms of the use of the dummy (see Appendix A4.3.16).

Figure 4.14. *Cointegration relationships of South Korea*



4.5.2. The long-run relationships of each country

These identified long-run relationships give some possible indications of the answers to the links between economic development and FDI. We would discuss the implications from these long-run relationships for each country respectively.

The long-run relationships of Taiwan

According to Table 4.8, the long-run equilibriums of Taiwan can be rewritten into equations by omitting the trend and drift terms:

$$GDPTW=0.368*KAPTW+1.341*EMTW-0.544*HKTW+0.192*OPENTW -0.491*TTECHTW \quad (4.4)$$

$$KAPTW=-6.973*OPEN+0.007*FDITW \quad (4.5)$$

$$EMTW=1.096*GDP-0.346*KAPTW-0.489*TTECHTW \quad (4.6)$$

Recalling the measurement of our variables in Section 4.3, equation (4.4) suggests that FDI does not have significant effect on economic growth in the long-run. GDP is stimulated statistically significantly by the traditional elements of inputs, such as capital formation and labour (employment), as well as the internationalization process. If thinking of equation (4.4) as the logarithmic transformation of a multiplicative aggregate production function, the elasticity of aggregate output with respect to the employment, the surrogate for the labour supply, is higher than that with respect to domestic capital formation. Human capital and technology imported impact output negatively according to equation (4.4), which implies that the productivity generated from developments of human capital and technology is less than efforts inputted in these two aspects. Hence, similar as the case of China (mainland), these two elements, which are suggested for sustainable economic growth by endogenous growth theory, could still not explain the economic growth in Taiwan. One explanation is that human capital improvement and technology development are mainly dominated by MNEs and are used to enhance their competitive advantages to domestic sectors, thus, could crowd out more productivity from domestic business in competition.

Equation (4.5) may provide an explanation for the long-run capital formation, where it seems to be hampered by openness and be complemented by FDI by a small margin. It implies that FDI could have an indirect influence through capital formation on economic growth. Also, this result suggests that international competition from overseas could strike investment motivations from domestic sectors when its market is more opened. In equation (4.6), employment is found to be improved by enhanced market size, but be impaired by increased capital formation or new technology transferred. This result may suggest that industrialization updated by domestic investment and new developed technology would attract high-skilled labour force and crush more of those with lower education, therefore, temper the whole employment.

The long-run relationships of South Korea

The long-run equilibrium relationships of South Korea are given by equations from equation (4.7) to equation (4.9):

$$GDPK=1*KAPK+1*EMK+1.645*HKK-1.479*OPENK-0.001*FDIK +8.289*TTECHK \quad (4.7)$$

$$KAPK=1*GDPK-2.941*EMK+0.839*HKK+0.002*FDIK-4.366*TTECHK \quad (4.8)$$

$$FDIK=98.467*GDPK+436.960*KAPK+682.7964*TTECHK \quad (4.9)$$

From the equation (4.7), the result suggests that output in South Korea, is negatively related to FDI with a significant but exiguous coefficient, or the change in FDI would cripple economic growth, since GDP is in the form of logarithm in estimation. As the case of China, the elasticities of aggregate output with respect to the domestic capital formation and to the surrogate for the labour supply could be restricted to equal one, when regarding equation (4.7) as the logarithmic transformation of a multiplicative aggregate production function. Contrary to China (mainland) and Taiwan, two sustainable elements for endogenous growth, human capital and new technology transfer, would positively stimulate economic growth in South Korea along with traditional elements, capital formation and employment. All of the findings are accepted statistically under our restrictions on the coefficients. Compared with the cases of China (mainland) and Taiwan, this result may suggest that the development strategy by South Korea, that promoting technology transfer through licensing and other technological agreements rather than FDI, may be more efficient in the diffusion and application of new technology in the process of production, therefore, exert more potential over human capital improvement and economic growth, as a result of increasing the likelihood of positive domestic technological spill-over effects (Read (2002)). However, this protection on domestic sectors in technology transfer has a negative effect on increasing the competitive capability of domestic sectors. Consequently, as shown in the equation (4.7), openness would temper output significantly, which may imply the disadvantages of domestic sectors in competition with foreign producers in either trade or investment.

Equation (4.8) gives the significant determinants of the long-run domestic capital formation, while it is positively determined by GDP, human capital and FDI and negatively affected by employment and technology transfer. As the explanation for China, the negative effect of technology transfer may reflect the substitutive relationship between domestic capital and foreign investment, since foreign companies who introduce new technology into South Korea would consequently crowd out domestic capital formation.

Associated with priori expectations, equation (4.9) indicates that FDI increases with output, capital formation, and technology transfer. Hence, the relationship between economic growth and FDI is more likely to be that FDI is attracted by rapid economic growth, rather than that economic growth is taking advantage of increased FDI inflow.

4.5.3. The ECM models of Taiwan and South Korea

In Table 4.9 and Table 4.10, we report the impact on the changes in the variables of the error correction terms for each country respectively. The unrestricted, non-zero, values of the adjustment coefficients are all statistically significantly different from zero except for the technology transfer in Taiwan, which is more likely to be a "weakly-exogenous" variable. It is apparent that the goodness-of-fit for most of these equations is particularly good for such modelling, especially for South Korea; while only the adjusted value is very low for the change in technology transfer in Taiwan. That could be rationalised by noting that this variable is a "weakly-exogenous" variable so that its first-difference equation is likely to be “weakly” explained.

Table 4.9. The results of the *ECM model of Taiwan: Adjustment matrix α, dummy coefficients and overall statistics*

Standard errors in ( ) & t-statistics in [ ]

Error Correction:	D(GDPTW)	D(KAPTW)	D(EMTW)	D(HKTW)	D(OPENTW)	D(FDITW)	D(TTECHTW)
CointEq1	0.000000	1.329423	0.290257	-0.360666	1.229445	0.000000	0.000000
	(0.00000)	(0.25450)	(0.04415)	(0.08527)	(0.14974)	(0.00000)	(0.00000)
	[NA]	[5.22364]	[6.57498]	[-4.22975]	[8.21054]	[NA]	[NA]
CointEq2	-0.014320	0.103213	0.013501	-0.012070	0.000000	18.97956	0.000000
	(0.00657)	(0.02385)	(0.00471)	(0.00433)	(0.00000)	(9.89247)	(0.00000)
	[-2.17909]	[4.32672]	[2.86518]	[-2.79004]	[NA]	[1.91859]	[NA]
CointEq3	0.000000	0.000000	0.000000	-0.373384	0.943157	0.000000	0.000000
	(0.00000)	(0.00000)	(0.00000)	(0.06910)	(0.12952)	(0.00000)	(0.00000)
	[NA]	[NA]	[NA]	[-5.40335]	[7.28194]	[NA]	[NA]
C	0.074498	0.070516	0.023248	0.008731	0.025568	4.051042	2.04E-05
	(0.00711)	(0.02244)	(0.00264)	(0.00229)	(0.01266)	(9.18008)	(0.00389)
	[10.4723]	[3.14283]	[8.81949]	[3.81176]	[2.02032]	[0.44129]	[0.00524]
DUMMY98	-0.020571	0.006439	-0.004905	0.018828	-0.005814	5.146726	0.014108
	(0.02235)	(0.07049)	(0.00828)	(0.00720)	(0.03976)	(28.8410)	(0.01221)
	[-0.92044]	[0.09135]	[-0.59225]	[2.61646]	[-0.14623]	[0.17845]	[1.15572]
R^2	0.385289	0.343768	0.671835	0.693411	0.200114	0.137935	0.066794
Adj. R^2	0.305971	0.259093	0.629491	0.653852	0.096903	0.026701	-0.053620
Sum sq. resids	0.021637	0.215240	0.002971	0.002243	0.068474	36031.12	0.006455
S.E. equation	0.026419	0.083326	0.009790	0.008506	0.046998	34.09244	0.014430
F-statistic	4.857543	4.059841	15.86616	17.52817	1.938884	1.240041	0.554706
Log likelihood	82.42220	41.06956	118.1617	123.2194	61.68490	-175.4369	104.1950

From Table 4.9 and Table 4.10, the negative coefficients of dummy variable indicate that these two economies were seriously hit by the financial crisis in 1998, especially South Korea suffered more from it. But it gave opportunities for MNEs to enter the market of these two countries, as a result that the coefficients of the change of FDI are both positively associated with the dummy variable.

Table 4.10. The results of the *ECM model of South Korea: Adjustment matrix* α*, dummy coefficients and overall statistics*

Standard errors in ( ) & t-statistics in [ ]

Error Correction	D(GDPK)	D(KAPK)	D(EMK)	D(HKK)	D(OPENK)	D(FDIK)	D(TTECHK)
CointEq1	0	-0.001241	0	0	0	-3.854742	-0.000391
	0	-0.00057	0	0	0	-0.90436	-5.50E-05
	[NA]	[-2.16915]	[NA]	[NA]	[NA]	[-4.26238]	[-7.12979]
CointEq2	0	0.237416	0.019059	0.083107	0.069795	383.0251	0.052697
	0	-0.07455	-0.00749	-0.01332	-0.03053	-117.863	-0.00755
	[NA]	[3.18454]	[2.54386]	[6.24007]	[2.28589]	[3.24976]	[6.98221]
CointEq3	-0.070404	-0.560411	-0.030036	0.084267	0	-1123.552	-0.132833
	-0.01365	-0.1982	-0.00894	-0.01437	0	-301.204	-0.01851
	[-5.15930]	[-2.82753]	[-3.36121]	[5.86499]	[NA]	[-3.73020]	[-7.17549]
C	0.099731	0.186526	0.045466	0.023715	0.07683	-61.89695	0.004939
	-0.00706	-0.03024	-0.00406	-0.0061	-0.01716	-23.1259	-0.00194
	[14.1338]	[6.16764]	[11.1910]	[3.88852]	[4.47687]	[-2.67652]	[2.54963]
DUMMY	-0.132693	-0.413858	-0.084252	-0.003896	-0.081917	270.4925	-0.015143
	-0.02274	-0.09747	-0.01309	-0.01965	-0.05531	-74.5296	-0.00624
	[-5.83508]	[-4.24621]	[-6.43475]	[-0.19820]	[-1.48111]	[3.62933]	[-2.42553]
R-squared	0.54875	0.37504	0.582695	0.659512	0.146733	0.522555	0.426222
Adj. R-squared	0.490525	0.2944	0.52885	0.615578	0.036634	0.46095	0.352186
Sum sq. resids	0.019496	0.358124	0.006463	0.014563	0.115321	209406.6	0.001469
S.E. equation	0.025078	0.107482	0.014439	0.021675	0.060992	82.18912	0.006885
F-statistic	9.424534	4.650797	10.82156	15.01146	1.332738	8.482251	5.756957
Log likelihood	84.29775	31.9053	104.1716	89.54793	52.30212	-207.115	130.8337

4.6. Conclusion

In this chapter, we have explored the fundamental question of the role of foreign direct investment played in the economic growth of the relatively developed economies in East Asia: Taiwan and South Korea. The VAR model and the relative ECM model have been implemented to investigate the relationships between economic growth and FDI in these two countries, while the long-run equilibrium relationships are estimated through cointegration analysis; and the dynamic correlations are captured by innovation analysis including impulse response and variance decomposition.

Our findings indicate that the long-run relationships between economic growth and FDI are similar to what we found in China: no evidence supports that FDI can stimulate output directly, while FDI actually could hamper economic growth in Taiwan; FDI is more likely to be attracted by enhanced market size of these two countries to take advantage of rapid economic growth; economic development in both countries are also suggested as the main stimulus for capital formation and employment; in explaining economic growths in these two countries, the traditional elements of inputted factors, such as capital formation and employment, are still playing important positive roles.

However, contrary to the case of China, technology transfer is found to have more apparent influence on economic growth associated with the development of human capital, either positively in South Korea or negatively in Taiwan, which is determined by the difference of development strategies of technology development in these two countries; openness is also more remarkable in affecting economic growth, but its effects are not coincident in these two countries, though both are regarded as export-oriented economies, that openness would hamper economy in the country adopting the more protective commercial policy like South Korea, but promote economic growth in the country with the more open policy toward international trade as Taiwan; in addition, the spillover effects of FDI on capital formation are demonstrated to be significantly positive in these two countries, as the domestic business has relatively higher competitive capability compared with the case of China and would input more to compete with MNEs instead of being crowded out .

The significance of the relationships has also been confirmed by variance decomposition from the VAR model of each country. The impulse responses are more focusing on the determinants of FDI from the short-run to the long-run. These impacts are not always positive, as some of them could be negative in the intermediate period. But these results from the dynamic correlations do not necessarily to be consistent with the long-run relationships.

Above all, in the analyses of the economies with higher development stances in South Korea and Taiwan, we have not find a more important role of FDI on economic growth compared to the case of China. New technology and openness become more active in either stimulating or hampering economic growths in these two countries. In general, the results suggest that the impacts from spillovers may be different with respect to the level of development. But the difference seems to be a consequence of different strategies of development. With employing the similar strategy as China (mainland) to promote technology through FDI and openness, Taiwan would be much harder to generate productivity from technology development and human capital improvement, but would be more sensible with international integration and competition. For the case of Korea, it could promote the economy through technology development and human capital improvement more successfully; on the other hand, it would hamper the economy by reducing competitive capability of domestic business with increased openness level. However, it at least indicates that FDI may not be the only channel to achieve the target of modernization and development. These results, together with those with China from the previous chapter, all imply the importance of government strategies of development in affecting FDI and economic growth.

CHAPTER FIVE

A SIMULTANEOUS EQUATION MODEL ANALYSIS OF ECONOMIC GROWTH, FDI AND GOVERNMENT POLICIES IN CHINA

5.1. Introduction

In Chapter Three, we discussed the interrelationships between Chinese economic growth, FDI and its spillover effects on capital formation, employment, human capital, international openness, and technology transfer by a VAR system. However, that system excluded influence of any exogenous or other form of government intervention in the economy. Although government intervention has stepped back from dominating the economic activities as it did before economic reform in 1979, the Chinese government still exercises a strong influence over the economy directly or indirectly. Hence, it is still necessary to discuss the influence on economic growth and spillovers via the participation of foreign capital.

In this chapter, we focus on these factors and introduce government policy intervention to build a more comprehensive framework to analyse the economic growth in China and to investigate the role of FDI. In this respect, the specification of the system has been extended to include relevant endogenous and exogenous variables related to government policies. Here this intervention mainly focuses on government policies, which include monetary policy, fiscal policy and commercial policy.

Some researches have been conducted for China on the impact of policy variables. For example, Dickinson and Liu (2005) tested the effects of the interest rate on output. Lardy (1992), as well as Zhang (1998), showed that China's exchange rate policy is closely related to foreign trade targets. The OECD (2000) concluded that there is a positive role of openness, physical and technology infrastructure in improving economic growth through increased productivity, as well as in attracting FDI inflows. However, nearly all of those studies about government policies have either only discussed the direct correlations of particular policy variables with economic growth without considering FDI, or focused on FDI policies and their indirect effects on economic growth. Little has been done in terms of combining government policies and doing so in an economic system with FDI participation.

Our framework is founded on a supply side approach to economic growth as in the endogenous growth theory. The analysis is based on the hypothesis that there are positive spillover effects of FDI according to the theory of international production, which states that growth is a function of FDI and, hence, its spillover effects (for example, see UNCTAD (1992, 2003) and Chudnovsky (1993)).

Being inserted only via economic shocks, government intervention could not be incorporated to our essentially endogenous VAR system directly. It is necessary now to estimate a simultaneous system, which could include exogenous variables at the same time when considering the simultaneous relationships between endogenous variables. Given the interaction between endogenous variables, our analysis is based on GMM estimation. It permits correlations between variables and error terms, therefore eliminates simultaneity bias. In addition, from the final form of our equations from the GMM estimation, we can calculate the dynamic multipliers to determine the impacts of policy variables on endogenous variables including economic growth.

The rationale for adopting a simultaneous system approach is as the following: it is to obtain more information about the variables that 'generate' the links between the endogenous variables in the VAR model and the ECM model. These are the intermediaries in the form of exogenous variables, policy and other variables determined outside the economic system, such as infrastructural investment of the government, interest rate fashioned by the central bank that affects the strength of monetary conditions and therefore, via capital formation, through to output and so on. In other words, the VAR system and the ECM model that we have estimated for China in Chapter Three give the 'top level' or 'overview' that emerges from the policy and other 'impulses' to the system, of the kind that we have enunciated. As it will be seen, the simultaneous system gives an opportunity to look into the 'black box' by constructing and estimating simultaneous multiple equations system. Comparatively, the Cointegrating Vectors from the VAR model are of no value since the variables are now measured differently in the simultaneous equations model. The information in the Cointegrating Vectors could only have provided sets of constraints on the coefficients in the model that we might have been able to impose upon, when solving its long-run equations, and hence its multiplier effects.

Accordingly, we are trying to find answers to the following questions: What kind of economic polices, or economic governance, will be beneficial to economic growth, directly or indirectly? Will these be maintained in the long-run? Will government policy affect FDI? If so, by what type and by what route? In addition, with respect to government intervention, will FDI stimulate economic growth? How do spillovers influence economic growth in the presence of government policy and intervention?

The main content of this chapter is divided into three sections. The first section comprises the hypotheses, the methodology and specifications of the model. The empirical results of the static analysis are reported in the second section. The dynamic analysis is reported in the third section, which includes the multiplier effects generated from the final restricted form of the model.

5.2. Modelling economic growth, FDI and government intervention

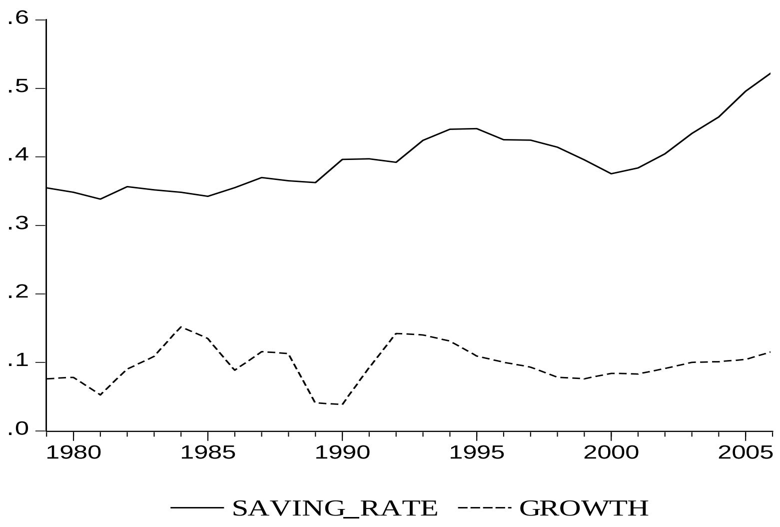
This attempt to model the economic growth in China is influenced, as noted above, mainly by the endogenous growth theory and the existence of positive spillover effects under the theory of international production. The model mostly relates to the earlier work by Bende-Nabende and Ford (1998) on economic growth in Taiwan. The hypothesis is that the growth of output is a function of FDI, associated with spillovers that lead to capital formation expansion, employment improvement, human resources development, new technology transfer, international openness, and is expected to have positive association with them.

5.2.1. Discussion about variables

According to the endogenous growth theory as well as the neoclassical theory, output, FDI and its spillovers, such as capital formation, employment, human capital, international openness and technology transfer, are all included as endogenous variables. For similar reasons as in Chapter Three, in our system to estimate output, capital formation and FDI, which indicate the net increase in stocks of domestic capital and foreign capital, are introduced to play the role of both domestic and foreign capital stocks. From the supply side, along with technology progress, human capital and labour quantity, capital stocks are the main determinants in the output production function (See Solow (1957), Locus (1988), Romer (1990)). As the data of capital stocks are not available, we firstly tried formulating arbitrary capital stocks by capital formation and FDI respectively, which capture the enhancement in the stock of capital in each year. And we find that the arbitrary capital stocks can be explained by capital formations from domestic side and foreign side respectively. Details can be found in Appendix A3.11. In addition, the results from the model based on this arbitrary data, are similar with those from the model with capital formation and FDI (see Appendix A5.6). Based on this econometric finding, it is reasonable to replace the variables of arbitrary capital stocks by domestic capital formation and FDI inflow with actual data in the system.

Apart from this, we introduce domestic saving in our analysis of economic growth. A high saving rate is considered a necessary condition for rapid growth, as savings provide resources for financing capital formation (for example: see Modigliani and Brunberg (1979)). Figure 5.1 shows the domestic saving rate in China, which has similar time cycle as economic growth rate. We also introduce financial wealth to capture the effect of financial development.

Figure 5.1. *Economic growth rate and domestic saving rate in China for 1970-2006*



The government intervention variables together with other exogenous variables are sorted into three categories: monetary policy variables, commercial policy variables, and fiscal policy variables.

Among monetary variables, interest rate and bank credit are the two implements we believe are used to adjust the economy and financial markets (See Dickinson and Liu (2005), Montes-Negret (1995)). Credit granted by state-owned banks is a particular monetary implement in China. The central bank has the authority to allocate quotas of credit to state-own banks. Since banks can only conduct business within their quota, this system allows the central bank to adjust the money supply by raising or reducing the total credit to banks. Hence, bank credit can be regarded as another instrument by which money market can be affected. The targets of monetary policy are not explicit. According to Zhou (2007), in order to maintain economic growth, one of the main targets for monetary policy is the money supply M2, but whether the central bank targets inflation is still not clear. Here we introduce inflation as an exogenous variable in our estimation. The exchange rate in China is fixed in terms of US dollars to facilitate international trade at most of time[1], and only changed to balance international trade (Zhang (1998)). In the early stage, China has strict restrictions on currency exchange. Consequently exchange rate cannot be applied as an instrument for monetary policy in our analysis. We treat it as an exogenous variable to affect international trade.

Commercial policy variables combine three variables, trade liberalization, financial liberalization and relative wage rate. Trade liberalization policy, represented by a dummy variable as formed in Chapter Three, is introduced to capture the economic reform begun at the end of 1979, when China begun to open up to the world and release the constraints on private economic sectors. Financial liberalization measures the progress of financial deregulation and innovation, which are supposed to facilitate trade and investment and thereby benefit the economy. This variable is measured by the credit issued by state-own banks to the private sectors. Since such credit was hardly permitted by state-own banks before the financial reform, we assume that the lower restriction on state-own banks, the greater amount of loans they can provide to private business. Therefore, we introduce this variable to measure the degree of financial liberalization. The relative wage rate has been viewed as one of the main determinants of FDI (see Blomstrom and Kokko (1997)). It represents the difference in wages of labour forces between the host country and the original developed country of FDI. This variable is a main reference for investors to make FDI decisions, as the lower this value is, the more labour cost investors can save through FDI in the host country compared with investing in their original country. In our estimation, we take Japan as the reference economy as it is the only developed country close to China and has been one of the major sources of FDI in China for a long time. Its investors have greater incentives to shift productions to China to save labour cost.

The fiscal policy of the Chinese government aims to boost domestic demand, and hence economic growth. From the supply side, government policy impacts growth through improvements in human capital and technology. Fiscal policy variables included in our discussion are tax revenues, government expenditure on infrastructure and government expenditure on education. Tax revenue includes all tax from income, good and services, exports and imports collected by government. This variable is treated as an exogenous variable in our estimation. Government spending on infrastructure and education are postulated to be two instruments used to affect long-run economic growth. Spending on infrastructure, including investment in railways, roads, communication and electricity, provide more facilities and reduce the individual cost and social cost for business. Expenditure on education improves labour quality and hence can benefit economic growth.

Data measurement

The annual data are collected from China Statistical Yearbook and UNSTATS database and are available from 1970 till 2006. All the variables in values are measured in domestic currency at constant prices by being deflated by the implicit price index (GDP deflator). The endogenous variables of output (**GDP**), capital formation (**KAP**), employment (**EM**), human capital (**HK**) and **FDI** are all defined as the same as in Chapter Three. However, openness (**OPEN**) and new technology transfer (**TTECH**) can not measured as a share of output when estimating simultaneously on output itself. Here we measure openness in its level as total international trade in goods and services including imports and exports. New technology transfer is measured in the value of machinery and transport imports. We have to scale variables in order to generate a stable system. Consequently, unlike the VAR model in Chapter Three, output, capital formation, FDI, openness and technology transfer are all measured in 10 billion in RMB at constant prices of 1990. Employment is measured in 10 million people and human capital is kept as a percentage share. The new introduced endogenous variable Saving (**SAV**), referring to domestic saving, is measured in 10 billion RMB at constant prices of 1990. Financial Wealth (WEALTH) is collected from the broad money supply (M2) and measured in 10 billion RMB at constant prices of 1990. All the endogenous variables are taken in logarithm in estimation.

Exogenous Variables are measured as follows:

Interest rate (interest): Nominal interest rate is measured as one year deposit rate in state-owned banks from China Statistical Yearbook and is scaled by being multiplied by 100.

Bank credit (bc): Total credit quantity issued by state-owned banks is from China Statistical Yearbook and calculated in 10 billion RMB at constant prices of 1990.

Financial liberalization (pc): Credit quantity issued by state-owned banks to private sectors is used to measure financial liberalization and deregulation in China. It is calculated in one billion RMB at constant prices of 1990 from China Statistical Yearbook.

Exchange rate (rmb): it is average nominal exchange rate, measured as RMB per US dollar from China Statistical Yearbook.

Inflation (inflat): Inflation rate is calculated as percentage change in annual implicit price index from China Statistical Yearbook.

Relative wage rate (wage): Relative wage rate between China and Japan is measured as a ratio of annual average wage paid in China divided by average wage paid in Japan, from China Statistical Yearbook and Japan Statistical Yearbook and scaled by being multiplied by 100.

Liberalization (libdummy)**:** Trade liberalization is represented by the same dummy variable in Chapter Three to capture economic reform and openness.

Tax revenues (tax)**:** Total amount of tax revenues collected by government is calculated in 10 billion RMB at constant prices of 1990 from China Statistical Yearbook.

Infrastructure (gtran)*:* Government expenditure in economic sectors, including transport and communication network, is measured in 10 billion RMB at constant prices of 1990 from China Statistical Yearbook.

Education spending (gee): Government spending in education sector is calculated in 10 billion RMB at constant prices of 1990 from China Statistical Yearbook.

In the system, educational spending, infrastructure, tax revenues and financial liberalization are all in logarithm.

5.2.2. Structure of the model

We have ten exogenous variables and nine endogenous variables within a simultaneous system. Through the multiplier effects, we can examine how the policy variables impact directly and indirectly, on economic growth, FDI and other endogenous variables. The structure of the model takes account of suggestions of the endogenous growth theory, as well as results from Chapter Three. But it is rather based on an empirical approach where we allow data to provide answers to the questions listed in the previous section. The model is expressed in equations in the following and all the specifications of the simultaneous relationship are summarized in Table 5.1.

GDP = f (*CAP, EM, HK, FDI, TTECH, SAV, libdummy, gtran*) (5.1)

KAP= f (*GDP, OPEN, FDI, SAV, interest, bc, libdummy, tax*) (5.2)

EM= f (*GDP, HK, OPEN, FDI, interest, inflat*) (5.3)

HK= f (*GDP, FDI, TTECH, SAV, interest, gtran, gee*) (5.4)

OPEN= f (*GDP, KAP, EM, HK, TTECH, interest, pc, rmb, inflat, libdmmy*) (5.5)

FDI= f (*GDP, HK, OPEN, TTECH, interest, pc, rmb, wage, libdummy, tax, gtran*) (5.6)

TTECH= f (*GDP, KAP, OPEN, FDI, rmb, gee*) (5.7)

SAV= f (*GDP, EM, WEALTH, interest, pc, tax*) (5.8)

WEALTH= f (GDP, OPEN, SAV, interest, bc, inflat) (5.9)

The output function is described in Equation (5.1). In this model, output is assumed to be determined by capital formation, employment, human capital, FDI, and technology transfer. The endogenous growth theory (see Romer (1986)) suggests that foreign capital in the form of FDI, human capital, and new technology development impact positively on domestic output. Liberalization policy releases the restrictions on businesses of private sectors and foreigners. Therefore, it is regarded as encouraging production. Infrastructure expenditure includes road networks, other communication networks, gas, water, electricity and other public services that facilitate the production and distribution process of goods and services. The higher the level and quality of infrastructure, the higher output is expected to be.

Capital formation is expressed in equation (5.2), where national income and domestic saving provides funding support for capital formation and are expected to be positively correlated with it. International openness can stimulate new capital through the demand for exports and is supposed to affect capital formation positively. The presence of FDI would attract relative investment of supporting facilities and is expected to have a positive effect on capital formation. Monetary policy instruments, interest rate and bank credit, which determine the price and quantity of money supply, are considered to influence capital formation. Trade liberalization reduces the cost of trade as well as the cost of investment. Hence, it is expected to have a positive relationship with capital formation. The fiscal policy variable tax revenues providing funds for public investment and state-owned enterprises, would be expected to affect capital formation positively.

Output, human capital, openness, international openness, FDI and domestic saving are expected to affect employment positively. Interest rate and inflation are also introduced into the equation of employment represented by equation (5.3). Along with output, capital formation and FDI, we introduce saving in the equation for human capital (Equation (5.4)) as they provide funding for education and training. All these variables are expected to affect human capital positively. Interest rate, government expenditures on infrastructure and education are also postulated to play positive roles in determining human capital. In equation (5.5), international openness is dependent upon output, capital formation, employment, human capital, FDI and technology transfer. Interest rate and the exchange rate are anticipated to have an impact on openness. The potential effect of liberalization in both financial and trade sectors are also taken into consideration in this equation.

Equation (5.6) states that foreign direct investment is expected to be determined by output, human capital, openness and technology transfer as well as some exogenous variables. From this point, aggregate output represents market size in the eyes of MNEs. Market growth is expected to be positively related to FDI inflows. Human capital represents the quality of labour resource, which is one of the major factors of production. The availability of skilled manpower induces FDI inflows. A large labour participating in economic activities could attract FDI especially in labour-intensive production. But from the results in Chapter Three, investment in labour-intensive industries would be crowded out by the increase of human capital. FDI can also be affected by its own previous lagged values as the effect of learning-by-doing. Within a given region, MNEs are expected to locate production in the countries with lower wage rate. Relative wage rate measures the wage “difference” between host country and original country. The lower the relative wage rate, the higher the incentive for cost-oriented FDI, therefore, the higher the FDI inflows. A negative relationship is expected between relative wage rate and FDI. Infrastructure expenditure determines the level of economic development achieved by the country. It is expect to have a positive relationship with FDI. Liberalization policy opens the door to the world, releasing the tariffs on international trade; therefore, it is expected to have a positive impact on FDI. The monetary policy variables like interest rate, as well as the financial liberalization variable (private credit) represent the cost of MNEs access to the domestic financial market, and will influence FDI decisions taken by MNEs. The interest rate will be expected to be negatively correlated with FDI, while private credit is expected to enhance FDI. Domestic currency depreciation and lower tax level are also considered to encourage FDI inflows.

Table5.1. *Endogenous and exogenous variables, and general specifications of the simultaneous equations*

		Eq1	Eq2	Eq3	Eq4	Eq5	Eq6	Eq7	Eq8	Eq9
Explanatory variables	Note	GDP	KAP	EM	HK	OPEN	FDI	TTECH	SAV	WEALTH
Gross Domestic Product	GDP		*	*	*	*	*	*	*	*
Capital Formation	KAP	*				*		*		
Employment	EM	*				*	*		*	
Human Capital	HK	*		*		*	*			
Openness	OPEN		*	*				*		*
Foreign Direct Investment	FDI	*	*	*	*			*		
Technology Transfer	TTECH	*			*	*	*			
Saving	SAV	*	*		*					*
Financial Wealth	WEALTH								*	
Monetary policy variables										
Interest rate	interest		*	*	*	*	*		*	*
Bank credit	bc									*
Exchange rate	rmb					*	*	*		
Inflation	Inflat			*		*				*
Commercial policy variables										
Financial Liberalization	pc					*	*		*	
Relative Wage ratio	wage						*			
Trade liberalisation	libdummy	*	*			*	*			
Fiscal policy variables										
Tax revenues	tax		*				*		*	
Government Infrastructural	gtran	*			*		*			
Government Expenditure on Education	gee				*			*		

Technology transfer is assumed to be positively correlated with output, capital formation, international openness, and FDI. Exchange rate depreciation and educational expenditure by government are believed to promote new technology imported. In equation (5.8), domestic saving depends on national income and financial wealth. Interest rate and financial liberalization, which impact the financial market, are considered to have positive effects on saving. From the household viewpoint, a rise in tax will reduce income, hence private saving. But from the government stance, increased tax revenues can extend public saving. We introduce this fiscal policy variable into the equation of domestic saving. Financial wealth measured by the money supply M2, is alleged to depend upon national income, saving and openness from the endogenous variables. The policy variables included in its equation (equation 5.9) are the interest rate and bank credit. Inflation as an exogenous variable also is expected to influence financial wealth.

5.2.3. Econometric specifications of the system

Unit root test

The first question we need to solve before establishing the system is to test whether variables included are stationary, which would determine whether the model can be estimated in level or in first difference. Output, capital formation, employment, human capital and FDI have already been proved as I(1) in Chapter Three. Augmented Dickey-Fuller test was applied to test the stationary of the rest variables in the system. The results as illustrated in Table 5.2, indicate that all series are non-stationary with 5% significant level. The same tests indicate that there are no unit roots of all the variables in first difference. Therefore, they are integrated with order one as I(1) variables. Hence, the model would be estimated with all variables in first difference.

Table 5.2. *ADF test on selected series in level and in first difference*

	Level			First difference		
	Deterministic term	t-stats.	Prob.	Deterministic term	t-stats	Prob.
Exogenous variables						
Interest	None	-0.80545	0.3601	None	-4.62318	0
bc	Constant, trend	-2.44622	0.3511	Constant	-3.76062	0.0004
rmb	Constant, trend	-1.89029	0.6388	None	-5.03222	0
infl	Constant	-2.72793	0.0798	None	-4.90823	0
pc	Constant	-1.72064	0.4119	None	-2.23084	0.0268
wage	Constant, trend	-1.1454	0.9066	None	-4.34841	0.0077
libdummy	Constant, trend	-2.22872	0.4602	None	-3.05329	0.0033
tax	None	2.612879	0.9971	None	-3.4523	0.0011
gtran	None	0.86867	0.8926	None	-3.73229	0.0005
gee	None	10.87552	1	Constant	-4.18605	0.0024
Endogenous variables						
SAV	Constant, trend	-2.89328	0.1778	Constant	-6.01545	0
WEALTH	Constant, trend	-2.15267	0.4999	Constant	-3.96816	0.0043
OPEN	C	-0.05205	0.9472	None	-2.71084	0.0082
TTECH	Constant, trend	-3.32673	0.0786	None	-3.41356	0.0012

The simultaneous equation system in first difference

Since right-hand side variables are correlated with error terms, our model cannot be estimated by OLS method. Therefore, Generalized Method of Moments (GMM) technique is the appropriate method to estimate the simultaneous structure model, which not only allows correlation between right hand side variables and errors, but also allows correlation across the residuals, Autocorrelation and Heteroskedasticity. In this method, all exogenous variables and the predetermined variables are used as instrumental variables together with the constant. The identity-weighting matrix in estimation uses the estimated coefficients by 2SLS estimator and GMM robust standard errors that is robust to Heteroskedasticity and Autocorrelation. Since it is confirmed that all variables are actually I(1), the system then is estimated by variables in first difference. The following is the model of equations in matrix form:

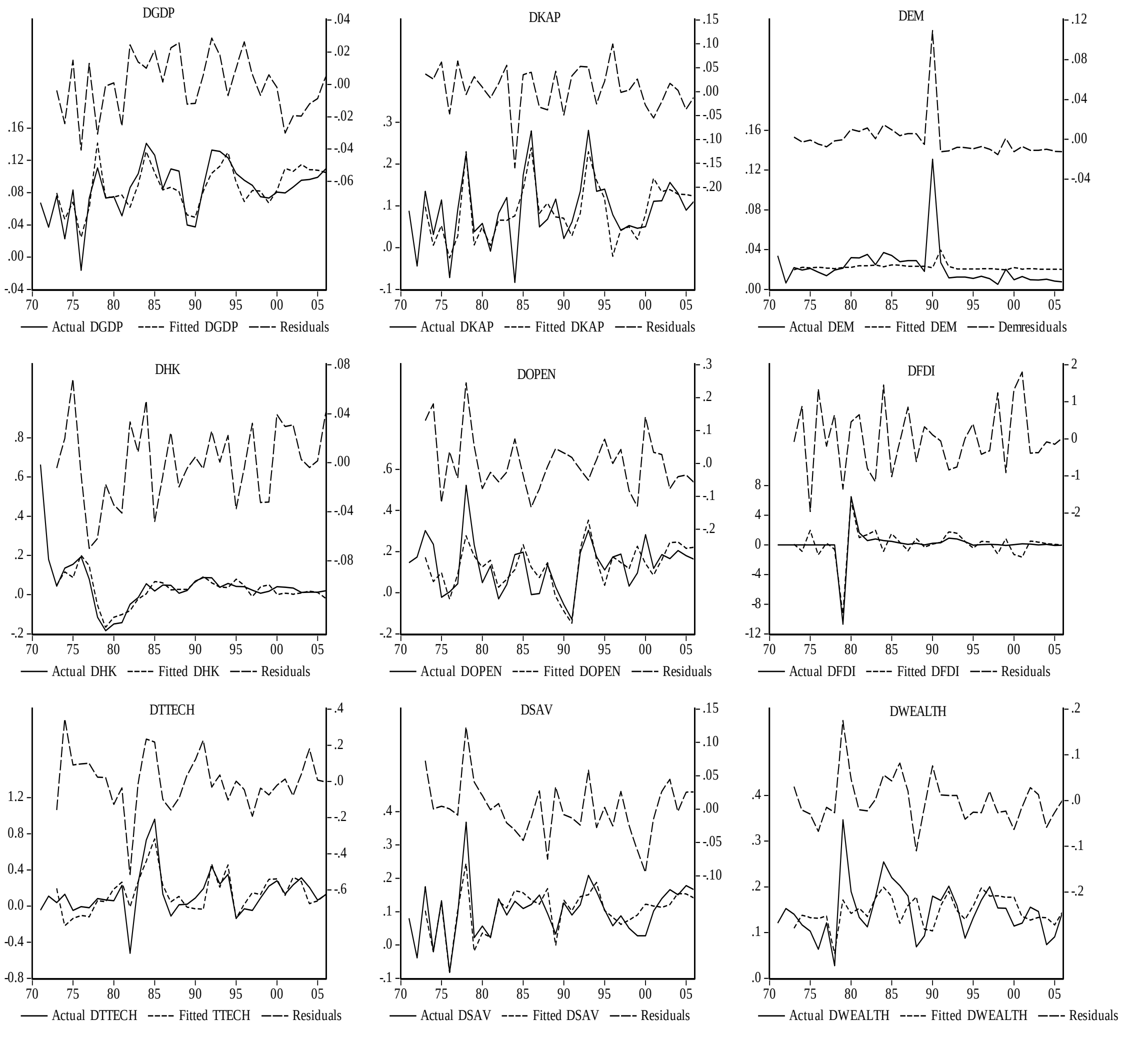
$$\boldsymbol{Y_t = K + AY_t + BY_{t-1} + CX_t + DX_{t-1} + e_t} \tag{5.10}$$

where Y'_t = (DGDP, DKAP, DEM, DHK, DOPEN, DFDI, DTTECH, DSAV, DWEALTH); and X'_t = (dinterest, dbc, dpc, drmb, dinflat, dwage, dlibdum, dtax, dgtran, dgee); $\boldsymbol{e_t}$ is error vector; *A, B, C, D* are relative coefficient matrices.

The selection of the lag length is based on mathematical stability that requires that all roots of the companion matrix be less than one in absolute value. Given the small sample size, it is an advantage to chose one lag as the appreciate one.

Since we release constrains on residuals, the only requirement for the system to be valid is the stability of the system, requires that all roots of the companion matrix be less than one in absolute value. It could be satisfied by an unrestricted system when eliminating numerous insignificant coefficients of variables from the original set of the proposed relationships. And with further restriction of zero coefficients added in the system, the final restricted system could be generated. It is also stable. This process is ensured by Wald significant test to determine whether these variables should be excluded from the system indeed (see Appendix 5.3.2). However, not all insignificant variables are excluded as some would affect the stability of the whole system and have to be kept in the system. In the final restricted system, we find that bank credit, which is one of the instruments for monetary policy has been excluded from all the equations, but it is still in the instrumental variables as it would provide almost the same results for all equations with better higher R^2, and adjusted-R^2 than those of the system without it completely.

Figure 5.2. *Residuals and actual-fitted values of the final restricted system*



And residuals of the restricted system then have been tested for stationary, serial correlation, normality, and ARCH (we do not have enough observation to run the Heteroskedasticity test). Results indicate that all the residuals are stationary and with no ARCH. Most of them pass serial correlation test and normality test (see Appendix A5.4). Hence, the final restricted system is acceptable.

Verification of estimation method

The GMM estimator belongs to a class of estimators known as M-estimators that are defined by minimizing some criterion function. GMM is a robust estimator in that it does not require information of the exact distribution of the disturbances. GMM estimation is based upon the assumption that the disturbances in the equations are uncorrelated with a set of instrumental variables. The GMM estimator selects parameter estimates so that the correlations between the instruments and disturbances are as close to zero as possible, as defined by a criterion function. By choosing the weighting matrix in the criterion function appropriately, GMM can be made robust to Heteroskedasticity and/or Autocorrelation of unknown form. Many standard estimators can be set up as special cases of GMM. For example, the ordinary least squares estimator (OLS) can be viewed as a GMM estimator, based upon the conditions that each of the right-hand side variables is uncorrelated with the residuals.

Honestly, GMM method is not the only econometric technique to deal with correlation between exogenous variables and error terms. There are several econometric techniques can be applied in estimation, like 2SLS estimation and 3SLS estimation. However, the system two-stage least squares (2SLS) estimator is not appropriate in this case, as it would only be an appropriate technique when some of the right-hand side variables are correlated with the error terms, and there is neither Heteroskedasticity, nor contemporaneous correlation in the residuals. Three-stage least squares (3SLS) is the two-stage least squares version of the SUR method (Seemingly Unrelated Regression). It is an appropriate technique when right-hand side variables are correlated with the error terms, and there is both Heteroskedasticity, and contemporaneous correlation in the residuals. However, we find that a better estimator than 3SLS could be GMM as experimental results were superior from the GMM for any specification of the system than 3SLS, especially when restrictions were imposed on some of the coefficients, the GMM produced better R^2, more crucially, better adjusted-R^2.

Estimation with I(1) variables in level

When estimating I(1) variables, there is still a possibility of cointegration that allows existence of variables in their levels in the system. According to Hsiao (1997a), when estimating I(1) variables that are cointegrated with 2SLS method, Wald type test statistics remain asymptotically Chi-square distributed. Hence, with a simultaneous system, the existence of non-stationary series in level might not lead to spurious regressions. Therefore, Hsiao (1997b) gave two conditions needed to validate using I(1) variables in level with 2SLS. Firstly, the variance-covariance matrix of the exogenous variables converges to a matrix that is non-singular, which means no multicollinearity among variables. Secondly, the roots of the companion matrix of the dynamic system are all less than one in absolute value, which is equivalent to the condition that the number of cointegrating vectors among all variables is equal to the number of those in endogenous variables. These assumptions imply that the stochastic trends in the endogenous variables are derived from those in the exogenous variables in the system. When these two assumptions are satisfied, an unrestricted VAR could be estimated and cointegrating vectors could be found. Then, the system can still be estimated with non-stationary variables.

In our case, the determinant of the variance-covariance matrix (see Appendix A5.1) of the exogenous variables is 4.1384E-17 and rules out cointegration between exogenous variables. However, when running the system of equations with 2SLS, the stability condition is not satisfied. There are two eigenvalues (-11.17047, 1.5591867) of the companion matrix exceed unit in absolute values (see Appendix A5.2). Hence, the stability requirement could not be satisfied, which rule out the possibility of estimating the system with non-stationary variables or allowing cointegration relationships of variables in the level in the system. Hence, our estimation of the system with all I(1) variables in first difference is a valid and efficient estimation.

Identification

Identification is another important issue to establish a simultaneous model. The sufficient and necessary condition for identification is the rank condition, which requires that the rank of the coefficient matrix for all variables excluding the specific equation is equal to the total number of endogenous variables minus one. In this model, we calculate the rank of all nine coefficient matrices. The results show that all nine sub-matrices have rank 8, which equals the number of endogenous variables (nine) minus one. Hence, the identification requirement has been met.

5.3. The dynamic analysis of the Chinese economy, FDI and government policies

From the restricted model, the direct effects on economic growth and other endogenous variables, both simultaneous and lagged ones, can be found from coefficient vectors. It could be noticed that all of the equations in the system have relatively considerable R^2 values except the one of employment. Actually, some of the R^2 values and adjusted R^2 values are very high. Hence, our restricted system is efficient to explain economic growth and other inputted factors from the supply side. When considering weak exogenous property of employment demonstrated in Chapter Three, the result of employment is still acceptable. Details of coefficients in each equation can be found in Appendix A5.4. Since all variables are in first difference, those relative coefficients then are interpreted as the effect of one unit change in the change of one explanatory variable on the change in the change of the given endogenous variable. Reminding that some of the variables are in logarithms in estimation, such as output, capital formation, FDI *et al*, their differences are representing proportional changes of the original values.

Determinants of the change in output (DGDP)

The coefficients of the DGDP equation are illustrated in Table 5.3. It indicates that current changes in capital formation and in employment have negative effects on the change in output. Both of the effects are significant. Hence, the assumption of Solow model has been demonstrated that capital and labour inputted in production would have diminishing returns on output with certain level of technology. Coefficient of the changes in technology transfer indicates a significant positive influence on the change in output, which reflects the increasing return of output from new technology development suggested by new growth theories. Domestic saving also has accelerating effect on output. In variables in their lags, only human capital has negative impact on the change in output, which may imply that economic growth in China is stimulated sustainably by technological factors, such as new equipment and new technology, rather than labour force development and physical capital enhancement.

Table 5.3. The e*quation of DGDP*

Equation of DGDP	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.064518	0.006358	10.14741	0
DKAP	-0.10678	0.04826	-2.212505	0.0279
DEM	-0.58753	0.156867	-3.745409	0.0002
DTTECH	0.051804	0.01562	3.316492	0.0011
DSAV	0.310042	0.065396	4.741016	0
DHK(-1)	-0.07632	0.027989	-2.726714	0.0069
Dlibdummy	0.241238	0.108076	2.23212	0.0265
R-squared	0.677593	Mean dependent var		0.086612
Adjusted R-squared	0.605947	S.D. dependent var		0.032336
S.E. of regression	0.020298	Sum squared resid		0.011125
Prob(F-statistic)	1.847762			

Changes in FDI and international trade, either in current forms or in lagged forms, have no significant impacts on the change in output. Among exogenous variables, only liberalization has accelerating effect on output. But this effect may mostly attribute to liberalization on domestic market rather than international market, as we don't find evidence of international trade affecting output sustainably.

Table 5.4. *The equation of DKAP*

Equation of DKAP	Coefficient	Std. Error	t-Statistic	Prob.
DFDI	0.007992	0.00422	1.893731	0.0595
DSAV	0.508758	0.120115	4.235591	0
dinterest	0.022037	0.008148	2.704709	0.0073
dlibdummy	0.52805	0.191711	2.754407	0.0063
dtax	0.296591	0.105487	2.811628	0.0053
R-squared	0.624933	Mean dependent var		0.093206
Adjusted R-squared	0.5732	S.D. dependent var		0.078331
S.E. of regression	0.051173	Sum squared resid		0.075943
Prob(F-statistic)	2.369629			

Determinants of the change in capital formation (DKAP)

Regarding to the equation of DKAP in Table 5.4, the results indicate that the change in capital formation is positively determined by changes in FDI and domestic saving as expected. The direct effect of the change in tax revenues is positively correlated with the change in capital formation, which implies that government maybe play the important role in total investment, so more tax revenues would fund government to invest more in public sectors or state-owned enterprises. And it may also explain the accelerating effect of interest rate on capital formation as government investment is not sensitive to the cost of capital, thus government could find more fund especially from state-owned banks when private investors are crowded out by higher cost of capital. Liberalization would release restrains on domestic business, so as to stimulate capital formation as expected.

Determinants of the change in FDI (DFDI)

From Table 5.5, we find more evidence that FDI in China is driven by rapid economic growth, as we observe that the change in output or market size directly accelerates the change in FDI. Human capital improvement accelerates FDI simultaneously, but the direct effect of the lagged one is significantly negative. Thus, human capital development would attract more FDI, especially those with relatively higher technology and management and require more skills in operation. But this improvement would narrow the gap between domestic business and MNEs, and crowed out those FDI that lost their advantage in technology and management. For the similar reason, we observe decelerating effects of technology development on FDI both in current form and in lagged form.

Among exogenous variables, our results indicate that the changes in interest rate and financial liberalization negatively impact the change in FDI. Financial liberalization facilitates economic activities by reducing transaction costs and relaxing constraints on the availability of financial funds especially for private sectors, thus, increases their capability of competing with foreign investors. Lower interest rate, on the contrary, would benefit more on FDI by saving costs on borrowing from the financial market in China.

Table 5.5. *The equation of DFDI*

Equation of DFDI	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-3.921246	0.741941	-5.285115	0
DGDP	55.36268	10.92059	5.069569	0
DHK	2.962761	0.427896	6.924023	0
DTTECH	-1.642193	1.167767	-1.406268	0.1609
DHK(-1)	-20.77836	3.347456	-6.207209	0
DTTECH(-1)	-1.955718	0.663393	-2.948052	0.0035
dpc	-2.110393	0.194813	-10.8329	0
drmb	-0.970493	0.233748	-4.151875	0
dwage	-3.395933	0.611876	-5.550035	0
dtax	0.748263	0.301567	2.48125	0.0138
dinterest(-1)	-0.178005	0.098678	-1.803903	0.0725
drmb(-1)	-0.91826	0.26781	-3.428771	0.0007
dwage(-1)	2.567548	0.499331	5.141972	0
dgtran(-1)	-5.274284	1.252781	-4.210061	0
R-squared	0.845777	Mean dependent var		0.089343
Adjusted R-squared	0.745532	S.D. dependent var		2.218901
S.E. of regression	1.11932	Sum squared resid		25.05754
Prob(F-statistic)	2.771324			

Changes in exchange rate, both current and lagged ones, are all negatively correlated with the change in FDI, as depreciating domestic currency raises the price of import goods, then demolishes those FDI that need import raw material or components of final products targeted on the domestic market of China. We also find inconsistent influence of the wage rate variable. Unlike the lagged one, the current decrease in the change in wage rate exaggerates the FDI increase. Hence, in the short-run, FDI would be stimulated by relative lower labour cost. But this effect does not last longer, as FDI would be decelerated by lower lagged wages. It might be explained by that lower labour cost would restrain improvements of human capital in the long-run, hence, limit improvement of the productive efficiency in the future. In term of government fiscal policies, our results imply that the increases in taxes are most likely funded by domestic business and give competitive advantages to MNEs, as they usually have tax-free privileges when investing in China, thus, could accelerate FDI. We also find a decelerating effect of the change in infrastructure investment on the change in FDI. Hence, improvement in infrastructure would have a diminishing return in attracting FDI.

Table 5.6. *Summary of direct relationships from the restricted system*

Explanatory variables	**DGDP**	**DKAP**	**DEM**	**DHK**	**DOPEN**	**DFDI**	**DTTECH**	**DSAV**	**DWEALTH**
Gross Domestic Product (DGDP)				(–)	(+)+	+	(+) +	(–) +	+
Capital Formation (DKAP)	–				+		(–)		
Employment (DEM)	–		(–)		(–)			+	
Human Capital (DHK)	(–)			(+)		(–)+			
Openness(DOPEN)							(–)		
Foreign Direct Investment (DFDI)		+		+					
Technology Transfer (DTTECH)	+			(+)		(–) –			
Saving (DSAV)	+	+		(+) –					–
Financial Wealth (DWEALTH)								–	
Interest rate (dinterest)		+			(–)–	(–)			
Financial Liberalization (dpc)					(–)	–			
Exchange rate (drmb)						(–) –	(–)+		
Relative Wage ratio (dwage)						(+)–			
Inflation (dinflat)					(+)+				(–)
Trade liberalisation (dlibdummy)	+	+			–				
Tax revenues (dtax)		+				+		(+)	
Government Infrastructural expenditure (dgtran)				(+)+		(–)			
Government Expenditure on Education (dgee)				(–) –			(+)		

(–) represent the coefficient of lagged variable is significantly negative

– represent the coefficient of current variable is significantly negative

(+) represent the coefficient of lagged variable is significantly positive

+ represent the coefficient of current variable is significantly positive

The direct relationships of other variables are summarized in Table 5.6. From it, we can find that direct effects of FDI on spillovers are significantly positive for capital formation and human capital. The change in output can accelerate changes in openness, technology development, saving and financial wealth, but decelerate the change in human capital, which is positively determined by technology development.

5.4. Impact, interim and total dynamic multipliers

Although the final restricted structural model gave us the direct effects of exogenous variables, the indirect effects, and hence, the long-run effects could still not be detected. Multipliers then provide an implement to investigate how endogenous variables respond to a unit change in one exogenous variable over time. In this case, they give us an opportunity to evaluate how economic growth, FDI and other spillovers respond to policy instruments in the long-run.

5.4.1. Derivation of the final form

To obtain the multipliers, we need to transform the structural system to a reduced form, and then the impact multipliers can be found. Based on the reduced-form system, after some calculation, the final form of the equation system can be generated, and hence the interim multipliers and the total, cumulative, multipliers.

Referring to the structural model

$$Y_t=K+AY_t+BY_{t-1}+CX_t+DX_{t-1}+e_t \tag{5.11}$$

Hence, moving Y_t to left hand side, we have:

$$(I-A)Y_t=K+BY_{t-1}+CX_t+DX_{t-1}+e_t \qquad (5.12)$$

By solving for Y_t, we obtain the reduced form model:

$$Y_t=d_0+D_1Y_{t-1}+D_2X_t+D_3X_{t-1}+u_t \qquad (5.13)$$

Where $d_0=(I-A)^{-1}K$, $D_1=(I-A)^{-1}B$, $D_2=(I-A)^{-1}C$, $D_3=(I-A)^{-1}D$, $u_t=(I-A)^{-1}e_t$.

With respect to (5.13), Y_{t-1} can be replaced by an equation lagged one period. Hence:

$$Y_t=(I+D_1)d_0+D^2{}_1Y_{t-2}+D_2X_t+(D_1D_2+D_3)X_{t-1}+D_1D_3X_{t-2}+u_t+D_1u_{t-1} \qquad (5.14)$$

Applying this substitution s times, as $s\longrightarrow\infty$, D_1^s converges to null matrix only if all the eigenvalues of D_1 are less then 1 in absolute values.

If this is the case, then we have

$$Y_t=(I+D_1)^{-1}d_0+D_2X_t+\sum_iD_1^{i-1}(D_1D_2+D_3)X_{t-i}+\sum_iD_1^iu_{t-I} \qquad (5.15)$$

which is a vector equation of the final form of the equation system.

And the coefficient matrices of the final form are:

$$D_2,\ D_1D_2+D_3,\ D_1(D_1D_2+D_3),\ D_1^2(D_1D_2+D_3),\ldots\ldots\ D_1^{i-1}(D_1D_2+D_3) \qquad (5.16)$$

The impact multipliers are defined by the elements of matrix D_2, which indicates the immediate effect of exogenous changes. The elements of the other matrices, i.e. $D_1(D_1D_2+D_3)$, $D_1^2(D_1D_2+D_3)$, …… $D_1^{i-1}(D_1D_2+D_3)$ provide the interim multipliers, hence, the effects during given later periods. Adding all the coefficient matrices in (5.16) together gives the total multiplier matrix of the system, which is:

$$G = (I - D_1)^{-1} (D_2 + D_3) \quad (5.17)$$

5.4.2. Dynamic analysis of multiplier effects

With respect to our restricted model, the condition to that the multipliers converge to zero over time is the same as the stability condition for our structural system. Both of them require the roots of the companion matrix of the system to be less than one in absolute value (see Appendix A 5.4.2). As the structural system is stable, our model meets the requirement for calculating all the multipliers. The impact multiplier matrix is reported in Table 5.7, which represents the immediate effect of exogenous variables on the change of endogenous variables. Since all the multiplier effects would die out to zero under the stability condition, we only need cover the multiplier effects within a certain period and discard the trivial ones in the long-run. Consequently, the interim and cumulative multipliers are calculated for a period of 30 years in our analysis. In fact, our results suggest that the interim multiplier effects of all exogenous variables would die out in about 10 years. All the dynamic multiplier effects of each exogenous variable are listed in Appendix A5.5.

Considering that our system was estimated by variables in first difference, the multipliers should be interpreted as the acceleration or rate of change of the endogenous variables as a result of a unit change in the change of one exogenous variable. So the acceleration effect is expressed by a positive multiplier, and a negative value represents the deceleration effect on endogenous variables. We will discuss all the multipliers effects (immediate multipliers, interim multipliers and cumulative multipliers) of exogenous variables. The purpose in doing so is to investigate the dynamic influence of changes in government policies on changes in output and FDI, and discover which implements are more efficient in macroeconomic adjustments for economic development.

Table 5.7. *Cumulative multipliers and impact multipliers*

Immediate multipliers									
	dinterst	dpc	drmb	dinflat	dwage	dlibdummy	dtax	dgtran	dgee
DGDP	-0.004957	0.003949	0.02636	0	0.006355	0.389454	-0.0014	-0.000874	0.001628
DKAP	0.01445	-0.011513	0.029278	0	-0.018526	1.124061	0.004082	0.002548	-0.004745
DEM	-1.76E-18	-1.08E-17	8.38E-19	0	-1.74E-17	1.38E-16	3.84E-18	2.40E-18	-4.46E-18
DHK	0.002	-0.030786	-0.029027	0	-0.049539	-0.157117	0.010915	0.164473	-0.306246
DOPEN	-0.025506	-0.002723	0.044012	1.527575	-0.004381	-0.158057	0.000965	0.000603	-0.001122
DFDI	-0.265808	-1.985114	0.02924	0	-3.19434	20.88256	0.703843	0.439376	-0.818114
DTTECH	-0.001652	0.001316	0.227507	0	0.002118	0.129797	-0.000467	-0.000291	0.000542
DSAV	-0.010736	0.008554	0.05709	0	0.013764	0.843474	-0.003033	-0.001893	0.003525
DWEALTH	-0.000345	0.000275	0.001833	0	0.000442	0.027088	-9.74E-05	-6.08E-05	0.000113
Cumulative multipliers									
	dinterst	dpc	drmb	dinflat	dwage	dlibdummy	dtax	dgtran	dgee
DGDP	-0.003459	0.011328	0.015351	-0.026551	0.003493	0.291343	0.011665	0.000389	0.271336
DKAP	0.01488	0.002274	0.005806	0.176739	0.000203	0.884247	0.501516	-0.068079	0.375275
DEM	-1.12E-18	-4.43E-18	-6.30E-18	-5.80E-17	-2.49E-18	1.37E-16	3.07E-17	-5.29E-17	1.07E-16
DHK	0.009773	-0.050312	-0.041795	-0.188597	-0.02034	-0.09767	-0.117381	0.164053	-0.857872
DOPEN	-0.055842	-0.019073	0.033706	2.138252	0.007014	-0.120233	0.316909	-0.039125	0.755536
DFDI	-0.574212	-0.767869	-0.699579	8.147655	-0.299149	17.50502	6.165997	-8.554937	21.7509
DTTECH	0.008505	0.050302	0.112651	-1.739243	0.007372	0.101331	-0.745072	0.105481	2.377627
DSAV	-0.005048	0.016531	0.022402	0.219408	0.005097	0.425157	0.305937	0.000568	0.39596
DWEALTH	-0.001299	0.004255	0.005766	-0.46896	0.001312	0.109422	-0.120766	0.000146	0.101908

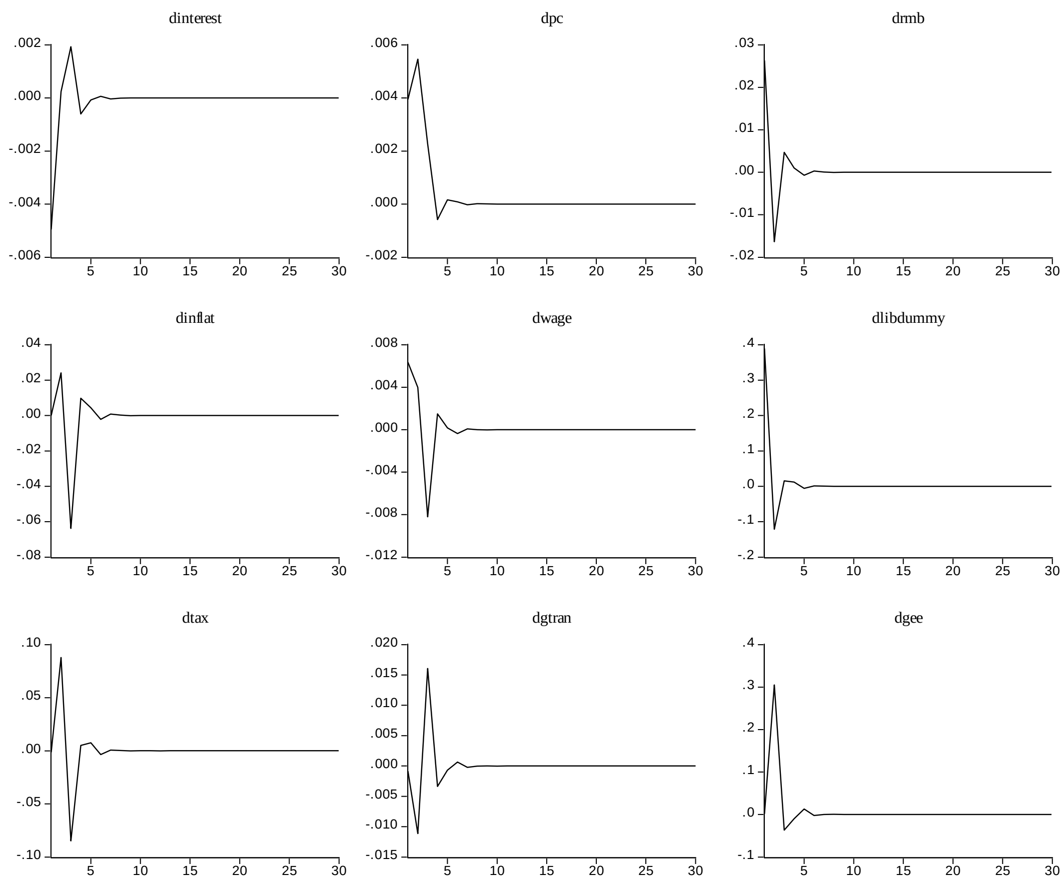
Dynamic multiplier effects on output

The immediate multipliers and cumulative multipliers listed in Table 5.7, indicate that all the government policies are actually effective in stimulating economic growth, though in the inter-medium term, the multipliers suffer from some overshooting effects on the change in output before dying out (see Figure 5.3). Among them, multipliers of liberalization and government expenditure on education are more significant in affecting the change of output.

For the monetary policy instrument, lower change in interest rate would accelerate economic growth both immediately and totally as expected. But its effect is quite small. An increase of credits to private sectors, representing financial liberalization, has the accelerating effect on economic growth, as it reduces transaction cost and provides more fund for private business, therefore stimulate the increase of output. Commercial policy instruments, such exchange rate, relative wage rate, and liberalization, all have positive multiplier effects on the change in output. The results demonstrate that economic development would be accelerated from depreciation of domestic currency and more international integration. Our results suggest that, the idea that keeping labour cost in a low level to increase profit margin therefore to stimulate FDI and economy, is actually not a beneficial choice for economic growth in China. On the contrary, the increase in the wage level would increase the national income, therefore, accelerate the economic growth both in the short-run and the long-run with a small margin.

Accordingly, fiscal policies would be more effective in the long-run rather than in the short-run. The rise in tax revenues reduces profits of companies therefore decelerates economic growth in the short-run. But as the rise in taxes provides more fund for government spending on public service and investment, the whole economy would be accelerated from the economic and social development committed by Chinese government in the long-run. The multipliers of government infrastructure expenditure tell similar story that better infrastructure could not benefit economic growth immediately, but would be beneficial in the long-run. The effect of expenditure on education is also more effective in the long-run as the total multiplier is much higher than the immediate one.

Figure 5.3. *Multiplier effects on DGDP*

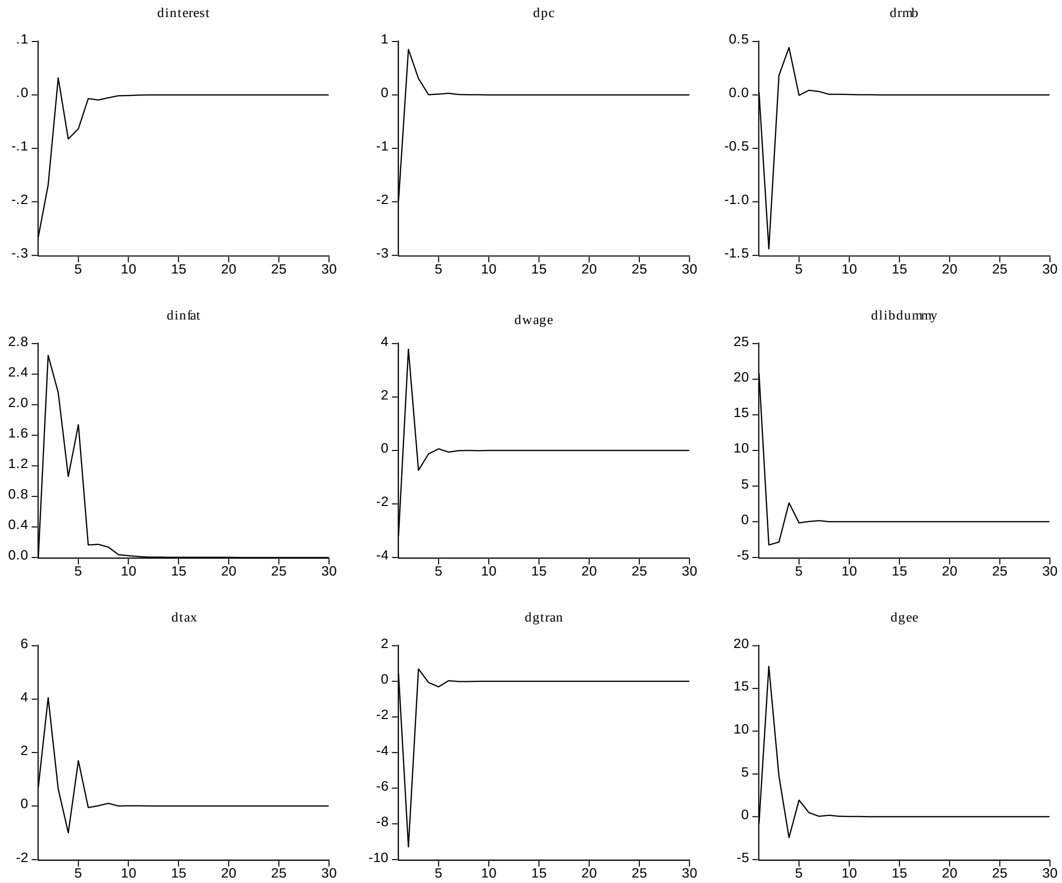


In affecting the change in FDI, most of exogenous policy variables are relatively more effective compared with their effects on economic growth both immediately and cumulatively. Their interim multipliers also fluctuant from the initial effects and die out after about seven years (see Figure 5.4).

As the same as the direct effect, we have both negative immediate and the cumulative multipliers of interest rate. Hence, lower change in interest rate would encourage the increase of FDI from aggregate level as it saves cost of FDI when borrowing money from the host country. Financial liberalization, on the country, would decelerate the change in FDI. This result may indicates that domestic sectors, especially private sectors, benefit more from the development of financial sectors compared with foreign investors and increase their competitiveness so as to crowd out FDI.

Among commercial policies, liberalization is confirmed to be a main reason to attract FDI, as it has the largest multipliers on the change of FDI both in the short-run and in the long-run. Labour cost is another main initial consideration for foreign investors, but its effect would slack in the long-run as the cumulative multiplier of relative wage ratio is much small than the immediate one. Depreciation of currency would have ambivalent multiplier effects on FDI. The negative immediate multiplier indicates that more depreciation of local currency would increase values of FDI measured in local currency, thus, raise the interests of MNEs. But exchange rate depreciation would raise prices of imports and damage those FDI that need import raw material or components of final products targeted on the market of the host country. Consequently, the cumulative effect in the long-run would be negative.

Figure 5.4. *Multiplier effects on DFDI*



According to our results, the increase in taxes has accelerating multiplier effects on the change in FDI both in the short-run and in the long-run. It implies that FDI have the competitive advantage compared with domestic business that bears the most of the burden of tax rise. As discussed before, MNEs benefit from better public service funded by more taxes as the same time enjoying tax-incentive privilege from government, hence, would intend to invest more in China. The positive immediate multiplier of the change in infrastructural expenditure indicates its accelerating effect on attracting FDI in the short-run. But the negative cumulative multiplier on FDI implies that, in the long-run, improvement of infrastructure would be beneficial to domestic business more and increase their capability of competing with MNEs to crowd out FDI. Multipliers of the change in government expenditure on education shows that the endeavour on human capital development would decelerate the increase of FDI in the short-run, especially those labour-intensive efficiency-seeking investments, but accelerate the increase of FDI cumulatively in the long-run, as more FDI with new technology that requires certain level of labour skill would benefit from this improvement.

Multiplier effects on other spillovers

Along with the multiplier effects on economic growth and FDI, there are also several points that need mention with the results of the multipliers on spillovers. Firstly, our results suggest the converse effect on capital formation of one monetary policy variable: the interest rate change. As discussed for the direct effect before, it maybe caused by that the capital from state-owned enterprises and from government, which is not sensible to the cost of capital. Hence, the effect of the change in interest rate on economic growth might be through other channels like FDI and openness, where international trade mainly conducted by private sectors that would benefit from lower cost of borrowing. Another point is that most of the policy instruments have negative effect on human capital improvement except infrastructure development. As suggested by Fujita and Hu (2001), it may caused by the enhanced regional disparity due to rapid economic growth and international integration, which results in agglomerations of human capital to more developed regions in China, but deterioration in its development at the whole national level. On the contrary, the policy instruments are confirmed to benefit technology improvement except the rise of taxes.

5.4. Conclusion

Estimated by a simultaneous equation model, the objective of this chapter actually has been achieved in two stages. Firstly, with the restricted system, we identified the direct relationships between output and other endogenous variables as well as the direct effects of exogenous variables. In the second stage, we captured the multiplier effects from the reduced form of the system, where we indentified the entire dynamic effects of policy variables on output, FDI and other endogenous variables, including both the direct effects and the indirect effects from the immediate short-run to the cumulative long-run.

The empirical results from the restricted system provide insight into the direct influence on economic growth, FDI and spillovers. As expected, we find that the change in technology transfer and saving are the main sustainable factors for economic growth, as both of them play significant positive roles in accelerating economic growth directly. However, the changes in capital formation and employment would decelerate economic development, when those in their levels, drive output to increase as suggested in Chapter Three. Thus, they have diminishing returns in output as assumed by the neo-classical model. According to our estimation, human capital, international openness and FDI, as well as financial wealth, do not have significant direct impacts on output. Therefore, we can make one conclusion that the acceleration of economic growth depends more on technology development than labour resource improvement and capital formation from both domestic sectors and foreign sectors. With regard to exogenous variables, our findings suggest that only liberalization is significantly directly beneficial to economic growth.

From the direct effects, we can conclude that FDI is mainly attracted by the rapid enhancement of market size in China, as well as taking advantage of current human capital improvement. However, with the technology development and human capital improvement continually, FDI would lost their advantage to domestic sectors and hence, be crowded out. And FDI have spillovers on the economy by accelerating capital formation enhancement and human capital improvement.

Compared with the VAR system in the previous two chapters, the simultaneous model in this chapter enables us to investigate the influence of government policies through the multiplier analysis. The overall effects of government policy variables have been better explained in impact, interim and total multiplier effects. Our results suggest that, the government policies are all beneficial to economic development, while changes in trade liberalization and government expenditure on education are the most effective instruments in accelerating the change in output in the cumulative long-run. According to the results, policy instruments also play important roles in affecting the change in FDI. Those two instruments, liberalization and government expenditure on education play the same remarkable roles in accelerating the change in FDI as for economic growth. But some instruments have decelerating effect on FDI in the long-run as they would contribute more on improving the competitiveness of domestic sectors therefore crowd out FDI consequently. According to our results, the role of the interest rate on capital formation in China is contradictory to what theoretic hypothesis has suggested. And human capital does not seem to benefit from policy instruments. In addition, we note that most of the exogenous variables, exhibits ambiguous dynamic effects on the endogenous variables. Thus, we conclude that output, FDI and the spillovers might overreact to government intervention at some stage.

Totally, we conclude that the monetary policies, fiscal policies and commercial policies committed by the government are indeed appreciative for economic development in China. However, efforts should still be done on establishing an effective monetary policy mechanism to direct domestic capital formation, and improving human capital development to deliver its potential on technology development and economic growth.

Compared with VAR model, which focus on the long-run relationships of factors evolved in production process from supply side, the simultaneous model establish a mechanism to investigate the intermediates of economic growth in terms of policy instruments determined outside the economic system. The emphasis would be on the effects of government policies rather than the long-run relationships of endogenous variables. Technically, the conclusion we made is constrained and depends on the presumptions of the original structure of the simultaneous equation system, whilst the VAR model provided a more general conclusion as it has few restrictions on the original assumption of relationships between variables. Hence, the conclusion drawn here is rather a specific result based on the pre-determined structure of economic system than a general one, and may vary if simultaneous relationships are assumed differently. However, as the restrictions we added are consistent with economic theories and the experimental results, the simultaneous system is still valid and rational for China, and hence, the conclusion.

Note:

1. The Chinese Authority claimed on 2006 that its currency RMB would then pegged to a basket of currencies including US dollars, Euros and etc.

CHAPTER SIX

GENERAL CONCLUSION

6.1. Introduction

Through a series of analyses for specific countries, our study gives empirical evidence of the influence of FDI and spillovers on economic development and makes contributions to the literature on the economic development with liberalization and globalization.

Our study expands the scale of the research on the impact of FDI on economic growth in China. Previous studies have been rather limited so far in number and scope, either focused on the direct correlation between FDI and economic growth (Tan *et al*. (2004)), or only considered the effects through certain spillover variables (see Tang (2005), Liu (2002), Shan (2002)), and have produced incomplete, but also competing answers on the role of FDI. Our objective has been to encompass the various narrow studies in one comprehensive framework into which the several feasible determinants of aggregate output and of FDI could be incorporated and be allowed potentially to interact with one another. The simple unifying feature driving the utilization of the resultant VAR framework is the aggregate production function based on the new endogenous growth theory. The VAR methodology enables us to not only capture the long-run equilibrium relationships through the ECM model, but also evaluate the total effects from spillovers through innovation analysis. Hence, the VAR analysis provides a more comprehensive view on the relationship between FDI and economic growth, especially in China. By employing the VAR analysis on two new industrialized countries, Taiwan and South Korea, we are able to value the FDI impacts on economic growth with different development stances compared to China.

We have also considered intruding interventions by government policies in evaluating the relationships between economic growth, FDI and other spillovers through a simultaneous equation model to complement the VAR system, as the latter excluded influence of any exogenous or other form of government intervention in the economy. Thus, the simultaneous model provides an opportunity to look into the intermediaries of the economy in the form of exogenous variables, policies and others determined outside the system by constructing and estimating simultaneous equations, whilst the VAR system gives the “overview” that emerges from the policy and other “impulses” to the system.

From the restricted form of the structure model, the direct simultaneous relationships between endogenous variables, the inputted factors in the production function, have been obtained by coefficients of each equation; the interventional effects of government policies have been captured by the dynamic multiplier effects. Hence, our results provide new evidence of the effects of government policies on FDI and economic development.

6.2. Main empirical findings

The empirical results throughout all our analyses gave answers to the questions initially asked in the introduction chapter related to how economic growth has been achieved, what is the role of FDI and other spillovers in this process.

In Chapter Three, we evaluated the economic growth of China in a VAR system with estimating on capital formation, employment, human capital, openness, FDI and technology transfer. Through the VAR model and the ECM model, the relationships then have been investigated by the long-run relationships in the cointegrating vectors and the short-run effects from the ECM model. The dynamic correlations of variables have been captured by the analyses of variance decomposition and impulse response.

From the cointegration analysis, we find that the Chinese economy is determined by traditional fundamentals as capital and employment. The sustainable elements, human capital and technology transfer, suggested by new growth theories, could have negative influence on output through affecting capital formation and employment. FDI, in the long-run equilibrium, could hamper economic development and capital formation significantly in a small margin. But it show positive effects on employment and technology transfer. The long-run relationships also suggest that, though FDI might not stimulate economic growth, it is attracted by rapid economic growth on the contrary.

The innovation analysis, including variance decomposition and impulse response, indicates the character of labour-intensive FDI in China. The results suggest that FDI and its effects are associated with the initial conditions of host economies, and this type of FDI would play a smaller role in the development of these economies. The innovation analysis also suggests that FDI could have negative effects on economy in the short-run, but the long-run effects could be positive, though all of them are not significant. Thus, FDI is by no means a necessary condition for achieving rapid growth for the whole country.

The results from the ECM model, suggest that, FDI and economic liberalization, does not voluntarily improve economic growth and technology development in the short-run. They only provide an access for the development. Efforts should be made by host economies to invest in appropriate technology and labour force for the sustainable economic growth.

In Chapter Four, we have explored the fundamental question of the role of foreign direct investment on economic growth of the relatively developed economies in East Asia, Taiwan and South Korea. The VAR models and the relative ECM models have been implemented to capture the long-run effects by the cointegration analyses and the dynamic correlations by innovation analyses.

As the case in China, our findings do not support an important role played by FDI on economic growth; but FDI is attracted by the rapid economic growth in these two countries; the traditional elements of inputted factors, such as capital formation and employment, still play important roles in stimulating economic growth in these two countries. Contrarily, the results suggest that the impacts from spillovers may be different with respect to the stages of development, whilst technology transfer and human capital, as well as openness, weight more in influencing economic growth. But the difference seems to be a consequence of different strategies of development. Taiwan employing the similar strategy as China (mainland) to promote technology through FDI and openness, would be much harder to generate productivity from technology development and human capital improvement, but would be more sensible with international integration and competition. For the case of Korea, it could promote the economy through technology development and human capital improvement more successfully; on the other hand, it would hamper the economy by reducing competitive capability of domestic business with increased openness level. In addition, the spillover effects of FDI on capital formation are demonstrated to be significantly positive in these two countries, as the domestic business has relatively higher competitive capability compared with the case of China and would input more to compete with MNEs instead of being crowded out. The significance of the relationships has also been confirmed by variance decomposition from the VAR model of each country. The impulse responses also provide complement supports for the cointegration analyses of the determinants of FDI from the short-run to the long-run.

In Chapter Five, we analyse the economic development through a simultaneous equation model with variables in first difference. And the results can be interpreted into two ways: the direct effects of endogenous variables are represented by the coefficients from each equation; the total influence from government interventions is captured by the multiplier effects. Since variables are estimated in first difference, the effects would be interpreted as the acceleration of the changes in variables, or acceleration for proportional changes of those variables in logarithm.

The empirical results from the restricted system provide insight into the direct influence on economic growth, FDI and spillovers. As expected, we find that the change in technology transfer and saving play significant positive roles in accelerating economic growth directly. However, the changes in capital formation and employment would decelerate economic development, when those in their levels, drive output to increase as suggested in Chapter Three. Thus, they have diminishing returns in output as assumed by the neo-classical growth theory. According to our estimation, human capital, international openness and FDI, as well as financial wealth, do not have significant direct impacts on output. Therefore, we can make one conclusion that the acceleration of economic growth depends more on technology development than labour resource improvement and capital formation enhancement from both domestic sectors and foreign sectors. With regard to exogenous variables, our findings suggest that only liberalization is significantly beneficial to output growth. According to our results, FDI has spillovers on the economy by accelerating capital formation enhancement and human capital improvement. From another aspect, FDI is found to be mainly attracted by the rapid enhancement of market size in China and taking advantage of current human capital improvement. However, with the technology development and human capital improvement, FDI would lost their advantage to domestic sectors and hence, be crowded out.

The overall effects of government policy variables have been explained in impact, interim and total multiplier effects. Our results suggest that, the government policies are all beneficial to economic development, while changes in trade liberalization and government expenditure on education are the most effective instruments in accelerating the change in output in the cumulative long-run. According to the results, policy instruments also play important roles in affecting the change in FDI. Those two instruments, liberalization and government expenditure on education play the same remarkable roles in accelerating the change in FDI as for economic growth. But some instruments have decelerating effect on FDI in the long-run as they would contribute more on improving the competitiveness of domestic sectors therefore crowd out FDI consequently. According to our results, the role of the interest rate on capital formation in China is contradictory to what theoretic hypothesis has suggested. And human capital does not seem to benefit from policy instruments. In addition, we note that most of the exogenous variables, exhibits ambiguous dynamic effects on the endogenous variables, which may suggest they have overshoot effects on endogenous variables.

The simultaneous equation model complements the conclusions generated from the

VAR model by providing the intermediate reactions of the factors in the economic system with employing more exogenous policy variables into estimation. The results from this model is rather specific based on the original simultaneous structure for the economic system, while the VAR gives a more general view of the system which is focusing on the overall level. All of them together provide a panoramic perspective of economic growth and FDI, especially for China.

6.3. Policy considerations

As our empirical results demonstrated that, in many occasions, FDI and its spillovers play positive roles on economic growth, we suggest that the liberalization policy should be maintained for further development. And some policies are considered to be beneficial to the social and economic development.

As our results don't suggest the positive role of human capital in China and Taiwan, more attentions should be drawn to promote the labour quality by the government through education and training in the process of openness. Most importantly, the government need impel national income to distribute more fairly among labour force and balance the economic disparities between different regions. Although it would not generate immediate effects on economic growth, it is still essential to obtain sustainable development and industrial upgrade as did by South Korea.

Although our study confirms the positive relations between FDI and technology transfer, we can hardly observe the role of technology transfer in stimulating economic growth in China. Therefore, the focus of the technology development policy should be on the process of diffusion and absorption of new technology among domestic sectors to enable that the new technology imported can raise capability of production soon.

In our study in China, we find that fiscal policies are more effective in influencing the economy than monetary policies. Government investment in infrastructures would be recommended for countries to stimulate their economies and promote technology development. Further reforms in money market should be undertaken to improve the mechanism from money market to affect real sectors in the economy in China.

With regard to FDI and liberalization policies, our results from China, Taiwan and South Korea suggest that attracting FDI, as did by China and Taiwan, is beneficial, but not the only channel that can lead to the process of economic growth and modernization. Promoting export-oriented industries and introducing new technology by domestic sectors could also be essential to achieve economic development. But it requires strong leadership and financial support from the government, especially at the initial stage, and need overcome the danger of losing international competitive capability of the domestic sectors with over protection.

6.4. Limitation and Further research

Our study expends the scale of the research on the relationships of FDI and economic growth in China and East Asian countries. However, there are still some limitations in this study. One big issue is that the study is restricted by the data availability. The sample size of our model is relatively limited. From 1970 to 2006, only 37 annual observations for each variable are taken into the system, which constrains the degree of freedom in the estimation when taking account of the number of variables and lags. Technically, the problem of small sample would affect the accuracy of our results. Further more, data from some variables that we are interested in are not available. For example, we could not find the data for stocks of domestic and foreign capitals and have to compensate with flows of such variables in our system. Also more information is needed to capture the effect of financial liberalization. If more observation can be obtained, for example if quarterly data are available to be estimated, and variables can be measured more precisely, the results from the framework we established would be more persuadable.

From another side, the restrictions in identifying the long-run relationships in the VAR model and the basic structure for the simultaneous equation model are not unique honestly. Those we put on the systems are based on the information we got from the realities of the relative economies and our own understanding of relationships based on economic theories. Thus our conclusions are rather specific based on these particular presumptions for China and two economies in East Asia and may not prevail for others if the condition changes. Even more, if the systems can be restricted more rationally, results could also change for the countries in our estimation. Hence, the methodology in estimation, rather than the results, is believed to be more valuable in investigating economic growth comprehensively with FDI integrated.

Based on our analysis, further research on the following areas would be beneficial to understand the relationships between FDI and economic development. Considered the unbalanced distribution of FDI in China, the impact of FDI in eastern coast area could be overwhelmed by that in western inland area, and cause the total negative impacts. Hence, further research would be suggested to investigate FDI and its impact of growth through regional analysis to distinguish the difference. In consideration of government policies toward economic development and liberalization, more efforts should be conducted to evaluate the effects of financial liberalization on FDI and economic growth. For example, the impacts of recent release in exchange rate mechanism in China should be considered into the investigation of development and openness. The effect of monetary policy variable, such as interest rate, also needs attentions. Further more, investigations in more countries, such as Japan, Hong Kong, and Southeast Asian countries, can be valuable in evaluating the relationships between FDI and economic growth with different development stages.

APPENDICES

APPENDIX TO CHAPTER THREE

A3.1. Summary of progress in legislation related to FDI in China

Time	Implementation of Laws and Regulations
July 1979	the Law of People's Republic of China on Joint Ventures Using Chinese and Foreign Investment
1983	Regulation for the Implementation of the Law of the People's Republic of china on Chinese –foreign Equity Joint Ventures
1986	Wholly Owned Subsidiaries Law (WOS Law)
1986	Provision for the FDI Encouragement
1986	Constitutional Status of Foreign invested Enterprises in Chinese Civil Law
1987	Adoption of Interim provision on guiding FDI
1988	Delegation on approval of selected FDI projects to more local governments
1988	Laws of cooperative joint ventures
1990	Revision of equity joint venture law
1990	Rules for implementation of WOS law
December 1990	Detailed Rules and Regulations for the Implementation of the People's Republic of China Concerning Joint Ventures with Chinese and Foreign Investment
1991	Income tax law and its rules for implementation
1992	Adoption of Trade Union Law
1993	Company Law
1993	Provision regulations of value-added tax, consumption tax, business tax and enterprise income tax
1994	Law on Certified Public Accountants
1994	Issues relating to Strengthening the Examination and Approval of Foreign-funded Enterprises.
1994	Provisions for Foreign Exchange Controls (1995)
1995	Provisional Guidelines for Foreign Investment Projects (1995)
1995	Insurance Law
1995	Law of Commercial Bank
1995	Detailed rules for implementation of Cooperative Joint Venture Law (1995)
1996	Further delegation For Approving FDI to Local Government
1997	Provisions for Foreign Exchange Controls (1997)
1998	Provisions on Guiding Foreign Investment Direction (1998)
2000	Industrial Catalogue for Foreign Investment in the Central and Western Region
2001	Administrational Rules for Foreign Financial Institutions
2001	Revision of Equity Joint Venture Law
2001	Revision of regulation for the implementation of the law of the People's Republic of China on Chinese-foreign Equity Joint Ventures
2001	Rules for Implementation of WOS Law
2002	Provisions on Guiding Foreign Investment Direction (2002)
2003	Provision Rules for Foreign-funded Enterprises in International Trade
2004	International Trade Law

Sources: China Investment Yearbook.

A3.2. Dummy variable based on legislation process

Year	Legislations	Dummy
1970	0	0
1971	0	0
1972	0	0
1973	0	0
1974	0	0
1975	0	0
1976	0	0
1977	0	0
1978	0	0
1979	1	0.030303
1980	1	0.030303
1981	1	0.030303
1982	1	0.030303
1983	2	0.060606
1984	2	0.060606
1985	2	0.060606
1986	5	0.151515
1987	6	0.181818
1988	8	0.242424
1989	8	0.242424
1990	11	0.333333
1991	12	0.363636
1992	13	0.393939
1993	15	0.454545
1994	18	0.545455
1995	22	0.666667
1996	23	0.69697
1997	24	0.727273
1998	25	0.757576
1999	25	0.757576
2000	26	0.787879
2001	30	0.909091
2002	31	0.939394
2003	32	0.969697
2004	33	1
2005	33	1
2006	33	1

A3.3. Registered foreign-invested enterprises in China by sector at the year-end

Number of Registered Enterprises (number)	**1991**	**1992**	**1993**	**1994**	**1995**
National Total	37215	84371	167507	206096	233564
Agriculture, forestry, animal husbandry, fishery and water	1194	2168	4246	6002	5661
Industry	31287	68636	124606	150382	169418
Geological survey and exploration	18	21	47	40	101
Construction	579	1573	4603	5971	7326
Transportation, post and telecommunication services	761	1182	1918	2168	2832
Commerce, foodservices, material supply and marketing	771	2436	8742	11903	13280
Real estate, public residential and consultancy	2038	6908	19384	24449	29906
Health Care, Sports and Social Welfare	50	130	357	412	509
Education, Culture and Arts	186	519	1609	2160	1524
Scientific research and polytechnic services	161	395	878	1164	1190
Finance and insurance	31	38	31	34	85
Other Sectors	139	365	1086	1411	1732
Total Investment (10thousands USD)	**1991**	**1992**	**1993**	**1994**	**1995**
National Total	717833	17845550	38238877	49072446	63900854
Agriculture, forestry, animal husbandry, fishery and water	144084	274406	487765	791015	795536
Industry	519519	11661982	21099082	26845691	37221209
Geological survey and exploration	2152	1705	4204	12607	29654
Construction	162851	296109	990570	950168	1431931
Transportation, post and telecommunication services	112726	323564	777970	1482278	1844076
Commerce, foodservices, material supply and marketing	94421	408345	1678319	2281780	2372310
Real estate, public residential and consultancy	134659	4545839	12405978	15550081	18816223
Health Care, Sports and Social Welfare	12745	88929	117676	19969889	245229
Education, Culture and Arts	26295	66319	250421	382926	331329
Scientific research and polytechnic services	13472	49156	102734	125499	117023
Finance and insurance	38928	42911	36824	40773	170796
Other Sectors	28873	86285	287334	423649	525538

A3.3. Registered foreign-invested enterprises in China by sector at the year-end (continued)

Number of Registered Enterprises (number)	**1996**	**1997**	**1998**	**1999**	**2000**
National Total	240447	235681	227807	212436	203208
Farming, Forestry, Animal Husbandry and Fishery	5748	7289	5538	5259	5066
Mining and Quarrying	1604	2115	1506	1277	1131
Manufacturing	172180	165636	161293	150020	142754
Electricity, Gas and Water Production and Supply	1236	1314	1349	1345	1301
Construction	7444	7112	6696	6172	5601
Geological Prospecting and Water Conservancy	109	152	129	137	134
Transportation, Storage, Post and Telecommunication	3158	3359	3474	3471	3352
Wholesale & Retail Trade & Catering Services	14271	14649	14315	13064	12275
Finance and Insurance	98	81	77	65	72
Real Estate Management	14470	13872	13911	13395	12732
Social Services	16284	16369	16023	15054	15331
Health Care, Sports and Social Welfare	572	569	532	485	455
Education, Culture and Arts, Radio, Film and Television	1084	892	802	676	611
Scientific Research and Polytechnic Services	1198	1136	1042	975	1189
Others	991	1136	1120	1041	1195
Total Investment (100 millions USD)	**1996**	**1997**	**1998**	**1999**	**2000**
National Total	7153	7535	7742	7786	8247
Farming, Forestry, Animal Husbandry and Fishery	86	125	92	91	92
Mining and Quarrying	31	86	32	30	28
Manufacturing	3892	3980	4103	4103	4536
Electricity, Gas and Water Production and Supply	362	446	474	478	491
Construction	179	222	237	229	221
Geological Prospecting and Water Conservancy1	3	5	6	42	42
Transportation, Storage, Post and Telecommunication	221	259	307	327	332
Wholesale & Retail Trade & Catering Services	256	271	259	247	253
Finance and Insurance	19	14	18	17	20
Real Estate Management	1511	1508	1566	1549	1512
Social Services	478	490	503	524	554
Health Care, Sports and Social Welfare	28	29	29	27	24
Education, Culture and Arts, Radio, Film and Television	23	18	17	16	15
Scientific Research and Polytechnic Services	14	16	17	19	27
Others	46	67	83	86	99

A3.3. Registered foreign-invested enterprises in China by sector at the year-end (continued)

Number of Registered Enterprises (number)	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
National Total	202306	208056	226373	242284	260000	274863
Farming, Forestry, Animal Husbandry and Fishery	4752	4640	4957	5310	5752	5821
Mining and Quarrying	1047	957	903	920	979	970
Manufacturing	141668	146515	159789	170654	179949	187458
Electricity, Gas and Water Production and Supply	1268	1185	1349	1585	1820	1980
Construction	5139	4197	4098	3861	3927	3876
Geological Prospecting and Water Conservancy1	128	153	160	613	793	786
Transportation, Storage, Post and Telecommunication	3499	3540	3660	8515	10522	11788
Wholesale & Retail Trade & Catering Services	12249	12431	13578	15642	18097	21980
Finance and Insurance	74	87	119	168	175	182
Real Estate Management	11925	11850	12203	19066	13265	14438
Social Services	16169	16825	18330	5947	12393	15381
Health Care, Sports and Social Welfare	469	468	505	275	225	210
Education, Culture and Arts, Entertainment	530	443	435	2332	2525	2504
Scientific Research and Polytechnic Services	1851	2705	3683	4504	5622	6954
Others	1538	2060	2604	2892	3956	535
Total Investment (100 millions USD)	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
National Total	8750	9819	11174	13112	14640	17076
Farming, Forestry, Animal Husbandry and Fishery	91	104	119	151	235	257
Mining and Quarrying	33	37	39	51	64	81
Manufacturing	4913	5728	6708	7913	8955	10412
Electricity, Gas and Water Production and Supply	495	539	562	668	760	866
Construction	215	229	255	255	281	308
Geological Prospecting and Water Conservancy1	42	44	45	76	100	102
Transportation, Storage, Post and Telecommunication	414	446	567	907	757	921
Wholesale & Retail Trade & Catering Services	246	263	286	233	561	660
Finance and Insurance	21	25	36	48	47	59
Real Estate Management	1491	1480	1562	1811	1852	2271
Social Services	563	590	639	190	344	496
Health Care, Sports and Social Welfare	28	32	38	18	20	22
Education, Culture and Arts, Entertainment	14	13	13	126	157	143
Scientific Research and Polytechnic Services	43	76	107	207	257	322
Others	140	214	197	197	251	154

Note: Since 2004, Geological Prospecting is categorized in Scientific Research and Polytechnic Services

Sources: China Statistical Yearbook

A3.4. Gross Domestic Product of China and its composition

Year	National Income (100m RMB)	GDP (100m RMB)	Share of Primary Industry	Share of Secondary Industry	Manufacturing	Construction	Share of Tertiary Industry	GDP per capita (RMB)
1978	3645.2	3645.2	28.19%	47.88%	44.09%	3.79%	23.94%	381
1979	4062.6	4062.6	31.27%	47.10%	43.56%	3.54%	21.63%	419
1980	4545.6	4545.6	30.17%	48.22%	43.92%	4.30%	21.60%	463
1981	4889.5	4891.6	31.88%	46.11%	41.88%	4.23%	22.01%	492
1982	5330.5	5323.4	33.39%	44.77%	40.62%	4.15%	21.85%	528
1983	5985.6	5962.7	33.18%	44.38%	39.84%	4.54%	22.44%	583
1984	7243.8	7208.1	32.13%	43.09%	38.69%	4.39%	24.78%	695
1985	9040.7	9016.0	28.44%	42.89%	38.25%	4.64%	28.67%	858
1986	10274.4	10275.2	27.14%	43.72%	38.61%	5.12%	29.14%	963
1987	12050.6	12058.6	26.81%	43.55%	38.03%	5.52%	29.64%	1112
1988	15036.8	15042.8	25.70%	43.79%	38.41%	5.38%	30.51%	1366
1989	17000.9	16992.3	25.11%	42.83%	38.16%	4.67%	32.06%	1519
1990	18718.3	18667.8	27.12%	41.34%	36.74%	4.60%	31.54%	1644
1991	21826.2	21781.5	24.53%	41.79%	37.13%	4.66%	33.69%	1893
1992	26937.3	26923.5	21.79%	43.45%	38.20%	5.26%	34.76%	2311
1993	35260.0	35333.9	19.71%	46.57%	40.15%	6.41%	33.72%	2998
1994	48108.5	48197.9	19.86%	46.57%	40.42%	6.15%	33.57%	4044
1995	59810.5	60793.7	19.96%	47.18%	41.04%	6.13%	32.86%	5046
1996	70142.5	71176.6	19.69%	47.54%	41.37%	6.16%	32.77%	5846
1997	78060.8	78973.0	18.29%	47.54%	41.69%	5.85%	34.17%	6420
1998	83024.3	84402.3	17.56%	46.21%	40.31%	5.91%	36.23%	6796
1999	88479.2	89677.1	16.47%	45.76%	39.99%	5.77%	37.77%	7159
2000	98000.5	99214.6	15.06%	45.92%	40.35%	5.57%	39.02%	7858
2001	108068.2	109655.2	14.39%	45.15%	39.74%	5.41%	40.46%	8622
2002	119095.7	120332.7	13.74%	44.79%	39.42%	5.37%	41.47%	9398
2003	135174.0	135822.8	12.80%	45.97%	40.45%	5.52%	41.23%	10542
2004	159586.7	159878.3	13.39%	46.23%	40.79%	5.44%	40.38%	12336
2005	184088.6	183217.4	12.24%	47.68%	42.15%	5.53%	40.08%	14053
2006	213131.7	211923.5	11.34%	48.68%	43.09%	5.59%	39.98%	16165

Source: China Statistical Yearbook,

A3.5. Total investment in fixed assets of China by source of funds

Year	Grouped by Source of Funds							
	State Budgetary Appropriation		Domestic Loans		Foreign Investment		Fundraising and Others	
	Amount	%	Amount	%	Amount	%	Amount	%
	(100mn RMB)		(10 mn RMB)		(100mn RMB)		(100mn RMB)	
1981	269.8	28.1	122.0	12.7	36.4	3.8	532.9	55.4
1982	279.3	22.7	176.1	14.3	60.5	4.9	714.5	58.1
1983	339.7	23.8	175.5	12.3	66.6	4.7	848.3	59.2
1984	421.0	23.0	258.5	14.1	70.7	3.9	1082.7	59.0
1985	407.8	16.0	510.3	20.1	91.5	3.6	1533.6	60.3
1986	455.6	14.6	658.5	21.1	137.3	4.4	1869.2	59.9
1987	496.6	13.1	872.0	23.0	182.0	4.8	2241.1	59.1
1988	432.0	9.3	977.8	21.0	275.3	5.9	2968.7	63.8
1989	366.1	8.3	763.0	17.3	291.1	6.6	2990.3	67.8
1990	393.0	8.7	885.5	19.6	284.6	6.3	2954.4	65.4
1991	380.4	6.8	1314.7	23.5	318.9	5.7	3580.4	64.0
1992	347.5	4.3	2214.0	27.4	468.7	5.8	5050.0	62.5
1993	483.7	3.7	3072.0	23.5	954.3	7.3	8562.4	65.5
1994	529.6	3.0	3997.6	22.4	1769.0	9.9	11531.0	64.7
1995	621.1	3.0	4198.7	20.5	2295.9	11.2	13409.2	65.3
1996	625.9	2.7	4573.7	19.6	2746.6	11.8	15412.4	66.0
1997	696.7	2.8	4782.6	18.9	2683.9	10.6	17096.5	67.7
1998	1197.4	4.2	5542.9	19.3	2617.0	9.1	19359.6	67.4
1999	1852.1	6.2	5725.9	19.2	2006.8	6.7	20169.7	67.8
2000	2109.5	6.4	6727.3	20.3	1696.3	5.1	22577.4	68.2
2001	2546.4	6.7	7239.8	19.1	1730.7	4.6	26470.0	69.6
2002	3161.0	7.0	8859.1	19.7	2085.0	4.6	30941.9	68.7
2003	2687.8	4.6	12044.4	20.5	2599.4	4.4	41284.8	70.5
2004	3254.9	4.4	13788.0	18.5	3285.7	4.4	54236.3	72.7
2005	4154.3	4.4	16319.0	17.3	3978.8	4.2	70138.7	74.1
2006	4672.0	3.9	19590.5	16.5	4334.3	3.6	90360.2	76.0

Source: China Statistical Yearbook

A3.6. Results of unrestricted VAR of China

A3.6.1. Results of unit root tests.

ADF test

Dependent variable	With constant or trend	Test statistics	Prob
Level			
GDP	Constant and trend	-3.1193	11.77%
KAP	Constant and trend	-2.74725	22.52%
EM	None	6.081321	100.00%
HK	Constant and trend	-1.83672	66.52%
OPEN	Cone	-2.15648	3.17%
FDI	Constant and trend	-1.76655	39.03%
TTECH	Constant and trend	-3.43851	6.25%
First difference			
D(GDP)	Constant	-2.99389	4.56%
D(KAP)	Constant	-5.72146	0.00%
D(EM)	None	-3.03535	0.35%
D(HK)	None	-7.81958	0.00%
D(OPEN)	None	-4.16673	0.01%
D(FDI)	None	-3.49846	0.09%
D(TTECH)	None	-4.31972	0.01%

KPSS test

Dependent Variable	With constant or trend	test statistic	Asymptotic critical values		
Level			1% level	5% level	10% level
GDP	Constant and trend	0.151262	0.216	0.146	0.119
KAP	Constant and trend	0.128733	0.216	0.146	0.119
EM	Constant and trend	7.399405	0.216	0.146	0.119
HK	Constant and trend	0.92794	0.216	0.146	0.119
OPEN	Constant and trend	0.236281	0.216	0.146	0.119
FDI	Constant and trend	0.738164	0.216	0.146	0.119
TTECH	Constant and trend	0.11481	0.216	0.146	0.119
First difference					
D(GDP)	Constant and trend	0.108652	0.216	0.146	0.119
D(KAP)	Constant	0.212028	0.739	0.463	0.347
D(EM)	Constant	0.268108	0.739	0.463	0.347
D(HK)	Constant	0.125458	0.739	0.463	0.347
D(OPEN)	Constant	0.170112	0.739	0.463	0.347
D(FDI)	Constant	0.206319	0.739	0.463	0.347
D(TTECH)	Constant	0.079758	0.739	0.463	0.347

A3.6.2. Coefficients of the unrestricted VAR

Standard errors in ( ) & t-statistics in [ ]

	GDP	KAP	EM	HK	OPEN	FDI	TTECH
GDP(-1)	0.644449	0.519865	-0.422002	-0.044279	1.427605	2.933487	3.979681
	(0.26465)	(0.51578)	(0.19091)	(0.44718)	(0.47557)	(14.9488)	(1.61582)
	[2.43511]	[1.00793]	[-2.21045]	[-0.09902]	[3.00190]	[0.19623]	[2.46295]
GDP(-2)	-0.421579	-0.861022	0.396501	0.907682	-2.850724	-13.78630	-2.091313
	(0.24614)	(0.47970)	(0.17756)	(0.41590)	(0.44230)	(13.9032)	(1.50280)
	[-1.71277]	[-1.79492]	[2.23307]	[2.18245]	[-6.44519]	[-0.99159]	[-1.39161]
KAP(-1)	-0.003233	-0.005495	0.092323	-0.002884	0.053384	6.987327	-0.345732
	(0.11867)	(0.23127)	(0.08560)	(0.20051)	(0.21324)	(6.70302)	(0.72453)
	[-0.02725]	[-0.02376]	[1.07849]	[-0.01438]	[0.25034]	[1.04242]	[-0.47718]
KAP(-2)	0.157773	0.130087	-0.066086	-0.135983	0.155809	-2.144664	-0.635874
	(0.10200)	(0.19880)	(0.07358)	(0.17236)	(0.18330)	(5.76173)	(0.62279)
	[1.54674]	[0.65438]	[-0.89810]	[-0.78896]	[0.85003]	[-0.37223]	[-1.02102]
EM(-1)	-0.449784	-0.663120	0.645687	0.938612	-3.268931	17.95692	0.886564
	(0.32612)	(0.63557)	(0.23525)	(0.55104)	(0.58602)	(18.4208)	(1.99111)
	[-1.37921]	[-1.04335]	[2.74464]	[1.70335]	[-5.57819]	[0.97482]	[0.44526]
EM(-2)	0.395858	0.515232	0.048030	1.495118	-1.966710	1.814951	-0.397693
	(0.41748)	(0.81363)	(0.30116)	(0.70542)	(0.75020)	(23.5817)	(2.54895)
	[0.94820]	[0.63325]	[0.15948]	[2.11947]	[-2.62157]	[0.07696]	[-0.15602]
HK(-1)	-0.047130	0.041988	-0.089488	0.926124	-0.366303	-4.305021	-0.189847
	(0.12544)	(0.24447)	(0.09049)	(0.21196)	(0.22541)	(7.08556)	(0.76588)
	[-0.37572]	[0.17175]	[-0.98893]	[4.36940]	[-1.62504]	[-0.60758]	[-0.24788]
HK(-2)	-0.052362	0.034802	0.046815	-0.212860	0.479738	0.395080	-0.314911
	(0.07588)	(0.14789)	(0.05474)	(0.12822)	(0.13636)	(4.28630)	(0.46331)
	[-0.69004]	[0.23533]	[0.85522]	[-1.66012]	[3.51818]	[0.09217]	[-0.67970]
OPEN(-1)	-0.001954	0.152458	-0.039837	0.052565	-0.069580	11.21394	-0.572593
	(0.08792)	(0.17135)	(0.06342)	(0.14856)	(0.15799)	(4.96627)	(0.53680)
	[-0.02222]	[0.88974]	[-0.62810]	[0.35383]	[-0.44040]	[2.25802]	[-1.06667]
OPEN(-2)	-0.053099	-0.217910	-0.039324	0.413006	-0.254173	-9.375651	0.385809
	(0.07209)	(0.14050)	(0.05201)	(0.12181)	(0.12955)	(4.07216)	(0.44016)
	[-0.73655]	[-1.55095]	[-0.75615]	[3.39047]	[-1.96201]	[-2.30238]	[0.87652]
FDI(-1)	-0.002672	0.003213	0.001159	-0.021991	0.011882	0.938418	-0.004948
	(0.00389)	(0.00757)	(0.00280)	(0.00657)	(0.00698)	(0.21954)	(0.02373)
	[-0.68758]	[0.42417]	[0.41353]	[-3.34846]	[1.70131]	[4.27442]	[-0.20851]
FDI(-2)	0.001319	-4.98E-05	-0.000428	0.005571	-0.001141	-0.346125	-0.033740
	(0.00305)	(0.00594)	(0.00220)	(0.00515)	(0.00548)	(0.17230)	(0.01862)
	[0.43254]	[-0.00838]	[-0.19433]	[1.08093]	[-0.20820]	[-2.00880]	[-1.81161]
TTECH(-1))	0.044631	0.077213	0.008434	0.019072	0.085092	-2.355427	0.724153
	(0.03435)	(0.06694)	(0.02478)	(0.05804)	(0.06172)	(1.94021)	(0.20972)
	[1.29936]	[1.15342]	[0.34036]	[0.32861]	[1.37860]	[-1.21401]	[3.45300]

A3.6.2. Coefficients of the unrestricted VAR (continued)

	GDP	KAP	EM	HK	OPEN	FDI	TTECH
TTECH (-2))	-0.013118	0.114785	-0.010468	-0.076832	-0.046087	0.917662	-0.425071
	(0.03437)	(0.06698)	(0.02479)	(0.05807)	(0.06176)	(1.94133)	(0.20984)
	[-0.38168]	[1.71369]	[-0.42223]	[-1.32304]	[-0.74623]	[0.47270]	[-2.02571]
C	17.73126	35.20423	5.856733	-66.86434	133.5199	-234.8946	-39.00655
	(11.3350)	(22.0909)	(8.17684)	(19.1528)	(20.3687)	(640.264)	(69.2061)
	[1.56429]	[1.59361]	[0.71626]	[-3.49110]	[6.55516]	[-0.36687]	[-0.56363]
TREND	0.057711	0.083313	0.014333	-0.114739	0.236086	0.860913	0.020890
	(0.02272)	(0.04427)	(0.01639)	(0.03838)	(0.04082)	(1.28314)	(0.13869)
	[2.54051]	[1.88186]	[0.87467]	[-2.98927]	[5.78352]	[0.67094]	[0.15062]
LIBDUMMY	0.056814	0.532795	-0.130041	0.004481	0.552519	-11.98357	-0.507274
	(0.14459)	(0.28178)	(0.10430)	(0.24431)	(0.25982)	(8.16702)	(0.88277)
	[0.39295]	[1.89079]	[-1.24678]	[0.01834]	[2.12657]	[-1.46731]	[-0.57464]
R-squared	0.999513	0.998339	0.996832	0.984430	0.987971	0.986801	0.971007
Adj. R-squared	0.999081	0.996863	0.994017	0.970590	0.977278	0.975069	0.945236
Sum sq. resids	0.014229	0.054045	0.007405	0.040625	0.045947	45.39930	0.530421
S.E. equation	0.028116	0.054795	0.020282	0.047507	0.050523	1.588138	0.171662
F-statistic	2310.640	676.2335	354.0264	71.13044	92.39699	84.11018	37.67788
Log likelihood	86.97401	63.61961	98.40464	68.61467	66.46044	-54.21545	23.65223
Akaike AIC	-3.998515	-2.663978	-4.651694	-2.949410	-2.826311	4.069454	-0.380127
Schwarz SC	-3.243060	-1.908523	-3.896239	-2.193955	-2.070856	4.824909	0.375327
Mean dependent	28.27930	27.27025	20.12752	-0.836112	-0.933635	19.09002	-3.193284
S.D. dependent	0.927350	0.978300	0.262206	0.277024	0.335173	10.05815	0.733544

Determinant resid covariance (dof adj.)	3.48E-17	-T/2log|Omega|	744.64125
Determinant resid covariance	3.31E-19	|Omega|	3.31410e-019
Log likelihood	397.0013	log|Y'Y/T|	-28.7391161
Akaike information criterion	-15.88579	R^2(LR)	0.999999
Schwarz criterion	-10.59761	R^2(LM)	0.738071

A3.6.3. F-test on variables

Significant probability in []

F-test on regressors except unrestricted: F(98,84) = 6.82016 [0.0000] **

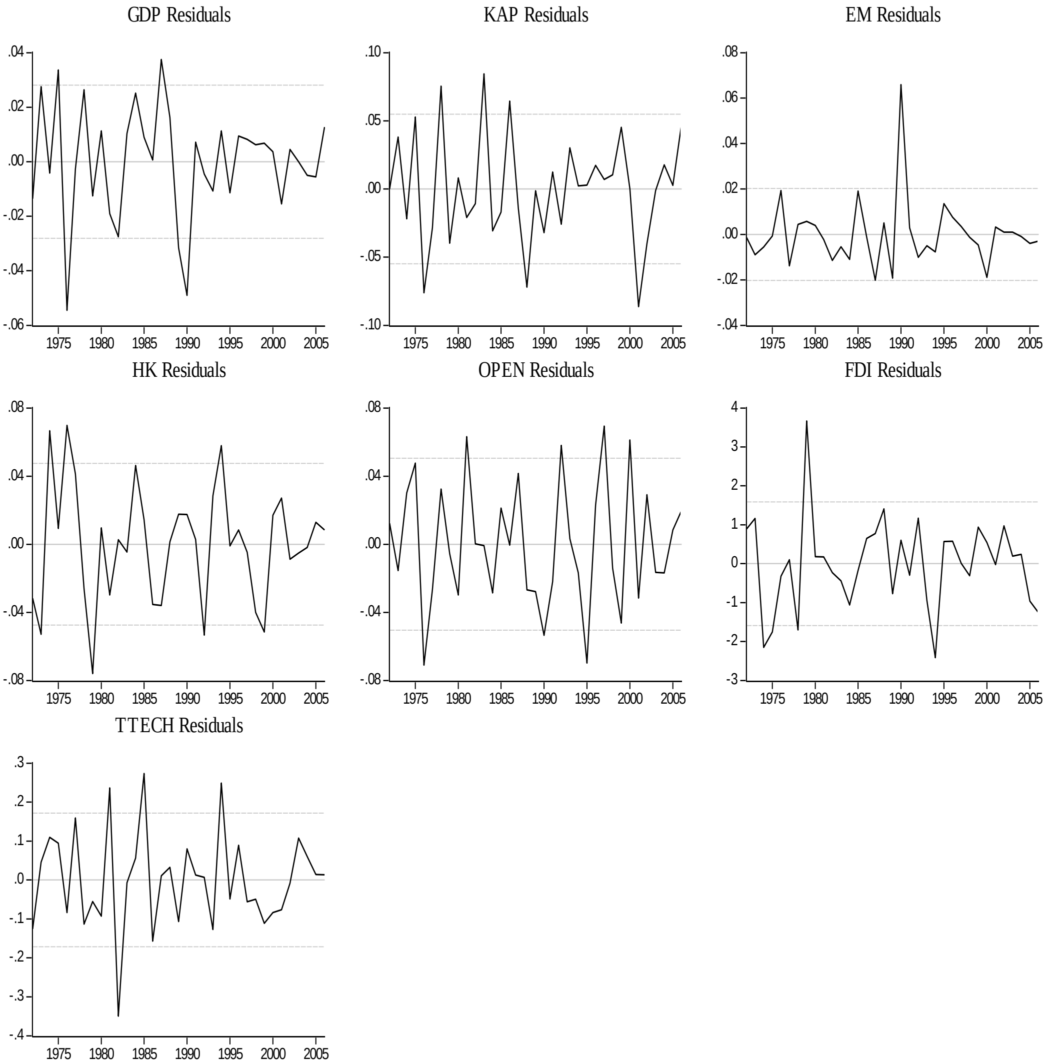
F-tests on retained regressors, F(7,12) =

GDP_1	2.23972 [0.105]	GDP_2	4.83756 [0.009]**
KAP_1	0.605819 [0.741]	KAP_2	0.567548 [0.769]
EM_1	3.50248 [0.028]*	EM_2	2.72418 [0.061]
HK_1	5.58101 [0.005]**	HK_2	2.34362 [0.093]
OPEN_1	3.33821 [0.032]*	OPEN_2	1.60984 [0.224]
FDI_1	2.83909 [0.054]	FDI_2	1.35469 [0.307]
TTECH_1	1.44955 [0.273]	TTECH_2	0.765693 [0.626]
Constant U	6.77897 [0.002]**	libdummy U	0.899596 [0.537]
Trend U	4.77441 [0.009]**		

A3.6.4. Residuals of the unrestricted VAR

Obs	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1970							
1971							
1972	-0.013608	-8.82E-05	-0.001334	-0.031763	0.012266	0.893036	-0.126165
1973	0.027536	0.038022	-0.008980	-0.052849	-0.015474	1.161369	0.045406
1974	-0.004174	-0.021800	-0.005513	0.066619	0.030147	-2.150278	0.109844
1975	0.033628	0.052860	-0.000701	0.009275	0.047555	-1.756083	0.094194
1976	-0.054446	-0.076245	0.019282	0.069795	-0.071062	-0.321992	-0.083364
1977	-0.002670	-0.028441	-0.013805	0.041342	-0.026636	0.100539	0.159111
1978	0.026336	0.075354	0.004385	-0.026091	0.032443	-1.701579	-0.113355
1979	-0.012522	-0.039817	0.005779	-0.076047	-0.005545	3.667068	-0.055241
1980	0.011332	0.008108	0.003980	0.009624	-0.029803	0.180439	-0.092941
1981	-0.019057	-0.020888	-0.002300	-0.029843	0.063169	0.171363	0.236660
1982	-0.027568	-0.010715	-0.011399	0.002615	0.000268	-0.230224	-0.349265
1983	0.010384	0.084523	-0.005400	-0.004649	-0.000846	-0.438038	-0.006829
1984	0.025178	-0.030751	-0.011007	0.046263	-0.028553	-1.059628	0.056533
1985	0.008915	-0.016968	0.019077	0.014360	0.021269	-0.179050	0.273397
1986	0.000645	0.064405	-0.001103	-0.035414	-0.000513	0.651406	-0.156586
1987	0.037463	-0.014069	-0.020175	-0.035993	0.041534	0.773421	0.011020
1988	0.016175	-0.072012	0.005021	0.001451	-0.026811	1.410432	0.032753
1989	-0.031563	-0.001386	-0.019242	0.017552	-0.027809	-0.768833	-0.106898
1990	-0.049042	-0.032109	0.065897	0.017369	-0.053560	0.599495	0.080003
1991	0.007146	0.012367	0.002939	0.002858	-0.021963	-0.297360	0.012374
1992	-0.004492	-0.025850	-0.010072	-0.053417	0.058108	1.169448	0.006448
1993	-0.010772	0.030207	-0.005017	0.028525	0.003226	-0.939996	-0.126939
1994	0.011346	0.002256	-0.007682	0.057856	-0.016812	-2.415763	0.248993
1995	-0.011452	0.002896	0.013543	-0.000955	-0.069881	0.566582	-0.048886
1996	0.009394	0.017270	0.007541	0.008398	0.023061	0.574736	0.089381
1997	0.008156	0.007060	0.003542	-0.004679	0.069363	0.011120	-0.055965
1998	0.006169	0.010461	-0.001270	-0.040043	-0.014139	-0.311287	-0.049257
1999	0.006746	0.045241	-0.004607	-0.051514	-0.046208	0.940677	-0.111389
2000	0.003665	8.84E-05	-0.018890	0.016955	0.061156	0.541739	-0.083649
2001	-0.015487	-0.086356	0.003283	0.027074	-0.031592	-0.022851	-0.076393
2002	0.004489	-0.040128	0.001022	-0.008787	0.029037	0.972973	-0.008402
2003	2.02E-05	-0.001219	0.001030	-0.005199	-0.016561	0.192899	0.107784
2004	-0.005008	0.017789	-0.000915	-0.001833	-0.016877	0.239382	0.060233
2005	-0.005551	0.002589	-0.003933	0.012840	0.008360	-0.962079	0.014079
2006	0.012687	0.047345	-0.002978	0.008304	0.019682	-1.263085	0.013309

A3.6.4. Residuals of the unrestricted VAR (continued)



A3.6.5. Residual correlation matrix

	GDP	KAP	EM	HK	OPEN	FDI	TTECH
GDP	1.000000	0.448902	-0.433253	-0.242260	0.389346	-0.137798	0.234976
KAP	0.448902	1.000000	-0.205295	-0.300199	0.221471	-0.291266	-0.138316
EM	-0.433253	-0.205295	1.000000	0.102181	-0.359620	0.143428	0.159189
HK	-0.242260	-0.300199	0.102181	1.000000	-0.244783	-0.657901	0.242399
OPEN	0.389346	0.221471	-0.359620	-0.244783	1.000000	-0.087127	0.138448
FDI	-0.137798	-0.291266	0.143428	-0.657901	-0.087127	1.000000	-0.191312
TTECH	0.234976	-0.138316	0.159189	0.242399	0.138448	-0.191312	1.000000

A3.6.6. Residual covariance matrix

	GDP	KAP	EM	HK	OPEN	FDI	TTECH
GDP	0.000791	0.000692	-0.000247	-0.000324	0.000553	-0.006153	0.001134
KAP	0.000692	0.003003	-0.000228	-0.000781	0.000613	-0.025347	-0.001301
EM	-0.000247	-0.000228	0.000411	9.85E-05	-0.000369	0.004620	0.000554
HK	-0.000324	-0.000781	9.85E-05	0.002257	-0.000588	-0.049638	0.001977
OPEN	0.000553	0.000613	-0.000369	-0.000588	0.002553	-0.006991	0.001201
FDI	-0.006153	-0.025347	0.004620	-0.049638	-0.006991	2.522183	-0.052156
TTECH	0.001134	-0.001301	0.000554	0.001977	0.001201	-0.052156	0.029468

A3.6.7. Correlation between actual and fitted values

GDP	KAP	EM	HK	OPEN	FDI	TTECH
0.99976	0.99917	0.99841	0.99218	0.99397	0.99338	0.98540

A3.6.8. Unit root test (ADF test) for residuals of the unrestricted VAR

Residuals	t-Statistic	Prob.*
GDP	-5.00366	0
KAP	-6.85056	0
EM	-6.99356	0
HK	-5.10316	0
OPEN	-5.59422	0
FDI	-5.85307	0
LRTT	-8.38009	0

*MacKinnon (1996) one-sided p-values.

A3.6.9. Autocorrelation test for residuals of the unrestricted VAR

	GDP		KAP		EM		HK	
Lag	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob
1	0.3402	0.56	1.3379	0.247	1.4406	0.23	0.6375	0.425
2	1.557	0.459	2.657	0.265	1.6301	0.443	2.5904	0.274
3	1.7637	0.623	3.4135	0.332	4.0753	0.253	5.8712	0.118
4	1.9252	0.75	5.5765	0.233	5.0405	0.283	7.4809	0.113
5	1.9374	0.858	5.5941	0.348	11.229	0.047	9.2041	0.101
6	2.9501	0.815	6.1543	0.406	11.239	0.081	10.381	0.109
7	3.1189	0.874	7.1888	0.409	11.25	0.128	10.721	0.151
8	3.2203	0.92	8.9835	0.344	13.044	0.11	10.885	0.208
9	3.4068	0.946	9.5597	0.387	13.2	0.154	10.89	0.283
10	3.6938	0.96	9.8036	0.458	13.284	0.208	10.89	0.366
11	3.7658	0.976	10.723	0.467	13.564	0.258	10.934	0.449
12	3.7743	0.987	10.725	0.553	13.887	0.308	10.975	0.531

	OPEN		FDI		TTECH	
Lag	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob
1	1.1352	0.287	0.0273	0.869	4.5467	0.033
2	6.3514	0.042	0.5582	0.756	4.7008	0.095
3	6.5674	0.087	0.8629	0.834	6.8846	0.076
4	7.4875	0.112	1.2375	0.872	11.313	0.023
5	7.5065	0.186	5.281	0.383	20.311	0.001
6	8.2159	0.223	5.6691	0.461	20.654	0.002
7	9.1833	0.24	6.2407	0.512	20.81	0.004
8	9.3077	0.317	6.2577	0.618	21.943	0.005
9	9.3792	0.403	7.5276	0.582	22.018	0.009
10	9.4229	0.492	7.6443	0.664	23.119	0.01
11	9.5787	0.569	8.0065	0.713	24.983	0.009
12	9.9045	0.624	8.0215	0.783	29.693	0.003

A3.6.10. Results of residuals tests of the unrestricted VAR

Significant probabilities are in [ ]

Single-equation Test	**Portmanteau (5)**	**AR(1-2) test F-test**	**Normality test Chi^2-test**	**ARCH (1-1) test F-test**	**Hetero test Chi^2-test**
GDP	1.83268	2.1292 [0.1514]	3.4417 [0.1789]	0.17595 [0.6805]	31.640 [0.2894]
KAP	5.29169	1.6620 [0.2209]	0.63175 [0.7291]	0.29298 [0.5958]	24.959 [0.6301]
EM	10.6221	1.5762 [0.2372]	25.746 [0.0000]**	0.0024748 [0.9609]	31.272 [0.3052]
HK	8.70662	0.90584 [0.4240]	0.15996 [0.9231]	0.04610 [0.8327]	30.792 [0.3264]
OPEN	7.10072	3.6099 [0.0508]	0.22668 [0.8928]	0.32354 [0.5774]	28.730 [0.4263]
FDI	4.99552	0.27467 [0.7633]	8.4540 [0.0146]*	0.10801 [0.7467]	33.375 [0.2222]
TTECH	19.2133	4.7416 [0.0242]*	4.2489 [0.1195]	0.44430 [0.5146]	34.479 [0.1855]
Vector Test	**Portmanteau (5)**	**AR1-2 test Chi^2-test**	**Normality test Chi^2-test**		**hetero test Chi^2-test**
System	314.624	0.038003 [1.0000]	27.937 [0.0145]*		823.91 [0.1567]

Note: Heteroskedasticity Tests have no cross terms (only levels and squares), there is not enough observations for cross term Heteroskedasticity tests

A3.6.11. Recursive estimation: 1-step Chow test

Prob. [ ]

Year	F-test	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1996	F(1,7)	0.68544 [0.4350]	0.31689 [0.5910]	0.92443 [0.3683]	0.66274 [0.4424]	4.3173 [0.0763]	0.35186 [0.5717]	0.099610 [0.7615]
1997	F(1,8)	0.28978 [0.6050]	0.042133 [0.8425]	1.2186 [0.3017]	0.91316 [0.3673]	2.7963 [0.1330]	0.038135 [0.8500]	1.2389 [0.2980]
1998	F(1,9)	0.050094 [0.8279]	0.36357 [0.5614]	1.5104 [0.2502]	0.92298 [0.3618]	0.060056 [0.8119]	0.00095527 [0.9760]	0.30180 [0.5961]
1999	F(1,10)	0.044617 [0.8370]	0.65544 [0.4370]	2.5654 [0.1403]	0.070451 [0.7961]	0.0058320 [0.9406]	6.5303e-005 [0.9937]	0.031562 [0.8625]
2000	F(1,11)	0.0076770 [0.9318]	0.99588 [0.3398]	2.4914 [0.1428]	2.2488 [0.1619]	2.6256 [0.1334]	0.89875 [0.3635]	0.40070 [0.5397]
2001	F(1,12)	0.39752 [0.5402]	9.8058 [0.0087]**	0.020642 [0.8881]	1.4202 [0.2564]	0.21783 [0.6491]	1.0283 [0.3306]	1.0535 [0.3249]
2002	F(1,13)	0.073023 [0.7912]	0.013772 [0.9084]	0.049052 [0.8282]	0.00060815 [0.9807]	0.47268 [0.5038]	0.052668 [0.8221]	0.80252 [0.3866]
2003	F(1,14)	0.014619 [0.9055]	1.6914 [0.2144]	0.080458 [0.7808]	0.060275 [0.8096]	0.016455 [0.8998]	1.6898 [0.2146]	1.4978 [0.2412]
2004	F(1,15)	0.0018898 [0.9659]	2.5529 [0.1309]	0.16173 [0.6932]	0.15400 [0.7003]	0.013154 [0.9102]	2.0977 [0.1681]	0.41089 [0.5312]
2005	F(1,16)	0.018120 [0.8946]	0.80982 [0.3815]	0.16196 [0.6927]	0.28768 [0.5991]	0.34822 [0.5634]	3.0813 [0.0983]	0.033612 [0.8568]
2006	F(1,17)	0.37511 [0.5483]	1.4611 [0.2433]	0.038911 [0.8460]	0.055235 [0.8170]	0.27798 [0.6048]	1.2219 [0.2844]	0.010840 [0.9183]

System 1-step Chow test

Year	F-test	Test statistics & Prob.[ ]
1996	F(7, 1)	39.669 [0.1217]
1997	F(7, 2)	2.7167 [0.2953]
1998	F(7, 3)	1.8891 [0.3237]
1999	F(7, 4)	0.73404 [0.6625]
2000	F(7, 5)	2.2534 [0.1941]
2001	F(7, 6)	1.3681 [0.3592]
2002	F(7, 7)	0.17348 [0.9829]
2003	F(7, 8)	1.5310 [0.2810]
2004	F(7, 9)	0.72076 [0.6595]
2005	F(7, 10)	0.38933 [0.8883]
2006	F(7, 11)	0.21513 [0.9741]

A3.6.12 Recursive estimation: Breakpoint (N-down) Chow test

Prob. [ ]

Year	F-test	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1996	F(11, 7)	0.14246 [0.9976]	1.5641 [0.2836]	0.90984 [0.5738]	0.56649 [0.8082]	1.2658 [0.3895]	0.65681 [0.7442]	0.41859 [0.9050]
1997	F(10. 8)	0.091773 [0.9995]	1.8465 [0.1983]	0.91705 [0.5600]	0.58138 [0.7924]	0.67908 [0.7219]	0.74789 [0.6729]	0.50762 [0.8441]
1998	F(9, 9)	0.075750 [0.9996]	2.2908 [0.1164]	0.86258 [0.5853]	0.54982 [0.8069]	0.36998 [0.9227]	0.92569 [0.5448]	0.41534 [0.8967]
1999	F(8, 10)	0.087244 [0.9990]	2.7038 [0.0715]	0.74364 [0.6559]	0.50708 [0.8261]	0.45113 [0.8641]	1.1569 [0.4064]	0.46177 [0.8570]
2000	F(7, 11)	0.10221 [0.9970]	3.0933 [0.0462]*	0.42317 [0.8685]	0.62201 [0.7289]	0.56588 [0.7694]	1.4543 [0.2777]	0.57374 [0.7638]
2001	F(6, 12)	0.12860 [0.9902]	3.4440 [0.0325]*	0.069785 [0.9981]	0.31780 [0.9153]	0.19603 [0.9717]	1.5601 [0.2409]	0.63426 [0.7014]
2002	F(5,13)	0.078454 [0.9945]	1.2947 [0.3247]	0.086100 [0.9932]	0.094284 [0.9916]	0.20394 [0.9550]	1.6628 [0.2127]	0.54816 [0.7373]
2003	F(4,14)	0.085471 [0.9855]	1.7373 [0.1977]	0.10231 [0.9798]	0.12675 [0.9703]	0.14211 [0.9636]	2.2152 [0.1199]	0.49150 [0.7422]
2004	F(3, 15)	0.11676 [0.9489]	1.6754 [0.2148]	0.11675 [0.9489]	0.15886 [0.9223]	0.19691 [0.8969]	2.2853 [0.1205]	0.15104 [0.9274]
2005	F(2, 16)	0.18578 [0.8322]	1.1273 [0.3483]	0.099478 [0.9059]	0.17030 [0.8449]	.30777 [0.7393]	2.2264 [0.1403]	0.021918 [0.9783]
2006	F(1, 17)	0.37511 [0.5483]	1.4611 [0.2433]	0.038911 [0.8460]	0.055235 [0.8170]	0.27798 [0.6048]	1.2219 [0.2844]	0.010840 [0.9183]

Breakpoint (N-down) Chow test for system

Year	F-test	Test statistics & Prob.[ ]
1996	F(77, 13)	1.8535 [0.1074]
1997	F(70, 18)	0.98636 [0.5440]
1998	F(63, 23)	0.83824 [0.7154]
1999	F(56, 26)	0.74045 [0.8278]
2000	F(49, 29)	0.78367 [0.7782]
2001	F(42, 31)	0.60800 [0.9336]
2002	F(35, 31)	0.49448 [0.9775]
2003	F(28, 30)	0.63413 [0.8855]
2004	F(21, 26)	0.41213 [0.9791]
2005	F(14, 20)	0.28972 [0.9893]
2006	F(7, 11)	0.21513 [0.9741]

Appendix A3.7. Variance decomposition

Variance Decomposition of GDP:								
Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.028116	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.038878	93.25706	0.021807	2.689562	0.679609	0.230691	0.452729	2.668541
3	0.042785	90.11460	0.629874	2.287641	0.897617	0.440025	0.754555	4.875682
4	0.043231	88.26585	1.134190	2.384430	0.916319	0.436038	1.093739	5.769436
5	0.043998	86.05493	1.282794	3.631853	1.567603	0.462089	1.112501	5.888235
6	0.044887	84.08742	1.241843	3.697213	3.593960	0.551061	1.131666	5.696838
7	0.045640	81.67359	1.257501	3.576289	5.837150	0.746028	1.360857	5.548580
8	0.046125	80.02323	1.251071	3.640065	7.188068	0.810760	1.549452	5.537350
9	0.046403	79.06585	1.236385	3.732142	7.918757	0.858246	1.669390	5.519231
10	0.046544	78.59220	1.230229	3.806639	8.260124	0.872841	1.749657	5.488304
Variance Decomposition of KAP:								
Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.054795	20.15126	79.84874	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.062867	31.42158	61.30744	2.289473	0.000364	1.833647	0.093029	3.054466
3	0.071887	29.64926	47.78921	1.954772	1.773184	1.654511	0.082186	17.09688
4	0.076181	26.98384	42.83752	3.635413	6.026918	1.490967	0.746387	18.27896
5	0.081566	26.46917	37.36835	8.279717	7.789579	1.381636	2.752932	15.95861
6	0.084444	28.15950	34.88331	9.471943	7.470760	1.364804	3.549695	15.09999
7	0.085347	28.37440	34.14893	9.417384	7.483787	1.566118	3.489429	15.51995
8	0.086038	28.32041	33.60327	9.295531	7.926286	1.547642	3.532684	15.77417
9	0.088026	30.34392	32.11307	9.091394	8.329469	1.479517	3.561551	15.08108
10	0.089866	31.89317	30.83946	9.099998	8.562002	1.421800	3.581980	14.60159
Variance Decomposition of EM:								
Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.020282	18.77080	0.014626	81.21457	0.000000	0.000000	0.000000	0.000000
2	0.029085	35.49619	2.192943	58.95546	2.728157	0.366662	0.090340	0.170251
3	0.035050	34.32138	1.543798	53.11234	7.952216	1.217132	1.174896	0.678240
4	0.038480	34.07626	1.325369	49.69784	10.94229	1.400642	1.780279	0.777325
5	0.040943	31.63989	1.171087	48.69878	13.42855	1.934795	2.298834	0.828062
6	0.042809	30.38618	1.079201	47.95899	15.06365	2.113029	2.594174	0.804780
7	0.044729	28.90823	1.025266	47.81492	16.41086	2.334831	2.766777	0.739110
8	0.046667	28.01547	0.960349	47.37818	17.60723	2.461756	2.895026	0.681981
9	0.048690	27.17968	0.891804	46.92000	18.76419	2.612771	3.002452	0.629103
10	0.050659	26.67349	0.827531	46.24033	19.85452	2.732810	3.090111	0.581209
Variance Decomposition of HK:								
Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.047507	5.869011	4.590226	0.003551	89.53721	0.000000	0.000000	0.000000
2	0.088814	4.026566	1.345305	2.537564	87.03544	0.734915	4.226836	0.093376
3	0.124111	2.461969	0.788320	11.05029	76.58335	1.826033	7.205875	0.084165
4	0.142752	1.901976	0.595902	15.06696	71.58456	1.880070	8.792732	0.177800
5	0.150154	2.663622	0.539916	16.41860	69.20698	1.765536	9.243034	0.162316
6	0.153569	4.407657	0.572180	16.57036	67.25871	1.714771	9.279886	0.196435
7	0.155753	6.474108	0.740869	16.41066	65.41710	1.667741	9.095537	0.193980
8	0.157189	7.654297	0.902981	16.21834	64.42149	1.642493	8.934383	0.226010
9	0.158328	7.904629	0.985544	16.10364	64.14233	1.641793	8.881843	0.340220
10	0.159437	7.796307	1.002605	16.06829	64.13822	1.658542	8.873253	0.462782

Cholesky Ordering: GDP KAP EM HK OPEN FDI TTECH

Appendix A3.7. Variance decomposition (continued)

Variance Decomposition of OPEN:

Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.050523	15.15901	0.273042	4.459216	2.205436	77.90330	0.000000	0.000000
2	0.108595	49.53524	0.088741	24.81970	6.692368	16.93817	0.682520	1.243268
3	0.138767	33.60690	0.770289	49.49898	4.179028	10.44409	0.715956	0.784764
4	0.149307	29.05395	0.725843	51.25412	8.096167	9.180599	0.878385	0.810932
5	0.158457	26.55338	0.658451	47.92397	13.06256	9.326792	1.743134	0.731720
6	0.164360	24.72255	0.741272	46.27538	16.24060	9.173287	2.150065	0.696848
7	0.172834	23.40396	1.010917	45.09536	18.79182	8.773186	2.293744	0.631017
8	0.183757	23.37485	0.982490	43.09626	21.17801	8.227044	2.548699	0.592646
9	0.194977	23.28492	0.873036	41.31899	23.28905	7.766137	2.925188	0.542674
10	0.204471	23.17116	0.800295	40.00351	24.90742	7.417877	3.206104	0.493628

Variance Decomposition of FDI:

Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	1.588138	1.898821	6.590975	0.800331	62.11375	1.793770	26.80236	0.000000
2	2.410873	0.899640	3.191767	1.237794	68.60283	1.667412	22.46774	1.932820
3	3.038366	0.728926	2.606737	1.772085	72.94427	1.235436	19.12243	1.590118
4	3.499972	5.310998	1.998283	3.894149	66.98287	2.557870	18.00809	1.247745
5	3.865374	18.15949	1.639416	3.204533	57.07225	2.529315	16.24072	1.154275
6	4.135343	26.50260	1.505945	4.202062	50.05577	2.210003	14.44897	1.074652
7	4.264332	28.93728	1.668820	5.580588	47.08338	2.079010	13.62868	1.022242
8	4.311100	29.39478	1.874539	6.161226	46.10489	2.059726	13.33764	1.067198
9	4.334464	29.28584	1.892457	6.503939	45.81376	2.047604	13.21069	1.245708
10	4.351129	29.06893	1.885360	6.838171	45.65536	2.032262	13.15252	1.367403

Variance Decomposition of TTECH:

Period	S.E.	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.171662	5.521381	7.443685	8.176604	6.571873	3.272655	0.298576	68.71523
2	0.246240	25.18694	7.516724	9.371757	5.080553	1.597036	0.339642	50.90735
3	0.264860	25.64185	7.345662	8.689202	7.871153	1.579034	3.511845	45.36125
4	0.274328	24.06305	7.502884	8.541208	8.393059	2.048227	6.981234	42.47034
5	0.285727	26.87986	7.590194	7.877317	7.762624	2.287429	7.122578	40.47999
6	0.290244	26.23956	7.466502	7.635253	9.311980	2.276183	6.999162	40.07136
7	0.302577	27.50692	6.893922	7.620409	11.79966	2.110473	7.191890	36.87673
8	0.322510	31.43332	6.092387	8.253367	12.64537	1.859719	7.024297	32.69154
9	0.330813	32.17066	5.796300	9.333624	12.65126	1.779577	6.875287	31.39329
10	0.331894	32.01236	5.821230	9.566470	12.63248	1.784214	6.835472	31.34777

Cholesky Ordering: GDP KAP EM HK OPEN FDI TTECH

A3.8. Impulse response analysis

A3.8.1. Impulse response to Cholesky one S.D. innovation

Response of GDP:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.028116	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.024881	-0.000574	-0.006376	0.003205	0.001867	-0.002616	0.006351
3	0.015493	0.003347	-0.001107	0.002482	-0.002137	-0.002640	0.006994
4	0.000130	0.003109	0.001639	0.000833	0.000307	-0.002575	0.004310
5	-0.004031	0.001907	0.005074	-0.003636	-0.000892	-0.001046	0.002482
6	-0.005323	-0.000434	0.002046	-0.006486	-0.001469	0.001125	0.000892
7	-0.002649	-0.001083	1.84E-05	-0.007012	-0.002106	0.002355	-0.000891
8	-0.001119	-0.000650	-0.001717	-0.005598	-0.001307	0.002149	-0.001494
9	3.00E-05	7.80E-05	-0.001709	-0.004193	-0.001110	0.001727	-0.001018
10	-0.000307	0.000169	-0.001450	-0.002904	-0.000655	0.001399	-0.000230
Response of KAP:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.024598	0.048964	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.025235	-0.005058	-0.009512	0.000120	0.008513	0.001917	0.010987
3	0.017039	-0.006824	0.003245	0.009572	-0.003610	-0.000755	0.027619
4	-0.005818	-0.004063	0.010487	0.016067	0.001015	-0.006251	0.013316
5	-0.013964	0.000170	0.018436	0.012980	0.002322	-0.011825	0.000950
6	-0.015715	0.001142	0.011161	0.003805	-0.002324	-0.008365	-0.003874
7	-0.007671	-0.000124	0.003249	-0.003523	-0.004094	-0.001027	-0.007332
8	0.005440	-0.000188	-0.001459	-0.006451	-0.000697	0.002708	-0.006099
9	0.015961	0.000882	-0.004042	-0.007659	0.000274	0.003802	-0.000930
10	0.014981	0.001505	-0.005519	-0.006786	-0.000427	0.003648	0.003263
Response of EM:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	-0.008787	-0.000245	0.018278	0.000000	0.000000	0.000000	0.000000
2	-0.014935	0.004300	0.012831	-0.004804	-0.001761	0.000874	0.001200
3	-0.011017	-0.000644	0.012400	-0.008638	-0.003443	0.003697	-0.002625
4	-0.009106	-0.000812	0.009132	-0.008021	-0.002406	0.003454	-0.001783
5	-0.005081	7.88E-05	0.008970	-0.007942	-0.003420	0.003489	-0.001540
6	-0.005145	0.000383	0.007909	-0.007138	-0.002508	0.003001	-0.000931
7	-0.004638	0.000857	0.008817	-0.007230	-0.002827	0.002795	-0.000197
8	-0.005636	0.000634	0.008671	-0.007425	-0.002627	0.002774	0.000255
9	-0.005850	0.000477	0.008974	-0.007835	-0.002886	0.002852	0.000249
10	-0.006338	0.000308	0.008622	-0.008043	-0.002862	0.002850	3.80E-05
Response of HK:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	-0.011509	-0.010178	-0.000283	0.044953	0.000000	0.000000	0.000000
2	-0.013607	-0.001586	0.014145	0.069602	0.007614	-0.018259	0.002714
3	-0.007850	-0.003913	0.038755	0.070223	0.014943	-0.027867	0.002366
4	0.002891	6.77E-05	0.036990	0.052830	0.010092	-0.026112	0.004824
5	0.014593	0.000546	0.025128	0.031875	0.003865	-0.017093	-0.000603
6	0.020951	0.003634	0.014355	0.016070	0.002517	-0.010225	-0.003119
7	0.023045	0.006692	0.008558	0.002781	0.000422	-0.004241	-0.000855
8	0.017908	0.006587	0.005122	-0.006929	-0.001121	0.001029	0.002964
9	0.009500	0.004893	0.005431	-0.012703	-0.002392	0.004349	0.005426
10	-0.000569	0.002795	0.006912	-0.015001	-0.003169	0.005396	0.005688

Cholesky Ordering: GDP KAP EM HK OPEN FDI TTECH

A3.8.1. Impulse response to Cholesky one S.D. innovation (continued)

Response of OPEN:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.019671	0.002640	-0.010669	-0.007503	0.044593	0.000000	0.000000
2	0.073856	-0.001870	-0.053039	-0.027073	-0.002988	0.008972	0.012109
3	0.025096	-0.011742	-0.081269	0.003938	-0.003695	0.007575	0.002121
4	-0.002323	0.003671	-0.043522	0.031625	0.005953	-0.007612	-0.005446
5	-0.013797	0.001876	-0.024643	0.038406	0.017183	-0.015552	-0.001717
6	0.003375	-0.005909	-0.021629	0.033278	0.011673	-0.011964	0.002127
7	0.017679	-0.010086	-0.031141	0.035016	0.011942	-0.010215	-0.000497
8	0.030029	-0.005457	-0.032884	0.039213	0.012542	-0.013245	-0.003409
9	0.030971	-0.000377	-0.033997	0.041262	0.013206	-0.015857	-0.002488
10	0.028904	0.001642	-0.031890	0.039494	0.012203	-0.015112	-0.000273
Response of FDI:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	-0.218842	-0.407721	0.142077	-1.251648	-0.212702	0.822195	0.000000
2	0.066318	0.138848	0.227505	-1.555888	0.227317	0.793656	-0.335174
3	0.122483	0.234798	-0.302735	-1.657276	-0.130905	0.677809	-0.185615
4	-0.763737	0.064346	-0.559850	-1.212970	-0.446411	0.663804	-0.077794
5	-1.436191	-0.012697	-0.042041	-0.567417	-0.254114	0.469669	-0.140054
6	-1.348702	-0.112186	0.489698	-0.181210	0.005117	0.210674	-0.106374
7	-0.854331	-0.214323	0.544248	-0.042658	-0.011133	0.085923	-0.045965
8	-0.448422	-0.211960	0.360966	0.083510	-0.068950	0.023840	-0.111603
9	-0.197255	-0.084574	0.277187	0.196042	-0.043393	-0.055588	-0.188927
10	-0.036382	0.037360	0.269615	0.190591	-0.007700	-0.090050	-0.157616
Response of TTECH:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.040336	-0.046835	0.049086	0.044007	0.031054	-0.009380	0.142299
2	0.116811	-0.048623	0.057210	0.033823	-0.001993	-0.010861	0.103046
3	0.052115	-0.024399	0.020323	0.049407	0.011805	-0.047515	0.030884
4	-0.010999	0.022211	0.018228	0.028189	-0.020826	-0.052822	-0.011844
5	-0.061934	0.023457	-0.001803	-0.004594	-0.018057	-0.023687	-0.032959
6	-0.012646	0.009658	-0.001013	-0.038822	-0.007074	0.009019	-0.026626
7	0.055487	-0.004658	-0.023338	-0.054391	0.003835	0.026233	-0.002237
8	0.086668	-0.005029	-0.040098	-0.048476	-0.001467	0.026866	0.015548
9	0.050119	0.002535	-0.040372	-0.026312	-0.003629	0.014762	0.018773
10	-0.007495	0.008307	-0.017983	-0.008365	-0.004226	0.002327	0.013223

Cholesky Ordering: GDP KAP EM HK OPEN FDI TTECH

A3.8.2. Impulse response to generalized one S.D. innovation

Response of GDP:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.028116	0.012621	-0.012181	-0.006811	0.010947	-0.003874	0.006607
2	0.024881	0.010656	-0.016519	-0.002834	0.012176	-0.007982	0.010747
3	0.015493	0.009946	-0.007750	-0.002115	0.004186	-0.006130	0.008603
4	0.000130	0.002837	0.001383	8.08E-05	1.43E-05	-0.002700	0.003633
5	-0.004031	-0.000106	0.006296	-0.002903	-0.002789	0.002963	0.001004
6	-0.005323	-0.002777	0.004155	-0.004767	-0.002861	0.006919	-0.001798
7	-0.002649	-0.002156	0.001177	-0.005762	-0.001909	0.007672	-0.003367
8	-0.001119	-0.001084	-0.001055	-0.004877	-0.000430	0.005867	-0.003604
9	3.00E-05	8.32E-05	-0.001554	-0.003982	2.00E-05	0.004171	-0.002717
10	-0.000307	1.32E-05	-0.001176	-0.002701	4.90E-05	0.002970	-0.001663

Response of KAP:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.024598	0.054795	-0.011249	-0.016449	0.012136	-0.015960	-0.007579
2	0.025235	0.006809	-0.019445	-0.004860	0.019066	-0.003272	0.015163
3	0.017039	0.001551	-0.004375	0.006372	0.000985	-0.007757	0.031530
4	-0.005818	-0.006243	0.012020	0.017421	-0.006182	-0.013252	0.018423
5	-0.013964	-0.006116	0.022662	0.015518	-0.009199	-0.013133	0.007125
6	-0.015715	-0.006034	0.016853	0.007096	-0.011032	-0.004147	-0.003012
7	-0.007671	-0.003555	0.006253	-0.001467	-0.006769	0.004172	-0.008505
8	0.005440	0.002274	-0.003670	-0.007373	0.002759	0.005748	-0.006071
9	0.015961	0.007953	-0.010569	-0.011279	0.008494	0.005181	-0.000539
10	0.014981	0.008070	-0.011482	-0.010340	0.007708	0.004349	0.002220

Response of EM:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	-0.008787	-0.004164	0.020282	0.002072	-0.007294	0.002909	0.003229
2	-0.014935	-0.002862	0.017982	-0.001925	-0.009141	0.006577	-0.001617
3	-0.011017	-0.005521	0.015956	-0.005441	-0.008697	0.011976	-0.004083
4	-0.009106	-0.004813	0.012184	-0.005264	-0.006448	0.010711	-0.003465
5	-0.005081	-0.002210	0.010284	-0.006355	-0.005707	0.010006	-0.002772
6	-0.005145	-0.001968	0.009352	-0.005637	-0.004807	0.008833	-0.002271
7	-0.004638	-0.001316	0.009944	-0.005954	-0.005044	0.008732	-0.001484
8	-0.005636	-0.001963	0.010249	-0.005848	-0.005208	0.009029	-0.001337
9	-0.005850	-0.002200	0.010616	-0.006152	-0.005531	0.009524	-0.001419
10	-0.006338	-0.002570	0.010512	-0.006192	-0.005604	0.009763	-0.001812

Response of HK:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	-0.011509	-0.014262	0.004854	0.047507	-0.011629	-0.031255	0.011516
2	-0.013607	-0.007526	0.018662	0.069412	-0.011984	-0.061780	0.023748
3	-0.007850	-0.007021	0.038374	0.068957	-0.008684	-0.066219	0.034495
4	0.002891	0.001358	0.032081	0.049055	-0.005620	-0.053613	0.032032
5	0.014593	0.007038	0.016316	0.026360	-0.000918	-0.034392	0.019770
6	0.020951	0.012652	0.003815	0.009266	0.005151	-0.020831	0.010584
7	0.023045	0.016325	-0.002353	-0.004436	0.007475	-0.008572	0.006348
8	0.017908	0.013925	-0.003223	-0.012336	0.006274	0.002443	0.004297
9	0.009500	0.008636	0.000719	-0.015403	0.002583	0.010505	0.003021
10	-0.000569	0.002242	0.006441	-0.014696	-0.002104	0.015020	0.001082

Generalized impulse

A3.8.2. Impulse response to generalised one S.D. innovation (continued)

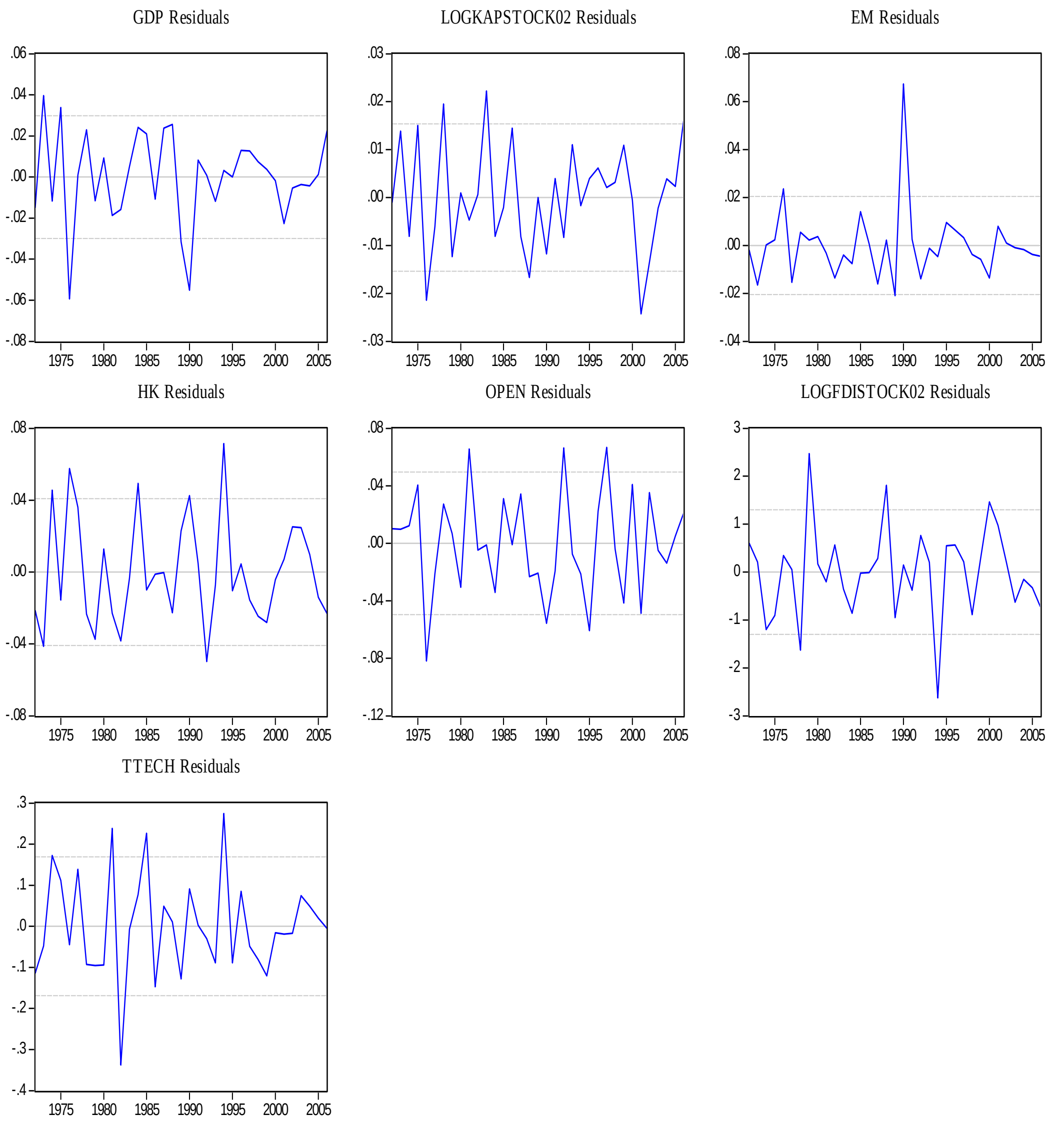
Response of OPEN:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.019671	0.011189	-0.018169	-0.012367	0.050523	-0.004402	0.006995
2	0.073856	0.031483	-0.079774	-0.042793	0.041241	0.011939	0.004764
3	0.025096	0.000774	-0.083970	0.000646	0.022473	-0.006401	-0.012453
4	-0.002323	0.002238	-0.038259	0.029960	0.009035	-0.034178	-0.008907
5	-0.013797	-0.004517	-0.016253	0.039428	0.009393	-0.041406	0.001580
6	0.003375	-0.003765	-0.020883	0.032066	0.010933	-0.034868	0.009280
7	0.017679	-0.001077	-0.035602	0.031198	0.018272	-0.037118	0.009284
8	0.030029	0.008604	-0.042579	0.031195	0.023597	-0.045120	0.009361
9	0.030971	0.013566	-0.044051	0.031824	0.024746	-0.049710	0.009430
10	0.028904	0.014442	-0.041281	0.030207	0.022979	-0.047842	0.010157
Response of FDI:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	-0.218842	-0.462570	0.227783	-1.044837	-0.138370	1.588138	-0.303831
2	0.066318	0.153843	0.174614	-1.519415	0.416731	1.582237	-0.636192
3	0.122483	0.264794	-0.328728	-1.646357	0.254462	1.570337	-0.761283
4	-0.763737	-0.285344	-0.174419	-0.973189	-0.389653	1.398053	-0.849573
5	-1.436191	-0.656054	0.584500	-0.186011	-0.690983	0.921784	-0.679221
6	-1.348702	-0.705681	1.026997	0.176386	-0.602954	0.509657	-0.291496
7	-0.854331	-0.575026	0.863205	0.209281	-0.462249	0.301031	-0.042394
8	-0.448422	-0.390701	0.522143	0.230917	-0.335151	0.104261	-0.029202
9	-0.197255	-0.164122	0.336283	0.249758	-0.207167	-0.103780	-0.055181
10	-0.036382	0.017052	0.258286	0.179548	-0.104248	-0.176255	-0.019915
Response of TTECH:							
Period	GDP	KAP	EM	HK	OPEN	FDI	TTECH
1	0.040336	-0.023744	0.027327	0.041611	0.023766	-0.032841	0.171662
2	0.116811	0.008988	0.001537	0.013782	0.024076	-0.030507	0.151396
3	0.052115	0.001592	-0.003969	0.039232	0.017806	-0.064218	0.067713
4	-0.010999	0.014910	0.020923	0.024471	-0.029538	-0.049330	-0.006905
5	-0.061934	-0.006841	0.024924	0.005642	-0.037762	-0.003873	-0.051940
6	-0.012646	0.002953	0.004450	-0.035735	-0.004683	0.035386	-0.039692
7	0.055487	0.020746	-0.045015	-0.063772	0.037751	0.047396	-0.008902
8	0.086668	0.034412	-0.073625	-0.065550	0.047853	0.038071	0.008999
9	0.050119	0.024763	-0.058127	-0.037342	0.028876	0.017697	0.006895
10	-0.007495	0.004058	-0.013059	-0.007772	-0.001175	0.005655	-0.001245

Generalized impulse

A3.9. The residuals of the unrestricted VAR by arbitrary capital stocks

obs	GDP	CAPITAL STOCK	EM	HK	OPEN	FDI STOCK	LRTT
1970	NA	NA	NA	NA	NA	NA	NA
1971	NA	NA	NA	NA	NA	NA	NA
1972	-0.015071	-0.001051	-0.00181	-0.021252	0.010145	0.606867	-0.114613
1973	0.039631	0.013875	-0.016585	-0.0413	0.009788	0.211749	-0.047808
1974	-0.011731	-0.008071	0.000189	0.045567	0.012328	-1.196272	0.172608
1975	0.033853	0.015037	0.00231	-0.015467	0.040577	-0.905735	0.11176
1976	-0.059353	-0.021453	0.023622	0.057615	-0.081784	0.342399	-0.044611
1977	0.000974	-0.006075	-0.015381	0.036113	-0.021206	0.051952	0.138463
1978	0.023037	0.019529	0.005551	-0.023393	0.027319	-1.627918	-0.092636
1979	-0.01154	-0.012308	0.002235	-0.037467	0.006775	2.469377	-0.095209
1980	0.009246	0.000985	0.003712	0.012761	-0.030632	0.170737	-0.094162
1981	-0.018742	-0.004699	-0.003203	-0.022896	0.065508	-0.205918	0.238482
1982	-0.015763	0.000635	-0.013604	-0.038354	-0.004799	0.564187	-0.33768
1983	0.005067	0.022201	-0.004009	-0.003455	-0.001089	-0.356446	-0.007203
1984	0.024209	-0.008105	-0.007622	0.049367	-0.034047	-0.858051	0.077531
1985	0.021026	-0.002075	0.014171	-0.009961	0.031149	-0.024828	0.226461
1986	-0.010829	0.014474	0.000656	-0.001167	-0.000958	-0.00914	-0.146986
1987	0.023777	-0.008132	-0.016084	-0.000274	0.034307	0.281245	0.049209
1988	0.025685	-0.016686	0.002246	-0.022616	-0.023206	1.808944	0.010761
1989	-0.03148	1.92E-06	-0.020917	0.022851	-0.020745	-0.947971	-0.127802
1990	-0.055102	-0.011751	0.067361	0.042457	-0.055663	0.144478	0.091025
1991	0.008256	0.003943	0.002613	0.004844	-0.019252	-0.378643	0.002958
1992	0.000868	-0.008311	-0.013959	-0.049698	0.066321	0.766183	-0.030189
1993	-0.011905	0.011025	-0.0011	-0.007279	-0.007574	0.201197	-0.088866
1994	0.003196	-0.001681	-0.004677	0.071531	-0.021307	-2.622736	0.27464
1995	4.28E-05	0.003956	0.00961	-0.010353	-0.060774	0.549923	-0.089019
1996	0.013003	0.006181	0.006451	0.004467	0.022282	0.564719	0.085384
1997	0.01265	0.002115	0.003245	-0.015555	0.066627	0.212157	-0.048733
1998	0.007371	0.003145	-0.003759	-0.024605	-0.003915	-0.890271	-0.080757
1999	0.003716	0.010889	-0.005742	-0.028112	-0.041509	0.30174	-0.120371
2000	-0.001784	-0.00057	-0.013633	-0.004177	0.040802	1.464947	-0.015686
2001	-0.022681	-0.024265	0.008066	0.00714	-0.048623	0.973645	-0.018797
2002	-0.005445	-0.013501	0.001014	0.025212	0.035167	0.196547	-0.017108
2003	-0.00367	-0.002188	-0.000973	0.024767	-0.00501	-0.62898	0.074858
2004	-0.004373	0.003876	-0.001687	0.009838	-0.013731	-0.150065	0.049085
2005	0.001235	0.002322	-0.003743	-0.014019	0.005063	-0.328124	0.020177
2006	0.022627	0.01673	-0.004562	-0.02313	0.021669	-0.751895	-0.005165

A3.9.1. The residuals of the unrestricted VAR by arbitrary capital stocks



A3.10. The ECM model results

A3.10.1. Vector Error Correction Estimation results

Standard errors in ( ) & t-statistics in [ ]

Cointegration Restrictions:

B(1,1)=1,B(1,5)=0,B(1,7)=0, A(3,1)=0,A(3,2)=0, A(3,3)=0,A(3,4)=0

B(2,2)=1,B(2,3)=0,B(2,4)=0,B(2,5)=0, A(6,1)=0,A(6,2)=0, A(6,4)=0,A(6,5)=0

B(3,3)=1,B(3,2)=0, A(7,1)=0, A(7,3)=0, A(7,5)=0

B(4,6)=1,B(4,2)=0,B(4,3)=0, B(4,7)=0 A(2,1)=0 , A(2,3)=0

B(5,7)=1,B(5,3)=0,B(5,4)=0,

B(1,2)=-1,B(1,3)=-1, B(2,1)=-1

Convergence achieved after 2482 iterations.

Restrictions identify all cointegrating vectors

LR test for binding restrictions (rank = 5):

Chi-square(7)	2.404213
Probability	0.934136

Cointegrating Eq:	CointEq1	CointEq2	CointEq3	CointEq4	CointEq5
GDP (-1)	1.000000	-1.000000	-0.466180	-94.10783	2.559329
			(0.10125)	(21.0802)	(0.76346)
			[-4.60447]	[-4.46428]	[3.35228]
KAP (-1)	-1.000000	1.000000	0.000000	0.000000	-0.158321
					(0.01786)
					[-8.86580]
EM(-1)	-1.000000	0.000000	1.000000	0.000000	0.000000
HK(-1)	0.512763	0.000000	-0.365955	1.558056	0.000000
	(0.10411)		(0.05770)	(3.10442)	
	[4.92516]		[-6.34278]	[0.50188]	
OPEN(-1)	0.000000	0.000000	0.022789	9.541357	-0.435986
			(0.01797)	(4.52260)	(0.16196)
			[1.26810]	[2.10971]	[-2.69188]
FDI (-1)	0.022288	0.014723	-0.021840	1.000000	-0.025605
	(0.00423)	(0.00840)	(0.00261)		(0.01134)
	[5.26849]	[1.75220]	[-8.35699]		[-2.25847]
TTECH (-1)	0.000000	0.828260	-0.087335	0.000000	1.000000
		(0.02580)	(0.01658)		
		[32.1015]	[-5.26654]		
@TREND(70)	-0.000143	-0.146551	0.054961	9.418907	-0.420107
	(0.01024)	(0.03506)	(0.01008)	(1.84910)	(0.08982)
	[-0.01399]	[-4.18000]	[5.45072]	[5.09379]	[-4.67695]
C	19.12930	6.217832	-8.183219	2466.676	-56.58195

A3.10.1. Vector Error Correction Estimation results (continued)

Error Correction:	D(GDP)	D(KAP)	D(EM)	D(HK)	D(OPEN)	D(FDI)	D(TTECH)
CointEq1	-1.803737	0.000000	0.000000	6.834144	-17.12682	0.000000	0.000000
	(0.81690)	(0.00000)	(0.00000)	(1.01561)	(1.78141)	(0.00000)	(0.00000)
	[-2.20803]	[NA]	[NA]	[6.72911]	[-9.61420]	[NA]	[NA]
CointEq2	-1.456663	-0.724592	0.000000	6.128162	-15.19331	0.000000	-0.849224
	(0.70050)	(0.14178)	(0.00000)	(0.87220)	(1.52601)	(0.00000)	(0.14931)
	[-2.07946]	[-5.11057]	[NA]	[7.02611]	[-9.95622]	[NA]	[-5.68761]
CointEq3	-2.045544	0.000000	0.000000	9.330099	-22.61393	19.60258	0.000000
	(1.08363)	(0.00000)	(0.00000)	(1.35598)	(2.36291)	(6.09680)	(0.00000)
	[-1.88768]	[NA]	[NA]	[6.88069]	[-9.57036]	[3.21522]	[NA]
CointEq4	0.043173	0.032299	0.000000	-0.164383	0.396037	0.000000	-0.014975
	(0.01876)	(0.00497)	(0.00000)	(0.02338)	(0.04084)	(0.00000)	(0.00444)
	[2.30143]	[6.50002]	[NA]	[-7.02985]	[9.69768]	[NA]	[-3.37056]
CointEq5	1.065976	0.793605	-0.011459	-4.315349	10.65575	0.000000	0.000000
	(0.49354)	(0.12889)	(0.00772)	(0.61517)	(1.07449)	(0.00000)	(0.00000)
	[2.15984]	[6.15713]	[-1.48518]	[-7.01485]	[9.91707]	[NA]	[NA]
D(GDP (-1))	0.346443	0.827119	-0.280655	-0.750178	2.765297	10.36996	2.252375
	(0.21139)	(0.40060)	(0.16869)	(0.38153)	(0.37186)	(12.5763)	(1.30396)
	[1.63892]	[2.06472]	[-1.66371]	[-1.96626]	[7.43632]	[0.82457]	[1.72733]
D(KAP (-1))	-0.154346	-0.136601	0.043078	0.064840	-0.149354	4.501479	0.484908
	(0.09345)	(0.17709)	(0.07457)	(0.16866)	(0.16439)	(5.55957)	(0.57644)
	[-1.65171]	[-0.77136]	[0.57765]	[0.38444]	[-0.90854]	[0.80968]	[0.84121]
D(EM(-1))	-0.395770	-0.509279	-0.031867	-1.435924	1.967066	-3.810042	0.561484
	(0.39832)	(0.75485)	(0.31787)	(0.71891)	(0.70071)	(23.6977)	(2.45708)
	[-0.99361]	[-0.67468]	[-0.10025]	[-1.99735]	[2.80725]	[-0.16078]	[0.22852]
D(HK(-1))	0.035281	-0.036996	-0.003596	0.310405	-0.497827	-3.232374	0.534426
	(0.06667)	(0.12634)	(0.05320)	(0.12032)	(0.11728)	(3.96622)	(0.41123)
	[0.52923]	[-0.29284]	[-0.06759]	[2.57977]	[-4.24492]	[-0.81498]	[1.29956]
D(OPEN(-1))	0.069892	0.225071	0.012228	-0.452607	0.273209	10.28666	-0.434387
	(0.06516)	(0.12348)	(0.05200)	(0.11761)	(0.11463)	(3.87664)	(0.40195)
	[1.07262]	[1.82268]	[0.23515]	[-3.84853]	[2.38346]	[2.65350]	[-1.08071]
D(FDI (-1))	-0.000205	0.000652	-0.001255	-0.007812	0.002257	0.391053	0.029854
	(0.00273)	(0.00517)	(0.00218)	(0.00492)	(0.00480)	(0.16219)	(0.01682)
	[-0.07527]	[0.12623]	[-0.57703]	[-1.58777]	[0.47071]	[2.41109]	[1.77525]
D(TTECH (-1))	0.008540	-0.116808	0.019012	0.092027	0.041770	-1.299775	0.460400
	(0.03215)	(0.06093)	(0.02566)	(0.05802)	(0.05656)	(1.91268)	(0.19832)
	[0.26565]	[-1.91723]	[0.74102]	[1.58600]	[0.73856]	[-0.67956]	[2.32156]

A3.10.1. Vector Error Correction Estimation results (continued)

Error Correction:	D(GDP)	D(KAP)	D(EM)	D(HK)	D(OPEN)	D(FDI)	D(TTECH)
C	0.089261	-0.132655	0.066531	0.163063	-0.384661	1.244398	0.141719
	(0.03579)	(0.06782)	(0.02856)	(0.06459)	(0.06296)	(2.12921)	(0.22077)
	[2.49414]	[-1.95592]	[2.32948]	[2.52444]	[-6.10982]	[0.58444]	[0.64194]
LIBDUMMY	-0.041070	0.450157	-0.064393	-0.098142	0.452999	-5.850617	-0.994961
	(0.05828)	(0.11045)	(0.04651)	(0.10519)	(0.10253)	(3.46756)	(0.35953)
	[-0.70465]	[4.07555]	[-1.38443]	[-0.93295]	[4.41816]	[-1.68725]	[-2.76738]
R-squared	0.588737	0.753330	0.361296	0.782946	0.904289	0.702850	0.692853
Adj. R-squared	0.334146	0.600629	-0.034093	0.648579	0.845040	0.518901	0.502715
Sum sq. resids	0.015162	0.054453	0.009656	0.049392	0.046922	53.66811	0.576957
S.E. equation	0.026870	0.050922	0.021443	0.048498	0.047269	1.598632	0.165753
F-statistic	2.312482	4.933370	0.913774	5.826921	15.26237	3.820883	3.643941
Log likelihood	85.86239	63.48793	93.75850	65.19505	66.09278	-57.14359	22.18053
Akaike AIC	-4.106422	-2.827882	-4.557628	-2.925431	-2.976730	4.065348	-0.467459
Schwarz SC	-3.484283	-2.205742	-3.935489	-2.303292	-2.354591	4.687487	0.154680
Mean dependent	0.085203	0.089287	0.021802	0.027632	0.046276	0.744672	0.054882
S.D. dependent	0.032929	0.080578	0.021087	0.081810	0.120080	2.304789	0.235049
Determinant resid covariance (dof adj.)		1.96E-17					
Determinant resid covariance		5.48E-19					
Log likelihood		387.1000					
Akaike information criterion		-14.23429					
Schwarz criterion		-8.101772					

A3.10.2. Roots of companion matrix

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.688231 - 0.512375i	0.858015
0.688231 + 0.512375i	0.858015
0.376243 - 0.695333i	0.790599
0.376243 + 0.695333i	0.790599
0.699478 - 0.084769i	0.704596
0.699478 + 0.084769i	0.704596
-0.082473 - 0.685325i	0.690269
-0.082473 + 0.685325i	0.690269
-0.654923	0.654923
-0.337931	0.337931
-0.007817 - 0.322619i	0.322714
-0.007817 + 0.322619i	0.322714

A3.10.3. ECM residuals Heteroskedasticity test: no cross terms (only levels and squares)

Joint test:					
Chi-sq	df	Prob.			
776.5857	728	0.1032			
Individual components:					
Dependent	R-squared	F(26,8)	Prob.	Chi-sq(26)	Prob.
res1*res1	0.706684	0.741321	0.7355	24.73394	0.5341
res2*res2	0.849329	1.734454	0.2125	29.72651	0.2791
res3*res3	0.765211	1.002811	0.5387	26.78237	0.4208
res4*res4	0.898596	2.726636	0.0713	31.45087	0.2119
res5*res5	0.748651	0.916470	0.5999	26.20278	0.4520
res6*res6	0.988617	26.72238	0.0000	34.60158	0.1205
res7*res7	0.749774	0.921965	0.5958	26.24209	0.4499
res2*res1	0.691913	0.691027	0.7755	24.21696	0.5636
res3*res1	0.739283	0.872486	0.6328	25.87491	0.4700
res3*res2	0.654592	0.583115	0.8578	22.91071	0.6380
res4*res1	0.793263	1.180632	0.4288	27.76419	0.3702
res4*res2	0.753189	0.938978	0.5835	26.36161	0.4434
res4*res3	0.771149	1.036819	0.5159	26.99023	0.4098
res5*res1	0.676062	0.642157	0.8137	23.66217	0.5953
res5*res2	0.633452	0.531741	0.8932	22.17083	0.6793
res5*res3	0.670395	0.625827	0.8262	23.46383	0.6066
res5*res4	0.883922	2.343039	0.1058	30.93726	0.2306
res6*res1	0.808877	1.302222	0.3664	28.31068	0.3433
res6*res2	0.800604	1.235431	0.3994	28.02115	0.3574
res6*res3	0.845301	1.681288	0.2267	29.58555	0.2851
res6*res4	0.959664	7.320473	0.0033	33.58823	0.1457
res6*res5	0.892991	2.567705	0.0837	31.25470	0.2189
res7*res1	0.802530	1.250479	0.3917	28.08854	0.3541
res7*res2	0.829812	1.500264	0.2843	29.04342	0.3091
res7*res3	0.823275	1.433384	0.3095	28.81461	0.3196
res7*res4	0.717761	0.782493	0.7028	25.12165	0.5121
res7*res5	0.895925	2.648751	0.0771	31.35737	0.2152
res7*res6	0.810714	1.317850	0.3591	28.37499	0.3403

A3.10.4. The long-run cointegrating vectors

obs	COINTEQ01	COINTEQ02	COINTEQ03	COINTEQ04	COINTEQ05
1970	NA	NA	NA	NA	NA
1971	NA	NA	NA	NA	NA
1972	-0.247998	1.608925	-0.095065	-62.64096	4.076864
1973	-0.081309	1.441954	-0.119998	-55.14948	3.773095
1974	-0.139558	1.321665	-0.085903	-50.65801	3.388672
1975	-0.098421	1.272532	-0.076216	-41.14089	3.036182
1976	-0.071348	1.048262	-0.086437	-40.33218	2.726177
1977	0.065349	0.853778	-0.077456	-28.89413	2.275892
1978	0.074518	0.648708	-0.064451	-26.52186	1.949754
1979	-0.117098	0.592196	0.012139	-23.76507	1.569763
1980	0.077113	0.588274	-0.143480	-7.680320	0.941857
1981	0.130429	0.507837	-0.177947	0.674215	0.535692
1982	0.121117	0.473643	-0.112300	7.433295	0.350189
1983	0.077206	-0.173821	-0.006077	8.110489	-0.435825
1984	0.045743	-0.163115	-0.001448	7.963868	-0.447225
1985	0.273720	-0.038138	-0.058205	5.171336	0.061737
1986	0.212696	0.559488	-0.116349	3.874747	0.728171
1987	0.020372	0.650696	-0.102259	4.718779	0.564349
1988	0.077266	0.263431	-0.071732	2.891406	0.245066
1989	0.094616	0.004138	-0.035814	2.758281	-0.024257
1990	0.011142	-0.081345	0.012114	8.322718	-0.372894
1991	-0.063935	-0.199367	0.144247	13.59995	-0.613425
1992	-0.013798	-0.282574	0.133560	13.06018	-0.625698
1993	0.036385	-0.162061	0.062127	11.60438	-0.473228
1994	-0.087998	-0.052960	0.030933	11.18463	-0.583182
1995	-0.073287	0.008377	-0.008280	10.02246	-0.513467
1996	-0.100450	-0.300878	0.016331	9.754279	-0.930872
1997	-0.075437	-0.566571	0.036867	11.05041	-1.279164
1998	-0.025085	-0.873174	0.065495	13.15576	-1.659786
1999	-0.003846	-1.029182	0.085245	15.13266	-1.862655
2000	0.009459	-1.081126	0.109646	17.80352	-1.961484
2001	0.051247	-1.092361	0.108691	21.62818	-2.071198
2002	0.028976	-1.162009	0.119340	24.09134	-2.271597
2003	0.013025	-1.159154	0.118376	26.40589	-2.384160
2004	-0.051382	-1.066096	0.116971	27.52625	-2.398811
2005	-0.087636	-1.087122	0.124140	29.00911	-2.532777
2006	-0.081792	-1.272852	0.143195	29.83477	-2.781755

A3.11. Formation of arbitrary capital stocks in China

The measurements of capital are mostly contributed to Jorgenson D. W (for example, see Jorgenson and Siebert (1968), and Jorgenson (1973,1980)). Basically, it can be expressed in Equation 6.1:

$$K_t=(1-\delta)K_{t-1}+KAP_t \qquad (6.1)$$

Where K_t is the current capital stock, KAP_t represents the current capital formation or capital accumulation. δ is the depreciation rate of capital.

Assuming that the depreciation rate keeps constant over time, if we know the initial capital stock K_{-1}, we can calculate the arbitrary capital stock series by adding capital formation at each year. The selection the initial capital stock could be either zero or a value larger than the investment level in the following year. In our calculation, we choose the latter idea and set the starting value of capital stock in 1969 at 4.00E+10, compared with the capital formation in 1970 at 3.066E+10.

In the case of China, the selection of depreciation rate of capital is also based some experiments, we tried calculating two different capital stock series *K1* and *K2* with two different depreciation rate at 0.10 and 0.20 respectively. After taking logarithms, we found that the series with the higher depreciation rate is more correlated with the capital formation series (see A3.11.1). So this series with depreciation rate at 0.20 has been selected for our arbitrary capital stock. Similarly, we choose the arbitrary FDI stock (LOGFDISTOCK02).

And we also found some correlation relationship when regressing capital formation on the arbitrary stock variable. The arbitrary capital stock, in this case, can be linearly represented by capital formation (Results can be found from A3.11.3 to A3.11.8). It would not distort the characters of the arbitrary stock when replace it by capital formation in our system. Test on arbitrary FDI stock generate similar result. Therefore, we would rather use the capital formation variables with original data than the capital stock variables created arbitrarily.

A3.11.1. Covariance analysis of arbitrary capital stock and capital formation

Covariance Correlation	LOGKAPSTOCK01	LOGKAPSTOCK02	KAP
LOGKAPSTOCK01	1.210627 1		
LOGKAPSTOCK02	1.137748 0.99835	1.072795 1	
KAP	1.078407 0.98494	1.022726 0.992277	0.990229 1

A3.11.2. Covariance analysis of arbitrary FDI stock and FDI inflow in China

Covariance Correlation	LOGFDISTOCK01	LOGFDISTOCK02	FDI
LOGFDISTOCK01	124.191 1		
LOGFDISTOCK02	122.9666 0.999963	121.7632 1	
FDI	117.6454 0.999314	116.5205 0.999577	111.5978 1

A3.11.3. Results of equation on arbitrary capital stock in China

Dependent Variable: D(LOGKAPSTOCK02)				
Convergence achieved after 36 iterations				
	Coefficient	Std. Error	t-Statistic	Prob.
D(KAP)	0.307319	0.011928	25.7654	0
D(KAP(-1))	0.226598	0.011843	19.13376	0
D(KAP(-2))	0.157144	0.010269	15.30204	0
D(KAP(-3))	0.087254	0.011688	7.465526	0
D(KAP(-4))	0.093681	0.010777	8.692571	0
D(KAP(-5))	0.067782	0.010111	6.703627	0
D(KAP(-6))	0.042812	0.009604	4.457763	0.001
AR(1)	0.757212	0.293074	2.583689	0.0254
AR(2)	-0.327744	0.322406	-1.016557	0.3312
AR(3)	0.05212	0.299543	0.173997	0.865
AR(4)	0.458177	0.280868	1.631292	0.1311
AR(5)	-0.584384	0.292269	-1.999474	0.0709
AR(6)	0.206022	0.228587	0.901287	0.3867
R-squared	0.988389	Mean dependent var		0.09825
Adjusted R-squared	0.975723	S.D. dependent var		0.025948
S.E. of regression	0.004043	Akaike info criterion		-7.880462
Sum squared resid	0.00018	Schwarz criterion		-7.24235
Log likelihood	107.5655	Hannan-Quinn criter.		-7.711171
Durbin-Watson stat	2.03662			
Inverted AR Roots	0.61	.58+.36i	.58-.36i	-.07+.91i
	-.07-.91i	-0.88		

A3.11.4. Results of equation on arbitrary FDI stock in China

Dependent Variable: D(LOGFDISTOCK02)				
Convergence achieved after 7 iterations				
	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI)	0.997081	0.008888	112.1785	0
D(FDI(-1))	0.000544	0.008438	0.064524	0.9491
D(FDI(-2))	0.017103	0.008437	2.027248	0.0544
D(FDI(-3))	0.01892	0.008879	2.130933	0.044
AR(1)	0.483844	0.19377	2.497003	0.0201
AR(2)	0.009447	0.221379	0.042676	0.9663
AR(3)	-0.380397	0.196882	-1.932105	0.0658
R-squared	0.998333	Mean dependent var		0.921066
Adjusted R-squared	0.997898	S.D. dependent var		2.458537
S.E. of regression	0.112729	Akaike info criterion		-1.326689
Sum squared resid	0.292282	Schwarz criterion		-0.999743
Log likelihood	26.90033	Hannan-Quinn criter.		-1.222096
Durbin-Watson stat	1.877395			
Inverted AR Roots	.54+.59i	.54-.59i	-0.6	

A3.11.5. Breusch-Godfrey serial correlation LM test on residuals of arbitrary capital stock

F-statistic	0.475639	Prob. F(6,5)		0.8040
Obs*R-squared	8.501975	Prob. Chi-Square(6)		0.2036
Test Equation:				
Dependent Variable: RESID				
Presample missing value lagged residuals set to zero.				
	Coefficient	Std. Error	t-Statistic	Prob.
D(KAP)	0.003821	0.015788	0.242056	0.8184
D(KAP(-1))	0.011190	0.018812	0.594833	0.5779
D(KAP(-2))	-0.001190	0.013745	-0.086599	0.9344
D(KAP(-3))	-0.003337	0.015359	-0.217268	0.8366
D(KAP(-4))	-0.003544	0.014981	-0.236595	0.8224
D(KAP(-5))	0.004751	0.014167	0.335396	0.7509
D(KAP(-6))	-0.000700	0.011602	-0.060294	0.9543
AR(1)	-1.219387	2.925584	-0.416801	0.6941
AR(2)	0.834991	2.021346	0.413086	0.6967
AR(3)	0.614579	1.339966	0.458653	0.6657
AR(4)	-0.148447	1.097201	-0.135296	0.8977
AR(5)	0.800784	1.720113	0.465541	0.6611
AR(6)	-0.988785	1.402069	-0.705233	0.5122
RESID(-1)	1.021763	2.895642	0.352862	0.7386
RESID(-2)	0.255459	1.407016	0.181561	0.8631
RESID(-3)	-1.154702	1.040665	-1.109580	0.3177
RESID(-4)	-0.879155	0.840915	-1.045474	0.3437
RESID(-5)	-0.068208	0.823820	-0.082794	0.9372
RESID(-6)	0.506861	0.951912	0.532467	0.6172
R-squared	0.354249	Mean dependent var		0.000325
Adjusted R-squared	-1.970455	S.D. dependent var		0.002776
S.E. of regression	0.004785	Akaike info criterion		-7.832026
Sum squared resid	0.000114	Schwarz criterion		-6.899400
Log likelihood	112.9843	Hannan-Quinn criter.		-7.584600
Durbin-Watson stat	1.642892			

A3.11.6. Breusch-Godfrey serial correlation LM test on residuals of arbitrary FDI stock

F-statistic	1.167872	Prob. F(6,17)		0.3682
Obs*R-squared	7.901371	Prob. Chi-Square(6)		0.2454
Test Equation:				
Dependent Variable: RESID				
Presample missing value lagged residuals set to zero.				
	Coefficient	Std. Error	t-Statistic	Prob.
D(FDI)	0.000772	0.008709	0.088590	0.9304
D(FDI(-1))	-0.000489	0.008280	-0.059078	0.9536
D(FDI(-2))	-0.000551	0.008284	-0.066522	0.9477
D(FDI(-3))	0.000875	0.008711	0.100434	0.9212
AR(1)	1.163191	5.237343	0.222096	0.8269
AR(2)	-0.158779	5.224430	-0.030392	0.9761
AR(3)	0.225885	3.412628	0.066191	0.9480
RESID(-1)	-1.080491	5.226863	-0.206719	0.8387
RESID(-2)	-0.276760	2.740821	-0.100977	0.9208
RESID(-3)	-0.740213	2.144775	-0.345124	0.7342
RESID(-4)	0.498030	1.132716	0.439677	0.6657
RESID(-5)	0.325852	0.815639	0.399506	0.6945
RESID(-6)	-0.097985	0.726484	-0.134876	0.8943
R-squared	0.263379	Mean dependent var		0.019416
Adjusted R-squared	-0.256589	S.D. dependent var		0.098431
S.E. of regression	0.110339	Akaike info criterion		-1.271831
Sum squared resid	0.206971	Schwarz criterion		-0.664645
Log likelihood	32.07746	Hannan-Quinn criter.		-1.077587
Durbin-Watson stat	1.972548			

A3.11.7. Heteroskedasticity test on residuals of arbitrary capital stock: (Breusch-Pagan-Godfrey)

F-statistic	0.908488	Prob. F(7,16)		0.5242
Obs*R-squared	6.826028	Prob. Chi-Square(7)		0.4472
Scaled explained SS	1.579973	Prob. Chi-Square(7)		0.9794
Test Equation:				
Dependent Variable: RESID^2				
	Coefficient	Std. Error	t-Statistic	Prob.
C	1.51E-05	1.31E-05	1.151898	0.2663
D(KAP)	-4.67E-05	4.12E-05	-1.135021	0.2731
D(KAP (-1))	-2.68E-05	3.71E-05	-0.722619	0.4803
D(KAP (-2))	-1.75E-06	3.77E-05	-0.046486	0.9635
D(KAP (-3))	-3.83E-05	3.52E-05	-1.088197	0.2926
D(KAP (-4))	2.62E-05	3.76E-05	0.697644	0.4954
D(KAP (-5))	-6.39E-06	3.28E-05	-0.195061	0.8478
D(KAP (-6))	2.16E-05	3.57E-05	0.606104	0.5529
R-squared	0.284418	Mean dependent var		7.49E-06
Adjusted R-squared	-0.028649	S.D. dependent var		1.14E-05
S.E. of regression	1.15E-05	Akaike info criterion		-19.64333
Sum squared resid	2.12E-09	Schwarz criterion		-19.25065
Log likelihood	243.72	Hannan-Quinn criter.		-19.53915
F-statistic	0.908488	Durbin-Watson stat		1.798858
Prob(F-statistic)	0.524217			

A3.11.8. Heteroskedasticity Test on residuals of arbitrary FDI stock:
(Breusch-Pagan-Godfrey)

F-statistic	0.171561	Prob. F(4,25)		0.9509
Obs*R-squared	0.801493	Prob. Chi-Square(4)		0.9382
Scaled explained SS	0.795734	Prob. Chi-Square(4)		0.9390
Test Equation:				
Dependent Variable: RESID^2				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011399	0.004081	2.793264	0.0099
D(FDI)	-0.000502	0.001610	-0.311942	0.7577
D(FDI(-1))	-0.000578	0.001780	-0.324872	0.7480
D(FDI(-2))	-8.15E-05	0.001781	-0.045770	0.9639
D(FDI(-3))	-0.000742	0.001610	-0.460812	0.6489
R-squared	0.026716	Mean dependent var		0.009743
Adjusted R-squared	-0.129009	S.D. dependent var		0.018213
S.E. of regression	0.019352	Akaike info criterion		-4.900992
Sum squared resid	0.009363	Schwarz criterion		-4.667459
Log likelihood	78.51488	Hannan-Quinn criter.		-4.826283
F-statistic	0.171561	Durbin-Watson stat		2.294387
Prob(F-statistic)	0.950898			

APPENDIX TO CHAPTER FOUR

A4.1. Unit root test results for Taiwan and South Korea

A4.1.1. Unit root test for Taiwan

ADF-test						
Variable	Level			First Difference		
	Deterministic term	t-stats.	Prob.	Deterministic term	t-stats	Prob.
OPENTW	Constant and trend	-3.455609	0.0599	Constant	-6.878559	0
FDITW	Constant and trend	-1.554493	0.7842	Constant	-4.053839	0.0043
TTECHTW	Constant and trend	-2.365925	0.3901	None	-6.655849	0
KPSS-test						
Variable	Level			First Difference		
	Deterministic term	t-stats	5% C.Vs	Deterministic term	t-stats	5% C.Vs
GDPTW	Constant and trend	0.889681	0.146	Constant and trend	0.044008	0.146
KAPTW	Constant and trend	0.217149	0.146	Constant	0.058023	0.463
EMTW	Constant and trend	0.538256	0.146	Constant and trend	0.075353	0.146
HKTW	Constant and trend	0.483067	0.146	Constant	0.0946	0.463

A4.1.2. Unit root test for South Korea

ADF-test						
Variable	LEVEL			FIRST DIFFERENCE		
	Deterministic term	t-stats.	Prob.	Deterministic term	t-stats	Prob.
GDPK	Constant	-1.902422	0.3275	Constant	-5.037268	0.0002
KAPK	Constant	-1.977064	0.2951	Constant	-5.164587	0.0002
OPENK	Constant and trend	-2.690033	0.2464	Constant	-5.152592	0.0002
KPSS-test						
Variable	Level			First Difference		
	Deterministic term	t-stats	5% C.Vs	Deterministic term	t-stats	5% C.Vs
EMK	Constant and trend	0.256529	0.146	Constant and trend	0.050066	0.146
HKK	Constant and trend	0.477612	0.146	Constant and trend	0.123978	0.146
FDIK	Constant and trend	0.124335	0.146	Constant	0.052822	0.463
TTECHK	Constant and trend	0.172559	0.146	Constant	0.041375	0.463

A4.2. Empirical results of Taiwan

A4.2.1. Estimation results of the unrestricted VAR of Taiwan

Standard errors in ( ) & t-statistics in [ ]

	LOP_GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
LOP_GDPTW(-1)	0.873454	1.611740	0.262409	0.001430	0.384456	-250.5921	0.081704
	(0.20841)	(0.62407)	(0.07848)	(0.06982)	(0.34084)	(261.885)	(0.10453)
	[4.19101]	[2.58262]	[3.34383]	[0.02048]	[1.12798]	[-0.95688]	[0.78166]
KAPTW(-1)	0.031260	0.451608	-0.067491	-0.015948	-0.186959	10.41786	-0.001253
	(0.06024)	(0.18039)	(0.02268)	(0.02018)	(0.09852)	(75.6993)	(0.03021)
	[0.51890]	[2.50349]	[-2.97530]	[-0.79017]	[-1.89766]	[0.13762]	[-0.04147]
EMTW(-1)	-0.456015	-0.298740	0.362080	0.308605	-0.201984	540.1891	-0.085880
	(0.45500)	(1.36247)	(0.17133)	(0.15244)	(0.74411)	(571.746)	(0.22820)
	[-1.00222]	[-0.21926]	[2.11337]	[2.02449]	[-0.27144]	[0.94481]	[-0.37633]
HKTW(-1)	0.330189	-1.037493	0.341711	0.702670	-0.119087	-320.5403	-0.077194
	(0.31256)	(0.93594)	(0.11769)	(0.10472)	(0.51116)	(392.758)	(0.15676)
	[1.05639]	[-1.10850]	[2.90342]	[6.71030]	[-0.23297]	[-0.81613]	[-0.49243]
OPENTW(-1)	0.043383	0.665644	0.047857	-0.061563	0.825244	82.10253	0.030787
	(0.12881)	(0.38571)	(0.04850)	(0.04315)	(0.21066)	(161.861)	(0.06460)
	[0.33680]	[1.72574]	[0.98668]	[-1.42657]	[3.91747]	[0.50724]	[0.47654]
FDITW(-1)	-0.000218	-0.001289	-0.000267	1.22E-05	-0.000584	0.203919	-0.000158
	(0.00022)	(0.00065)	(8.1E-05)	(7.2E-05)	(0.00035)	(0.27103)	(0.00011)
	[-1.01033]	[-1.99627]	[-3.28781]	[0.16858]	[-1.65428]	[0.75240]	[-1.46067]
TTECHTW(-1)	-0.735214	-3.133583	0.061704	-0.037174	-0.980243	385.3867	0.287857
	(0.47593)	(1.42514)	(0.17921)	(0.15945)	(0.77834)	(598.044)	(0.23870)
	[-1.54479]	[-2.19879]	[0.34431]	[-0.23314]	[-1.25940]	[0.64441]	[1.20594]
C	9.958374	-25.76872	4.514911	-4.426417	-2.443650	-1908.505	-0.871213
	(5.55829)	(16.6439)	(2.09293)	(1.86215)	(9.09004)	(6984.42)	(2.78772)
	[1.79163]	[-1.54824]	[2.15722]	[-2.37705]	[-0.26883]	[-0.27325]	[-0.31252]
DUMMY98	-0.020888	0.096541	-0.006014	0.013893	0.044343	-11.22606	0.030236
	(0.02751)	(0.08237)	(0.01036)	(0.00922)	(0.04499)	(34.5660)	(0.01380)
	[-0.75932]	[1.17203]	[-0.58061]	[1.50750]	[0.98569]	[-0.32477]	[2.19161]
TREND	0.012849	-0.061688	-0.005657	-0.001912	-0.001160	9.033596	-0.001907
	(0.00905)	(0.02709)	(0.00341)	(0.00303)	(0.01479)	(11.3670)	(0.00454)
	[1.42040]	[-2.27733]	[-1.66074]	[-0.63089]	[-0.07840]	[0.79472]	[-0.42026]
R-squared	0.999166	0.993142	0.998711	0.997138	0.976059	0.577320	0.920747
Adj. R-squared	0.998877	0.990768	0.998264	0.996148	0.967771	0.431007	0.893313
Sum sq. resids	0.015456	0.138590	0.002191	0.001735	0.041339	24405.28	0.003888
S.E. equation	0.024382	0.073010	0.009181	0.008168	0.039874	30.63763	0.012229
F-statistic	3458.986	418.3637	2237.597	1006.614	117.7757	3.945800	33.56245

A4.2.1. Estimation results of the unrestricted VAR of Taiwan (continued)

Standard errors in ( ) & t-statistics in [ ]

	LOP_GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
Log likelihood	88.47682	48.99373	123.6389	127.8449	70.76884	-168.4244	113.3193
Akaike AIC	-4.359823	-2.166318	-6.313273	-6.546941	-3.376046	9.912468	-5.739959
Schwarz SC	-3.919957	-1.726452	-5.873407	-6.107075	-2.936180	10.35233	-5.300093
Mean dependent	28.92389	27.57463	15.84797	-0.127673	0.872442	31.94094	0.135942
S.D. dependent	0.727460	0.759869	0.220363	0.131608	0.222110	40.61644	0.037438

Determinant resid covariance (dof adj.)	4.54E-20	R^2(LR)	1
Determinant resid covariance	4.65E-21	R^2(LM)	0.602681
Log likelihood	485.1304	-T/2log|Omega|	842.702944
Akaike information criterion	-23.06280	log|Y'Y/T|	-31.4794519
Schwarz criterion	-19.98374		

A4.2.2. Root of companion matrix from the unrestricted VAR of Taiwan

Root	Modulus
0.956211	0.956211
0.768406 - 0.179566i	0.789108
0.768406 + 0.179566i	0.789108
0.346437 - 0.579740i	0.675364
0.346437 + 0.579740i	0.675364
0.260467 - 0.099079i	0.278675
0.260467 + 0.099079i	0.278675

A4.2.3. F-test for significance of the unrestricted VAR of Taiwan

F-test	Test statistics[prob.]
F-test on regressors except unrestricted: F(56,113)	32.8036 [0.0000] **
F-tests on retained regressors, F(7,20)	
GDPTW (-1)	3.61890 [0.011]*
KAPTW (-1)	13.4650[0.000]**
EMTW (-1)	1.78076 [0.147]
HKTW (-1)	9.05313 [0.000]**
OPENTW (-1)	9.91807 [0.000]**
TTECHTW (-1)	5.93850[0.001]**
FDITW (-1)	2.01443 [0.104]
Trend	3.52142 [0.013]*
Constant	3.35711 [0.016]*
dummy98	2.99855[0.025]*

A4.2.4. Residuals of the unrestricted VAR of Taiwan

obs	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1970	NA	NA	NA	NA	NA	NA	NA
1971	0.007611	-0.028996	-0.004439	-0.001742	-0.023686	8.855024	-0.010661
1972	0.012206	-0.057501	-0.006691	0.010506	-0.003971	10.11488	0.002115
1973	0.011373	-0.034475	0.011867	-0.002652	0.016655	18.69678	0.003196
1974	-0.054585	0.072810	-0.009129	-0.002868	-0.001078	-5.895987	-0.005963
1975	-0.041270	-0.068223	-0.006784	0.005059	-0.023169	-21.56570	-0.011452
1976	0.012308	0.118809	-0.004464	-0.008794	0.061736	3.164510	0.018961
1977	0.010732	0.037294	0.012647	0.000375	-0.005451	-4.469807	0.002143
1978	0.048753	0.057166	0.012856	-0.018959	0.018340	-5.425428	0.014215
1979	0.023200	0.066300	0.007488	-0.004307	0.024743	-11.91886	0.009029
1980	0.014849	0.027271	-0.000311	-0.001211	0.014302	-14.44894	0.005741
1981	-0.001027	-0.016574	-0.003894	0.005557	-0.000691	-8.773950	0.003787
1982	-0.032058	-0.085518	-0.008908	0.017102	-0.038096	-3.960423	-0.010758
1983	-0.010335	0.025573	0.002683	0.004304	-0.015242	8.255980	-0.008062
1984	-0.000721	-0.019058	0.005098	0.003861	-0.005392	5.637991	-0.004977
1985	-0.045021	-0.202537	-0.012602	-0.005313	-0.086825	8.486327	-0.021078
1986	0.011599	-0.018601	0.012433	0.007892	-0.004117	9.062193	-0.002374
1987	0.018418	0.037940	0.007813	0.003348	0.022162	11.27616	0.006634
1988	-0.013698	0.043878	-0.009637	-0.005308	0.066737	0.161163	0.016137
1989	0.032219	0.008107	0.002937	-0.001310	-0.007649	-1.856171	-0.001007
1990	0.005130	-0.029021	-0.010500	0.003574	-0.030515	-1.330694	-0.001398
1991	0.004179	0.047402	-0.004418	0.000473	0.028571	9.426956	-0.004929
1992	-0.003072	0.008116	0.001770	0.000881	-0.007063	-5.995431	-0.001425
1993	-0.005980	-0.008650	-0.003978	-0.006004	-0.010610	-9.228276	-0.005237
1994	0.003622	-0.005671	0.008197	0.001777	-0.040593	-1.709097	-0.007369
1995	-0.001832	0.005659	0.005217	-0.010831	0.021562	-0.023457	0.012654
1996	0.002942	-0.023809	-0.004663	-0.005034	0.003051	-5.953504	-0.006912
1997	-0.009542	0.042308	-0.000588	0.009628	0.026291	9.417760	0.008989
1998	-0.007072	-0.021479	0.006993	0.002878	-0.022879	-36.43422	-0.004644
1999	0.011763	-0.029362	-0.004775	0.005387	-0.018470	29.56311	-0.011218
2000	0.024334	0.127356	0.007017	-0.006793	0.106556	62.56861	0.030343
2001	-0.019919	-0.114374	-0.005637	0.005119	-0.050038	16.74417	-0.015929
2002	0.010116	0.062200	0.002441	-0.005180	-0.003477	-30.82178	0.001666
2003	-0.023678	-0.044376	-0.014628	-0.004503	-0.029086	-48.43636	-0.008579
2004	-0.007347	0.051198	-0.008171	-0.007374	0.019345	-18.22959	0.011450
2005	0.004576	0.003939	0.006530	-0.001130	-0.001176	-64.32109	-8.08E-05
2006	0.007228	-0.035104	0.010229	0.011597	-0.000775	89.36716	-0.003007

A4.2.5. Covariance matrix of residuals of the unrestricted VAR of Taiwan

	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
GDPTW	0.000429	0.000603	0.000102	-3.77E-05	0.00032	0.107604	0.000116
KAPTW	0.000603	0.00385	0.000163	-0.000175	0.001736	0.00936	0.000503
EMTW	0.000102	0.000163	6.09E-05	-3.71E-06	7.13E-05	0.042458	2.70E-05
HKTW	-3.77E-05	-0.000175	-3.71E-06	4.82E-05	-8.36E-05	0.044497	-3.14E-05
OPENTW	0.00032	0.001736	7.13E-05	-8.36E-05	0.001148	0.214517	0.000319
FDITW	0.107604	0.00936	0.042458	0.044497	0.214517	677.9244	0.037693
TTECHTW	0.000116	0.000503	2.70E-05	-3.14E-05	0.000319	0.037693	0.000108

A4.2.6. Correlation matrix of residuals of the unrestricted VAR of Taiwan

	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
GDPTW	1	0.469118	0.633165	-0.261909	0.455112	0.199451	0.537086
KAPTW	0.469118	1	0.337037	-0.406512	0.825538	0.005794	0.780848
EMTW	0.633165	0.337037	1	-0.068562	0.269785	0.209005	0.33355
HKTW	-0.261909	-0.406512	-0.068562	1	-0.35555	0.246185	-0.43593
OPENTW	0.455112	0.825538	0.269785	-0.355546	1	0.243133	0.906221
FDITW	0.199451	0.005794	0.209005	0.246185	0.243133	1	0.139303
TTECHTW	0.537086	0.780848	0.33355	-0.435928	0.906221	0.139303	1

A4.2.7. Correlation between actual and fitted

GDPTW	KAPTW	EMTW	HKTW	OPENTW	TTECHTW	FDITW
0.99958	0.99657	0.99936	0.99857	0.98796	0.95956	0.75982

A4.2.8. Unit root test (ADF test) for residuals of the unrestricted VAR of Taiwan

Residuals	Deterministic term	t-stats.	Prob.
GDPTW	None	-4.943955	0
KAPTW	None	-7.032117	0
EMTW	None	-6.011479	0
HKTW	None	-5.344749	0
OPENTW	None	-7.05374	0
FDITW	None	-4.911575	0
TTECHTW	None	-7.153489	0

*MacKinnon (1996) one-sided p-values.

A4.2.9. Results of residuals tests of the unrestricted VAR of Taiwan

Significant probabilities are in [ ]

Single-equation Test	Portmanteau(5)	AR(1-2) test F-test	Normality test Chi^2-test	ARCH (1-1) test F-test	Hetero test Chi^2-test
GDPTW	13.3788	1.079	3.6105	0.24237	0.32493
		[0.3559]	[0.1644]	[0.6270]	[0.5740]
KAPTW	1.77129	0.88197	7.2574	0.023644	0.77214
		[0.4270]	[0.0266]*	[0.8791]	[0.3883]
EMTW	3.65999	0.90991	2.9697	0.35627	0.84367
		[0.4160]	[0.2265]	[0.5562]	[0.3675]
HKTW	3.32996	0.1553	2.7001	0.92207	0.23775
		[0.8570]	[0.2592]	[0.3465]	[0.6303]
OPENTW	2.04775	2.5328	9.3695	0.038061	0.96237
		[0.1005]	[0.0092]**	[0.8470]	[0.3364]
FDITW	5.53397	0.30116	16.039	3.5261	0.95322
		[0.7427]	[0.0003]**	[0.0788]	[0.3386]
TTECHTW	2.65191	1.4376	3.1383	0.13503	1.0809
		[0.2572]	[0.2082]	[0.7165]	[0.3089]
Vector Test	Portmanteau(5)	AR(1-2) test (Chi^2-test)	Normality test (Chi^2-test)		Hetero test (Chi^2-test)
	245.469	1.1025	38.074		26.481
		[0.3625]	[0.0005]**		[0.5466]

Note: Heteroskedasticity Tests have no cross terms (only levels and squares), there is not enough observations for cross term Heteroskedasticity tests

A4.2.10. Variance decomposition of unrestricted VAR of Taiwan

Variance Decomposition of GDPTW

Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.026419	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.036590	97.57632	1.642753	0.016404	0.169955	0.064164	0.530401	0.000000
3	0.044488	93.21759	4.130831	0.117910	0.461734	0.224044	1.833920	0.013972
4	0.051494	88.74148	6.466170	0.268614	0.717407	0.419400	3.323859	0.063067
5	0.057982	84.96520	8.399075	0.406040	0.888910	0.602290	4.597467	0.141014
6	0.064089	81.92673	10.00147	0.507991	0.993961	0.757962	5.580383	0.231501
7	0.069889	79.42870	11.38323	0.579202	1.059955	0.888802	6.337300	0.322811
8	0.075430	77.29486	12.61357	0.630316	1.105482	1.000948	6.945128	0.409689
9	0.080747	75.42034	13.72443	0.669451	1.140152	1.099251	7.455729	0.490645
10	0.085862	73.75171	14.72910	0.701244	1.168238	1.186637	7.897442	0.565622

Variance Decomposition of KAPTW:

Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.083326	20.95867	79.04133	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.122609	28.39571	66.93621	1.452047	0.303480	0.155557	2.698444	0.058556
3	0.146607	32.87828	60.04431	2.639989	0.317200	0.194428	3.782025	0.143772
4	0.161246	36.20411	56.07659	3.327760	0.265189	0.171606	3.764254	0.190490
5	0.171324	38.93241	53.34116	3.684753	0.247203	0.154824	3.445834	0.193814
6	0.179434	41.31897	51.06293	3.872100	0.257246	0.165103	3.144638	0.179011
7	0.186680	43.50549	48.95771	3.985145	0.274813	0.197950	2.912011	0.166874
8	0.193453	45.54926	46.94504	4.068678	0.291668	0.245263	2.734747	0.165345
9	0.199877	47.45929	45.01681	4.139048	0.307382	0.302192	2.600255	0.175016
10	0.206000	49.23085	43.18292	4.199939	0.323263	0.366417	2.502267	0.194340

Variance Decomposition of EMTW:

Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.009790	48.13200	0.118261	51.74974	0.000000	0.000000	0.000000	0.000000
2	0.014935	56.49929	9.965648	29.81647	0.122704	0.099518	3.308233	0.188131
3	0.019969	47.59491	29.39136	20.45183	0.163686	0.072110	2.099870	0.226230
4	0.025601	35.59190	45.90304	15.75009	0.589245	0.287657	1.734499	0.143571
5	0.031621	26.63620	55.66405	13.28708	1.008217	0.631392	2.652659	0.120400
6	0.037639	20.91949	61.01997	11.86074	1.259551	0.955482	3.800051	0.184709
7	0.043478	17.28884	64.17502	10.89528	1.380518	1.217657	4.744944	0.297752
8	0.049115	14.86512	66.23836	10.15832	1.431145	1.423220	5.458206	0.425631
9	0.054572	13.14224	67.70120	9.562608	1.449471	1.586710	6.006880	0.550887
10	0.059871	11.84888	68.78820	9.071635	1.454284	1.720203	6.449810	0.666991

Variance Decomposition of HKTW:

Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.008506	6.469825	7.338391	1.720647	84.47114	0.000000	0.000000	0.000000
2	0.014321	5.027790	22.95781	2.359291	63.76603	0.868686	3.716946	1.303454
3	0.020547	3.665865	33.79855	2.453811	48.59395	1.728648	7.028280	2.730900
4	0.027089	2.715100	40.97366	2.354475	38.56194	2.350904	9.232296	3.811626
5	0.033832	2.085361	45.84211	2.215107	31.80353	2.785712	10.70065	4.567531
6	0.040677	1.665398	49.23155	2.087342	27.09565	3.095374	11.73214	5.092541
7	0.047532	1.377619	51.64771	1.982887	23.70939	3.322688	12.49416	5.465556
8	0.054325	1.173547	53.41278	1.900162	21.20201	3.494520	13.07724	5.739739
9	0.061001	1.023743	54.73571	1.834540	19.29633	3.627709	13.53375	5.948224
10	0.067527	0.910297	55.75250	1.781731	17.81391	3.733114	13.89713	6.111317

Cholesky Ordering: GDPTW KAPTW EMTW HKTW OPENTW FDITW TTECHTW

A4.2.10. Variance decomposition of unrestricted VAR of Taiwan (continued)

Variance Decomposition of OPENTW:								
Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.046998	22.93647	55.04885	0.003600	0.029118	21.98196	0.000000	0.000000
2	0.062045	23.39348	48.81232	0.414321	0.366041	26.34480	0.060378	0.608653
3	0.070715	21.89257	44.77501	0.421881	1.475769	29.70232	0.388645	1.343807
4	0.077554	19.82775	41.66704	0.351402	2.949510	31.63997	1.696018	1.868304
5	0.083892	17.92821	39.41786	0.340661	4.230225	32.62888	3.284363	2.169796
6	0.089958	16.42768	37.99116	0.353886	5.141330	33.20003	4.543044	2.342864
7	0.095774	15.30074	37.13995	0.360054	5.751599	33.61151	5.376421	2.459728
8	0.101340	14.44534	36.61172	0.356415	6.173429	33.94973	5.908272	2.555093
9	0.106662	13.76884	36.24991	0.348161	6.487562	34.23773	6.266787	2.641003
10	0.111758	13.21063	35.97993	0.339128	6.738043	34.48177	6.530720	2.719780
Variance Decomposition of FDITW:								
Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	34.09244	8.644587	0.171472	1.546375	20.11213	12.92812	56.59731	0.000000
2	46.88865	11.50358	1.140283	1.413035	18.66634	15.10773	52.16904	0.000000
3	56.44224	14.33980	3.236702	1.143028	17.26554	17.26864	46.73104	0.015248
4	64.59957	16.45566	5.445121	0.915554	16.14485	19.07841	41.89001	0.070392
5	71.93703	17.79485	7.432715	0.752376	15.32419	20.49543	38.03952	0.160920
6	78.71140	18.56726	9.197393	0.635896	14.71945	21.58354	35.02686	0.269596
7	85.07180	18.99228	10.80239	0.549812	14.24363	22.42448	32.60471	0.382703
8	91.11058	19.22112	12.28965	0.483573	13.84108	23.08723	30.58408	0.493256
9	96.88509	19.34075	13.67411	0.430772	13.48450	23.62152	28.84970	0.598640
10	102.4317	19.39686	14.95753	0.387572	13.16283	24.06080	27.33630	0.698107
Variance Decomposition of TTECHTW:								
Period	S.E.	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.014430	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
2	0.020406	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
3	0.024993	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
4	0.028859	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
5	0.032265	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
6	0.035345	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
7	0.038177	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
8	0.040813	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
9	0.043289	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001
10	0.045630	30.77229	40.23567	0.086647	2.006024	15.99421	0.984165	9.921001

Cholesky Ordering: GDPTW KAPTW EMTW HKTW OPENTW FDITW TTECHTW

A4.2.11. Impulse response effects to Cholesky one S.D innovation of the VAR of Taiwan

Response of GDPTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.024382	0	0	0	0	0	0
2	0.013637	-0.002562	-0.003318	0.001523	-0.005744	-0.004946	-0.003399
3	0.0076	-0.005394	-0.00289	0.004299	-0.006475	-0.000581	-0.005172
4	0.004864	-0.005077	-0.000958	0.005155	-0.00524	0.002884	-0.005107
5	0.00414	-0.003552	0.000473	0.004324	-0.003981	0.002934	-0.004213
6	0.003953	-0.002745	0.000853	0.003269	-0.003272	0.001346	-0.003324
7	0.003468	-0.002925	0.000695	0.002827	-0.002916	0.000195	-0.002696
8	0.002667	-0.00339	0.000606	0.002893	-0.002614	5.56E-05	-0.002221
9	0.001895	-0.003552	0.000769	0.003016	-0.00227	0.000388	-0.001762
10	0.001385	-0.003345	0.001035	0.00294	-0.001947	0.000574	-0.001298
Response of KAPTW							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.03425	0.064477	0	0	0	0	0
2	0.038868	0.031088	-0.007846	-0.014624	-0.018407	-0.030248	-0.014488
3	0.03023	0.000252	-0.016462	-0.00419	-0.020805	-0.022254	-0.021412
4	0.016963	-0.014032	-0.014224	0.00823	-0.015898	6.76E-05	-0.022321
5	0.008908	-0.012888	-0.006553	0.012036	-0.0092	0.013494	-0.018495
6	0.006764	-0.006644	-0.000763	0.008992	-0.004505	0.012966	-0.013128
7	0.006574	-0.003134	0.000944	0.004968	-0.002561	0.006191	-0.00877
8	0.005456	-0.003502	0.000448	0.003273	-0.002135	0.001193	-0.006037
9	0.003267	-0.005138	6.50E-05	0.003587	-0.00192	0.000207	-0.004304
10	0.00119	-0.005797	0.000561	0.00422	-0.00147	0.001215	-0.002887
Response of EMTW							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.005813	0.000416	0.007094	0	0	0	0
2	0.005102	-0.00251	0.001893	0.00014	-0.001996	-0.006839	0.000285
3	0.001923	-0.006477	0.000113	0.003191	-0.002914	-0.003852	-0.00048
4	-0.000284	-0.006976	0.00104	0.005067	-0.002501	0.000711	-0.000556
5	-0.000517	-0.005074	0.002405	0.004756	-0.001868	0.002191	-4.18E-05
6	0.000319	-0.003253	0.00284	0.003496	-0.001691	0.000982	0.000423
7	0.001058	-0.002648	0.002418	0.002609	-0.001908	-0.000603	0.000508
8	0.001263	-0.002887	0.001819	0.002439	-0.002168	-0.001176	0.000311
9	0.001139	-0.003181	0.001491	0.002615	-0.002259	-0.00085	7.07E-05
10	0.001017	-0.003151	0.001436	0.002717	-0.002196	-0.000346	-7.87E-05
Response of HKTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	-0.002139	-0.002624	0.001182	0.007339	0	0	0
2	-0.001508	-0.004754	0.00324	0.005322	-0.001408	0.00034	-0.000172
3	-0.000592	-0.005013	0.003401	0.004381	-0.001595	-0.000315	0.000445
4	-0.000183	-0.004997	0.003102	0.004022	-0.001783	-0.000711	0.000818
5	-1.83E-05	-0.004826	0.00285	0.00389	-0.00197	-0.000673	0.000934
6	0.000168	-0.004468	0.002697	0.003735	-0.002113	-0.000532	0.00091
7	0.000443	-0.004039	0.002548	0.003501	-0.002228	-0.000512	0.000805
8	0.000743	-0.003681	0.002347	0.003254	-0.002331	-0.000587	0.000639
9	0.000991	-0.003442	0.002115	0.003062	-0.002411	-0.000639	0.000434
10	0.001159	-0.003287	0.001897	0.002931	-0.002448	-0.000609	0.000223

Cholesky Ordering: GDPTW KAPTW EMTW HKTW OPENTW FDITW TTECHTW

A4.2.11. Impulse response effects to Cholesky one S.D innovation of the VAR of Taiwan (continued)

Response of OPENTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.018147	0.027634	-0.002568	-0.000197	0.022144	0	0
2	0.007023	0.005577	-0.005189	-0.004725	0.00562	-0.014044	-0.004532
3	-0.002066	-0.008201	-0.005593	0.001674	0.00245	-0.005172	-0.00472
4	-0.007614	-0.009973	-0.001555	0.005683	0.003683	0.0054	-0.002359
5	-0.008163	-0.005215	0.002578	0.004547	0.005022	0.007738	0.000844
6	-0.006015	-0.000723	0.004	0.001362	0.004888	0.003753	0.003175
7	-0.003966	0.000731	0.003169	-0.000718	0.003664	-0.000704	0.004007
8	-0.003055	0.000141	0.001844	-0.000981	0.002328	-0.002418	0.003765
9	-0.002812	-0.000585	0.001116	-0.000394	0.001437	-0.001841	0.003161
10	-0.002507	-0.000577	0.00099	2.71E-05	0.000969	-0.000789	0.002613
Response of FDITW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	6.110711	-3.044993	3.458391	8.530317	12.68237	25.42602	0
2	3.339921	6.207558	3.742304	-1.135975	6.469852	4.873198	1.781764
3	2.678977	4.216387	0.500974	-3.670032	2.486427	-4.676315	1.414199
4	0.525883	-0.142766	-1.547057	-1.762232	0.684656	-4.304365	0.452985
5	-1.517055	-1.988847	-1.273981	0.393356	0.532262	-0.439425	0.057058
6	-2.120335	-1.184156	-0.064692	0.87597	0.94578	1.795097	0.316837
7	-1.566774	0.283244	0.663195	0.160209	1.129028	1.452749	0.726636
8	-0.806321	0.986606	0.596187	-0.5887	0.936561	0.127603	0.889982
9	-0.416082	0.842231	0.183304	-0.794605	0.609869	-0.669455	0.775466
10	-0.380815	0.443111	-0.110873	-0.59652	0.37938	-0.629718	0.557997
Response of TTECHTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.006568	0.007323	-0.000532	-0.001315	0.00536	-0.000809	0.004623
2	0.003099	0.003526	-0.001479	-0.002299	0.000221	-0.00425	0.001331
3	0.001324	0.00054	-0.001851	-0.000908	-0.000952	-0.002231	-0.000309
4	0.000358	-0.000261	-0.001272	0.000114	-0.000721	0.000273	-0.000846
5	0.0002	0.000228	-0.000559	0.000152	-0.000258	0.001154	-0.000792
6	0.000419	0.000754	-0.00026	-0.000249	-5.13E-06	0.000727	-0.000601
7	0.000545	0.00079	-0.000323	-0.000501	4.61E-05	9.15E-05	-0.000487
8	0.000432	0.000509	-0.000449	-0.000461	4.85E-05	-0.000125	-0.000447
9	0.000203	0.000255	-0.000455	-0.000298	9.29E-05	1.86E-05	-0.000403
10	1.41E-05	0.000177	-0.000354	-0.000191	0.000172	0.000208	-0.000319

Cholesky Ordering: GDPTW KAPTW EMTW HKTW OPENTW FDITW TTECHTW

A4.2.12. Impulse response effects to generalized one S.D innovation of the VAR of Taiwan

Response of GDPTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.024382	0.011438	0.015438	-0.006386	0.011096	0.004863	0.013095
2	0.013637	0.004134	0.005954	-0.001861	0.001447	-0.003458	0.002295
3	0.0076	-0.001199	0.002335	0.003187	-0.003711	-0.00024	-0.00424
4	0.004864	-0.002202	0.002109	0.00485	-0.004179	0.003027	-0.005359
5	0.00414	-0.001195	0.002826	0.00401	-0.00284	0.003223	-0.003921
6	0.003953	-0.00057	0.003038	0.002907	-0.001992	0.00183	-0.00269
7	0.003468	-0.000956	0.0026	0.002672	-0.002127	0.000803	-0.002533
8	0.002667	-0.001742	0.002003	0.003077	-0.00264	0.000707	-0.002924
9	0.001895	-0.002248	0.001633	0.003466	-0.002924	0.00104	-0.003154
10	0.001385	-0.002305	0.001525	0.003503	-0.002851	0.001214	-0.003003
Response of KAPTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.03425	0.07301	0.024607	-0.029679	0.060272	0.000423	0.057009
2	0.038868	0.045689	0.019956	-0.034439	0.02959	-0.033017	0.029863
3	0.03023	0.014404	0.006432	-0.014145	0.00346	-0.024101	0.001812
4	0.016963	-0.004434	-0.000886	0.0054	-0.009958	-0.001061	-0.01497
5	0.008908	-0.007203	-6.84E-06	0.011672	-0.009624	0.013059	-0.01586
6	0.006764	-0.002695	0.003392	0.008331	-0.004024	0.013322	-0.009076
7	0.006574	0.000316	0.00475	0.003885	-0.000688	0.00719	-0.003769
8	0.005456	-0.000533	0.003642	0.002702	-0.001175	0.002505	-0.002836
9	0.003267	-0.003005	0.001886	0.004027	-0.003162	0.001545	-0.004193
10	0.00119	-0.004562	0.000924	0.005423	-0.00435	0.002451	-0.005127
Response of EMTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.005813	0.003094	0.009181	-0.000629	0.002477	0.001919	0.003062
2	0.005102	0.000177	0.00458	-0.000131	-0.000649	-0.004982	0.000825
3	0.001923	-0.004818	0.001011	0.00446	-0.005255	-0.002475	-0.004398
4	-0.000284	-0.006294	0.000307	0.007019	-0.006445	0.001719	-0.006274
5	-0.000517	-0.004723	0.001302	0.006386	-0.004967	0.003042	-0.004912
6	0.000319	-0.002723	0.002249	0.004513	-0.003249	0.001795	-0.002923
7	0.001058	-0.001843	0.002418	0.003267	-0.002582	0.000183	-0.002008
8	0.001263	-0.001957	0.002075	0.003051	-0.002759	-0.00045	-0.002147
9	0.001139	-0.002275	0.001729	0.003289	-0.00305	-0.000201	-0.002547
10	0.001017	-0.002305	0.001611	0.003395	-0.003046	0.000238	-0.002665

A4.2.12. Impulse response effects to generalized one S.D innovation of the VAR of Taiwan (continued)

Response of HKTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	-0.002139	-0.003321	-0.00056	0.008168	-0.002904	0.002011	-0.003561
2	-0.001508	-0.004906	0.001333	0.007172	-0.004998	0.001718	-0.005075
3	-0.000592	-0.004705	0.002026	0.006193	-0.004871	0.001062	-0.00445
4	-0.000183	-0.004499	0.002055	0.005716	-0.004756	0.000602	-0.004084
5	-1.83E-05	-0.00427	0.001972	0.005463	-0.004649	0.000507	-0.003908
6	0.000168	-0.003867	0.001988	0.005137	-0.004385	0.000506	-0.003651
7	0.000443	-0.003359	0.002066	0.004695	-0.004016	0.000405	-0.003307
8	0.000743	-0.002902	0.002117	0.004251	-0.003675	0.000233	-0.002999
9	0.000991	-0.002575	0.002106	0.003903	-0.003424	0.000103	-0.002801
10	0.001159	-0.002359	0.00205	0.00366	-0.003247	6.88E-05	-0.002692
Response of OPENTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.018147	0.032918	0.010757	-0.014177	0.039874	0.009695	0.036135
2	0.007023	0.00822	0.00069	-0.008627	0.01054	-0.010384	0.009524
3	-0.002066	-0.008211	-0.006001	0.00387	-0.004911	-0.003041	-0.006326
4	-0.007614	-0.012379	-0.006474	0.010079	-0.008259	0.006885	-0.01024
5	-0.008163	-0.008435	-0.003413	0.008272	-0.004729	0.008947	-0.0061
6	-0.006015	-0.003461	-0.00075	0.003611	-0.000789	0.004841	-0.00089
7	-0.003966	-0.001215	-2.92E-05	0.000618	0.000536	0.000227	0.001414
8	-0.003055	-0.001308	-0.000503	0.00014	-0.000113	-0.001731	0.001073
9	-0.002812	-0.001836	-0.000945	0.000732	-0.000957	-0.00142	7.95E-05
10	-0.002507	-0.001686	-0.000848	0.00101	-0.001067	-0.000577	-0.000273
Response of FDITW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	6.110711	0.177502	6.403407	7.542524	7.449021	30.63763	4.267904
2	3.339921	7.048932	5.287576	-3.347614	9.17963	6.877768	8.657739
3	2.678977	4.980397	2.274341	-5.280901	5.508005	-3.701614	6.27048
4	0.525883	0.120619	-0.868893	-1.899128	0.628976	-3.834966	1.209785
5	-1.517055	-2.468099	-2.035037	1.205178	-1.693047	-0.283547	-1.70877
6	-2.120335	-2.040458	-1.446152	1.71336	-1.260566	1.812623	-1.523723
7	-1.566774	-0.484859	-0.46675	0.559301	0.066732	1.45181	-0.044457
8	-0.806321	0.493047	-0.005171	-0.548368	0.801403	0.138095	0.933675
9	-0.416082	0.548613	-0.083656	-0.848961	0.725135	-0.670366	0.963145
10	-0.380815	0.21268	-0.306715	-0.594598	0.354551	-0.664152	0.548699
Response of TTECHTW:							
Period	GDPTW	KAPTW	EMTW	HKTW	OPENTW	FDITW	TTECHTW
1	0.006568	0.009549	0.004079	-0.005331	0.011082	0.001703	0.012229
2	0.003099	0.004568	0.000979	-0.004224	0.004083	-0.003975	0.004969
3	0.001324	0.001098	-0.000567	-0.001604	0.000572	-0.002497	0.000826
4	0.000358	-6.26E-05	-0.000768	-9.12E-05	-0.000337	-8.63E-05	-0.000575
5	0.0002	0.000295	-0.000295	-7.03E-05	0.000141	0.000848	-0.000237
6	0.000419	0.000862	9.85E-05	-0.000613	0.000728	0.000511	0.000437
7	0.000545	0.000953	0.000131	-0.000893	0.000844	-5.07E-05	0.000664
8	0.000432	0.000653	-5.01E-05	-0.000756	0.000608	-0.000227	0.000467
9	0.000203	0.00032	-0.000212	-0.000469	0.000351	-6.53E-05	0.0002
10	1.41E-05	0.000163	-0.000257	-0.000284	0.000248	0.000136	9.05E-05

A4.2.13. Vector Error Correction model of Taiwan

Standard errors in ( ) & t-statistics in [ ]

Cointegration Restrictions:

β (1,1)=1, β (2,2)=1, β (3,3)=1, β (1,6)=0, β (3,6)=0

β (2,4)=0, β (3,4)=0 , β (3,5)=0, β (2,3)=0, β (2,1)=0, β (2,7)=0

α (7,1)=0, α (7,2)=0, α (7,3)=0 , α (6,1)=0, α (6,3)=0

α (1,1)=0, α (1,3)=0, α (5,2)=0, α (3,3)=0, α (2,3)=0

Convergence achieved after 578 iterations; Restrictions identify all cointegrating vectors

LR test for binding restrictions (rank = 3):

Chi-square(12): 9.393985; Probability: 0.668961.

Cointegrating Eq:	**CointEq1**	**CointEq2**	**CointEq3**
GDPTW(-1)	1.000000	0.000000	-1.096142
			(0.07517)
			[-14.5820]
KAPTW(-1)	-0.368336	1.000000	0.346313
	(0.02645)		(0.03845)
	[-13.9264]		[9.00788]
EMTW(-1)	-1.340825	0.000000	1.000000
	(0.14544)		
	[-9.21887]		
HKTW(-1)	0.544182	0.000000	0.000000
	(0.10499)		
	[5.18341]		
OPENTW(-1)	-0.191559	6.973336	0.000000
	(0.04435)	(0.88643)	
	[-4.31911]	[7.86679]	
FDITW(-1)	0.000000	-0.007255	0.000000
		(0.00179)	
		[-4.04968]	
TTECHTW(-1)	0.491037	0.000000	0.489131
	(0.30492)		(0.34497)
	[1.61040]		[1.41789]
@TREND(70)	-0.023770	-0.156982	0.036519
	(0.00232)	(0.01921)	(0.00432)
	[-10.2337]	[-8.17360]	[8.44779]
C	3.109487	-30.32100	5.537911

(β_{ij} denotes the coefficient on the j^{th} variable in equation i; and α_{ij} denotes the coefficient on the j^{th} error correction term in the first difference equation of variable i).

A4.2.13. Vector Error Correction model of Taiwan (continued)

Standard errors in ( ) & t-statistics in [ ]

Error Correction:	D(GDPTW)	D(KAPTW)	D(EMTW)	D(HKTW)	D(OPENTW)	D(FDITW)	D(TTECHTW)
CointEq1	0.000000	1.329423	0.290257	-0.360666	1.229445	0.000000	0.000000
	(0.00000)	(0.25450)	(0.04415)	(0.08527)	(0.14974)	(0.00000)	(0.00000)
	[NA]	[5.22364]	[6.57498]	[-4.22975]	[8.21054]	[NA]	[NA]
CointEq2	-0.014320	0.103213	0.013501	-0.012070	0.000000	18.97956	0.000000
	(0.00657)	(0.02385)	(0.00471)	(0.00433)	(0.00000)	(9.89247)	(0.00000)
	[-2.17909]	[4.32672]	[2.86518]	[-2.79004]	[NA]	[1.91859]	[NA]
CointEq3	0.000000	0.000000	0.000000	-0.373384	0.943157	0.000000	0.000000
	(0.00000)	(0.00000)	(0.00000)	(0.06910)	(0.12952)	(0.00000)	(0.00000)
	[NA]	[NA]	[NA]	[-5.40335]	[7.28194]	[NA]	[NA]
C	0.074498	0.070516	0.023248	0.008731	0.025568	4.051042	2.04E-05
	(0.00711)	(0.02244)	(0.00264)	(0.00229)	(0.01266)	(9.18008)	(0.00389)
	[10.4723]	[3.14283]	[8.81949]	[3.81176]	[2.02032]	[0.44129]	[0.00524]
DUMMY98	-0.020571	0.006439	-0.004905	0.018828	-0.005814	5.146726	0.014108
	(0.02235)	(0.07049)	(0.00828)	(0.00720)	(0.03976)	(28.8410)	(0.01221)
	[-0.92044]	[0.09135]	[-0.59225]	[2.61646]	[-0.14623]	[0.17845]	[1.15572]
R^2	0.385289	0.343768	0.671835	0.693411	0.200114	0.137935	0.066794
Adj. R^2	0.305971	0.259093	0.629491	0.653852	0.096903	0.026701	-0.053620
Sum sq. resids	0.021637	0.215240	0.002971	0.002243	0.068474	36031.12	0.006455
S.E. equation	0.026419	0.083326	0.009790	0.008506	0.046998	34.09244	0.014430
F-statistic	4.857543	4.059841	15.86616	17.52817	1.938884	1.240041	0.554706
Log likelihood	82.42220	41.06956	118.1617	123.2194	61.68490	-175.4369	104.1950
Akaike AIC	-4.301233	-2.003865	-6.286763	-6.567744	-3.149161	10.02427	-5.510834
Schwarz SC	-4.081300	-1.783931	-6.066830	-6.347811	-2.929228	10.24421	-5.290901
Mean dependent	0.069355	0.072126	0.022022	0.013438	0.024114	5.337724	0.003547
S.D. dependent	0.031712	0.096805	0.016083	0.014458	0.049456	34.55691	0.014058

Determinant resid covariance (dof adj.)	7.66E-20
Determinant resid covariance	2.69E-20
Log likelihood	451.6677
Akaike information criterion	-21.81487
Schwarz criterion	-19.21966

A4.2.14. Roots of companion matrix

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.838354	0.838354
0.408260 - 0.356873i	0.542250
0.408260 + 0.356873i	0.542250

A4.2.15. Cointegrating vectors of the ECM of Taiwan

obs	COINTEQ01	COINTEQ02	COINTEQ03
1970	NA	NA	NA
1971	0.136155	-1.666691	-0.188118
1972	0.137963	-1.254832	-0.184021
1973	0.151133	-0.796825	-0.183048
1974	0.088685	-0.396812	-0.136275
1975	-0.038217	-0.186773	-0.006374
1976	0.029500	-0.752118	-0.051508
1977	0.044201	-0.197629	-0.061498
1978	0.033400	-0.355639	-0.058539
1979	0.038089	-0.223426	-0.069406
1980	-0.002334	-0.007361	-0.026833
1981	0.006488	-0.102932	-0.025697
1982	0.029378	-0.292352	-0.034728
1983	0.052926	-0.683048	-0.046275
1984	0.031488	-0.554490	-0.035197
1985	0.032417	-0.349369	-0.040497
1986	0.062253	-0.881527	-0.066599
1987	0.039119	-0.260989	-0.048107
1988	-0.010548	0.336232	-0.004427
1989	-0.062448	0.899293	0.049961
1990	-0.031310	0.424841	0.012559
1991	-0.005742	0.169934	0.000616
1992	-0.036397	0.518590	0.018669
1993	-0.056313	0.615983	0.040997
1994	-0.062728	0.552486	0.047708
1995	-0.061954	0.231532	0.052321
1996	-0.060842	0.410312	0.061968
1997	-0.038808	0.241795	0.035559
1998	-0.063644	0.510839	0.072720
1999	-0.080801	0.861764	0.118886
2000	-0.056221	0.327626	0.106218
2001	-0.074572	0.675093	0.136429
2002	0.005625	-0.529121	0.067211
2003	0.009320	0.092557	0.063345
2004	-0.016455	0.553282	0.085541
2005	-0.081708	1.050887	0.148388
2006	-0.087096	1.018891	0.148051

A4.2.16. Result of arbitrary capital stock in Taiwan

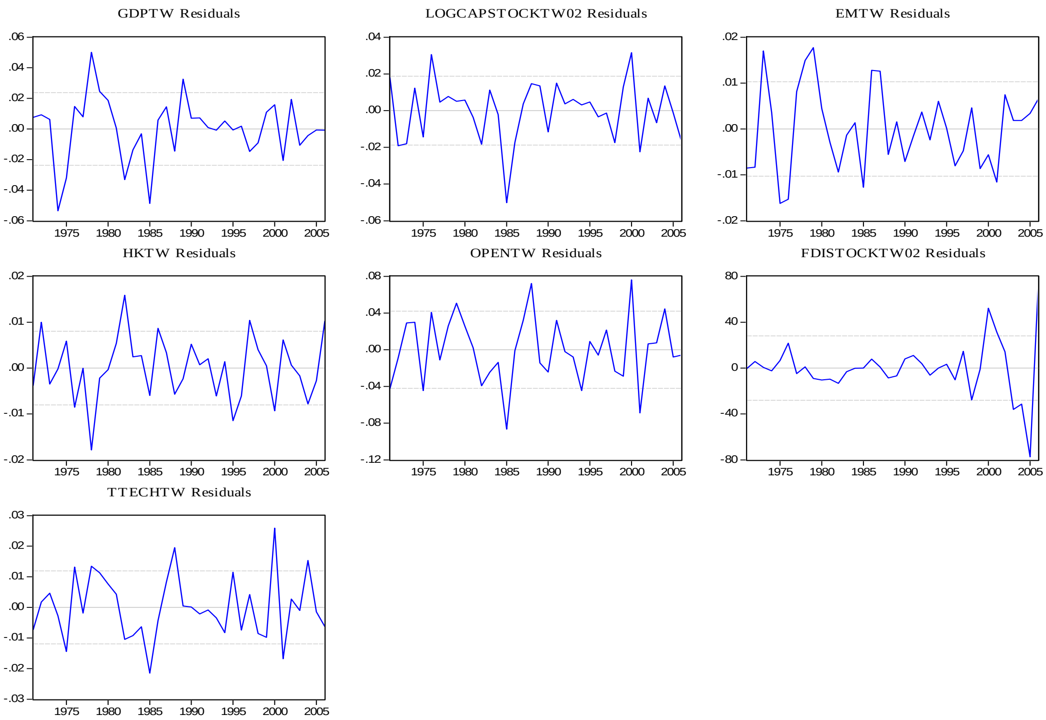
A4.2.16.1. Covariance and correlation of capital formation and arbitrary capital stock series

Covariance Correlation	LOGCAPSTOCKTW02	LOGCAPSTOCKTW01	KAPTW
LOGCAPSTOCKTW02	0.912979 1		
LOGCAPSTOCKTW01	1.020729 0.999411	1.14254 1	
KAPTW	0.746861 0.990858	0.832307 0.987074	0.622295 1

A4.2.16.2. Covariance and correlation of FDI and arbitrary FDI stock series

Covariance Correlation	FDI	FDISTOCKTW01	FDISTOCKTW02
FDI	1574.262 1		
FDISTOCKTW01	4898.389 0.778083	25175.45 1	
FDISTOCKTW02	3380.773 0.820056	16389.85 0.994151	10796.13 1

A4.2.16.3. Residuals of unrestricted VAR with arbitrary capital stock and FDI stock in figure.



A4.2.16.4. Residuals of unrestricted VAR with arbitrary capital stock and FDI stock in table.

obs	GDPTW	LOGCAPSTOCKTW02	EMTW	HKTW	OPENTW	FDISTOCKTW02	TTECHTW
1970	NA	NA	NA	NA	NA	NA	NA
1971	0.007533	0.018082	-0.008539	-0.003859	-0.04246	-0.381	-0.007341
1972	0.009304	-0.019143	-0.008325	0.010007	-0.008819	5.657648	0.001748
1973	0.006211	-0.017973	0.01702	-0.003458	0.029284	0.553829	0.004614
1974	-0.053444	0.012209	0.003563	-0.000203	0.029885	-2.462507	-0.002791
1975	-0.031994	-0.014315	-0.016216	0.005871	-0.044569	6.604474	-0.014446
1976	0.014668	0.030545	-0.015298	-0.008523	0.040736	21.68258	0.013167
1977	0.007889	0.004651	0.008131	-3.32E-05	-0.011125	-4.767138	-0.001843
1978	0.05013	0.007703	0.014935	-0.017841	0.026066	1.11562	0.013451
1979	0.02452	0.005046	0.017723	-0.002186	0.050611	-8.979371	0.011285
1980	0.018634	0.005713	0.004444	-0.000338	0.025559	-10.44558	0.007621
1981	0.000552	-0.003672	-0.002891	0.005384	0.002105	-9.673445	0.004305
1982	-0.033088	-0.018317	-0.009371	0.015872	-0.039227	-13.24211	-0.010437
1983	-0.013638	0.011222	-0.001345	0.002463	-0.024523	-3.135299	-0.009213
1984	-0.00315	-0.002221	0.001354	0.002717	-0.013866	-0.213493	-0.006308
1985	-0.048673	-0.050145	-0.012698	-0.005971	-0.086576	-0.033741	-0.021505
1986	0.005806	-0.017475	0.012782	0.008665	-0.001207	7.793147	-0.004347
1987	0.014528	0.003701	0.012584	0.00336	0.032295	0.955789	0.008337
1988	-0.014501	0.014698	-0.005525	-0.005696	0.07224	-8.653928	0.019524
1989	0.03262	0.013463	0.001554	-0.002353	-0.014289	-6.845958	0.000472
1990	0.007019	-0.011613	-0.00708	0.005207	-0.024334	7.967802	0.000119
1991	0.00728	0.01494	-0.001554	0.000733	0.032007	11.02407	-0.002146
1992	0.000925	0.003704	0.003707	0.002033	-0.002148	3.942718	-0.000849
1993	-0.000778	0.006088	-0.002391	-0.006065	-0.007843	-6.129079	-0.003447
1994	0.005215	0.003065	0.006041	0.001384	-0.044456	-0.03754	-0.008262
1995	-0.000668	0.004705	0.000152	-0.011478	0.009038	3.331719	0.01148
1996	0.001819	-0.003367	-0.008014	-0.006086	-0.005864	-10.1902	-0.007382
1997	-0.014719	-0.001293	-0.004744	0.010397	0.02148	14.56099	0.004193
1998	-0.009088	-0.017446	0.004607	0.004003	-0.023348	-27.71425	-0.008567
1999	0.01099	0.01291	-0.008629	0.000495	-0.028815	-1.077553	-0.00976
2000	0.015872	0.031591	-0.005602	-0.009328	0.076149	52.10561	0.025913
2001	-0.020593	-0.022487	-0.011561	0.006139	-0.068731	31.43858	-0.016819
2002	0.019338	0.006809	0.007456	0.000633	0.006468	14.11243	0.002705
2003	-0.010659	-0.006605	0.001844	-0.001693	0.007568	-36.03583	-0.00099
2004	-0.004307	0.013423	0.001863	-0.00779	0.044423	-31.29937	0.015306
2005	-0.000727	-0.001235	0.003411	-0.002737	-0.007841	-77.41088	-0.001494
2006	-0.000826	-0.016959	0.006612	0.010278	-0.005873	75.88127	-0.006295

A4.3. Empirical results of South Korea

A4.3.1. Estimation results of the VAR of South Korea

Standard errors in ( ) & t-statistics in [ ]

	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
GDPK(-1)	1.093453	1.813046	0.181532	-0.416714	-0.050647	1730.969	0.124732
	-0.23045	-0.94943	-0.15015	-0.21361	-0.56821	-805.53	-0.06687
	[4.74492]	[1.90962]	[1.20904]	[-1.95083]	[-0.08913]	[2.14886]	[1.86521]
KAPK(-1)	-0.250113	-0.267381	-0.082736	0.051568	-0.164785	-0.50361	-0.019876
	-0.07261	-0.29916	-0.04731	-0.06731	-0.17904	-253.814	-0.02107
	[-3.44453]	[-0.89378]	[-1.74884]	[0.76616]	[-0.92040]	[-0.00198]	[-0.94330]
EMK(-1)	0.543889	1.528454	0.795123	0.599702	0.668784	-3067.31	-0.249756
	-0.37446	-1.54274	-0.24397	-0.3471	-0.92329	-1308.92	-0.10866
	[1.45247]	[0.99074]	[3.25906]	[1.72777]	[0.72435]	[-2.34340]	[-2.29845]
HKK(-1)	0.095	0.192041	-0.001264	0.793708	-0.088864	464.3748	0.025092
	-0.0524	-0.2159	-0.03414	-0.04858	-0.12921	-183.181	-0.01521
	[1.81281]	[0.88947]	[-0.03701]	[16.3396]	[-0.68773]	[2.53505]	[1.65003]
OPENK(-1)	-0.064138	0.295364	0.032999	0.047612	0.813546	260.5788	0.055644
	-0.07286	-0.30017	-0.04747	-0.06753	-0.17964	-254.673	-0.02114
	[-0.88032]	[0.98400]	[0.69517]	[0.70502]	[4.52869]	[1.02319]	[2.63188]
FDIK(-1)	0.000135	0.000337	7.36E-05	-4.45E-05	5.53E-05	0.124733	-6.24E-07
	-4.80E-05	-0.0002	-3.10E-05	-4.40E-05	-0.00012	-0.16619	-1.40E-05
	[2.83992]	[1.72210]	[2.37671]	[-1.00954]	[0.47168]	[0.75053]	[-0.04524]
TTECHK(-1)	-0.032958	-1.640278	0.082849	-0.722948	-1.510406	-5169.76	0.132322
	-0.59548	-2.45337	-0.38798	-0.55198	-1.46828	-2081.52	-0.1728
	[-0.05535]	[-0.66858]	[0.21354]	[-1.30975]	[-1.02869]	[-2.48364]	[0.76574]
C	-4.252571	-43.10392	0.139214	1.907194	-4.456744	-3628.06	0.87391
	-4.73328	-19.5009	-3.08392	-4.38744	-11.6708	-16545.2	-1.37354
	[-0.89844]	[-2.21036]	[0.04514]	[0.43469]	[-0.38187]	[-0.21928]	[0.63625]
DUMMY	-0.127343	-0.448081	-0.083187	0.004826	-0.030872	346.5451	-0.013731
	-0.02746	-0.11311	-0.01789	-0.02545	-0.0677	-95.9699	-0.00797
	[-4.63822]	[-3.96133]	[-4.65038]	[0.18965]	[-0.45603]	[3.61098]	[-1.72347]
TREND	0.004847	-0.062162	-0.001082	0.010674	0.012685	-64.7454	-0.002997
	-0.01041	-0.04288	-0.00678	-0.00965	-0.02566	-36.3794	-0.00302
	[0.46574]	[-1.44973]	[-0.15958]	[1.10642]	[0.49431]	[-1.77972]	[-0.99219]
R-squared	0.999271	0.992273	0.997397	0.993181	0.990352	0.855006	0.712487
Adj. R-squared	0.999018	0.989598	0.996496	0.99082	0.987012	0.804816	0.612964
Sum sq. resids	0.013618	0.231152	0.005781	0.011701	0.082792	166392.9	0.001147
S.E. equation	0.022886	0.094289	0.014911	0.021214	0.05643	79.9983	0.006641
F-statistic	3958.878	370.9595	1106.962	420.7472	296.5319	17.03533	7.158978
Log likelihood	90.75609	39.7858	106.1791	93.48752	58.2672	-202.976	135.2963
Akaike AIC	-4.48645	-1.654766	-5.343284	-4.638196	-2.681511	11.83202	-6.960908
Schwarz SC	-4.046583	-1.2149	-4.903417	-4.198329	-2.241645	12.27189	-6.521042

A4.3.1. Estimation results of the VAR of South Korea (continued)

Standard errors in ( ) & t-statistics in [ ]

	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
Mean dependent	32.70653	31.45741	16.61903	-0.208473	-0.56749	134.0724	0.089132
S.D. dependent	0.730469	0.924479	0.251901	0.221413	0.495149	181.075	0.010675
Determinant resid covariance (dof adj.)			1.74E-17				
Determinant resid covariance			1.78E-18				
Log likelihood			378.0971				
Akaike information criterion			-17.11651				
Schwarz criterion			-14.03744				

A4.3.2. Roots of the companion matrix of the VAR of South Korea

Root	Modulus
0.817127 - 0.195933i	0.84029
0.817127 + 0.195933i	0.84029
0.835664	0.835664
0.252649 - 0.348278i	0.430266
0.252649 + 0.348278i	0.430266
0.255144 - 0.053737i	0.260742
0.255144 + 0.053737i	0.260742

A4.3.3. F-test for significance of the unrestricted VAR of South Korea

F-test	Test statistics[prob.]
F-test on regressors except unrestricted: F(56,113)	30.4478 [0.0000] **
F-tests on retained regressors, F(7,20)	
GDPK (-1)	6.57713 [0.000]**
KAPK (-1)	3.82556 [0.009]**
EMK (-1)	5.79179 [0.001]**
HKK (-1)	49.6595 [0.000]**
OPENK (-1)	6.33521 [0.001]**
FDIK (-1)	1.31830 [0.293]
TTECHK (-1)	1.87484 [0.128]
Trend	3.41732 [0.014]*
Constant	1.91144 [0.121]
dummy	5.19475 [0.002]**

A4.3.4. Residuals of the unrestricted VAR of South Korea

Obs	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1970	NA	NA	NA	NA	NA	NA	NA
1971	0.011222	0.05582	-0.010944	-0.013703	-0.046482	-85.614	-0.005208
1972	-0.022419	-0.129503	-0.001768	-0.013132	-0.042032	106.51	-0.007443
1973	-0.021794	-0.055696	-0.011206	0.023836	0.088389	-43.341	0.006422
1974	-0.005917	0.053524	-0.001857	0.013547	-0.075081	-25.965	0.006712
1975	0.007149	-0.044698	-0.003317	0.010594	-0.017653	72.641	0.006409
1976	0.011563	0.008581	0.024582	-0.016744	0.095986	31.623	-0.003371
1977	0.011954	0.018846	0.001144	-0.007683	0.021584	27.152	-0.006872
1978	0.032957	0.136653	0.021204	0.007751	0.05468	-46.765	0.009521
1979	0.037691	0.181958	0.000839	-0.001166	0.016665	38.681	0.004461
1980	-0.027087	-0.0794	-0.001751	-0.021441	0.045958	-31.706	-0.010104
1981	-0.009849	-0.075678	0.00649	0.03489	-0.000461	-2.3799	-0.00214
1982	-0.028643	-0.101547	0.00018	-0.042783	-0.056113	-0.8624	-0.011454
1983	-0.001515	-0.048199	-0.014691	-0.011806	-0.052783	-5.6678	0.002471
1984	-0.012394	-0.002198	-0.034157	0.031772	-0.035983	-52.082	0.009486
1985	-0.003402	0.020673	0.00376	0.013803	-0.032855	-71.784	0.005824
1986	0.008414	0.035098	0.002408	0.009711	0.085121	55.09	-0.001417
1987	0.008084	-0.006794	0.014534	-0.001557	0.044169	-33.811	-0.001098
1988	0.006952	-0.040504	-0.004934	-0.012741	-0.019441	19.757	-0.000647
1989	-0.020919	-0.023426	0.00475	-0.011564	-0.052354	-20.257	-0.005477
1990	0.009443	0.083552	0.006348	0.023442	-0.06297	36.068	0.003376
1991	0.023474	0.130855	0.014004	-0.036808	-0.007684	36.324	0.006281
1992	0.00081	0.010673	0.002596	0.01435	-0.028265	1.3616	0.002567
1993	-0.013061	-0.023319	-0.007535	0.005261	-0.045308	-14.163	-0.007265
1994	0.003023	0.048469	0.008454	0.01688	0.001762	-66.241	0.000716
1995	0.018077	0.02907	0.00555	-0.00832	0.064507	-17.615	0.004212
1996	-0.000731	-0.017242	-0.008566	0.006086	0.018171	20.766	-0.000293
1997	-0.023079	-0.165566	-0.016116	-0.012476	0.038471	72.282	-0.005668
1998	-0.0456	-0.185506	-0.026079	0.028596	0.006836	-13.105	0.001561
1999	0.023348	0.106395	0.004572	-0.004458	0.015131	176.33	-0.004406
2000	0.01678	0.03519	0.011264	-0.001569	0.049404	33.354	0.007692
2001	-0.012411	-0.052964	-0.005305	-0.00987	-0.101336	-122	-0.009642
2002	0.035091	0.083311	0.02596	-0.024128	-0.01753	-138.7	-0.001958
2003	-0.001245	0.041441	0.000551	-0.014395	0.017473	-78.871	0.003057
2004	0.019016	0.055406	0.012935	0.001077	0.049349	174.79	0.003976
2005	-0.028833	-0.072343	-0.016295	0.020023	-0.022874	26.709	0.000992
2006	-0.006146	-0.010931	-0.007604	0.004724	0.003548	-58.505	-0.00127

A4.3.5. Covariance matrix of residuals of the unrestricted VAR of South Korea

	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
GDPK	0.000524	0.001886	0.000223	-9.37E-05	0.000338	0.213167	5.57E-05
KAPK	0.001886	0.00889	0.000779	-0.00015	0.000615	-0.05307	0.000274
EMK	0.000223	0.000779	0.000222	-0.000109	0.000258	0.062128	2.59E-06
HKK	-9.37E-05	-0.00015	-0.000109	0.00045	3.38E-05	-0.02828	6.79E-05
OPENK	0.000338	0.000615	0.000258	3.38E-05	0.003184	1.171219	7.22E-05
FDIK	0.213167	-0.053074	0.062128	-0.028281	1.171219	6399.728	-0.002024
TTECHK	5.57E-05	0.000274	2.59E-06	6.79E-05	7.22E-05	-0.00202	4.41E-05

A4.3.6. Correlation matrix of residuals of the unrestricted VAR of South Korea

	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
GDPK	1	0.873825	0.654687	-0.193082	0.261486	0.1164	0.366645
KAPK	0.873825	1	0.554176	-0.075022	0.115568	-0.007	0.436884
EMK	0.654687	0.554176	1	-0.345777	0.306767	0.0521	0.026132
HKK	-0.193082	-0.075022	-0.345777	1	0.028275	-0.0167	0.481657
OPENK	0.261486	0.115568	0.306767	0.028275	1	0.2594	0.192754
FDIK	0.116431	-0.007036	0.052083	-0.016664	0.259448	1	-0.003809
TTECHK	0.366645	0.436884	0.026132	0.481657	0.192754	-0.0038	1

A4.3.7. Correlation between actual and fitted

GDPK	KAPK	KEMK	HKK	OPENK	FDIK	TTECHK
0.99964	0.99613	0.99870	0.99658	0.99516	0.92467	0.84409

A4.3.8. Unit root test (ADF test) for residuals of the unrestricted VAR of South Korea

Residuals	Deterministic term	t-stats.	Prob.
GDPK	None	-5.389209	0
KAPK	None	-5.064875	0
EMK	None	-5.22006	0
HKK	None	-7.425108	0
OPENK	None	-5.379505	0
FDIK	None	-5.116572	0
TTECHK	None	-5.860639	0

A4.3.9. Residuals tests for the VAR of South Korea

Significant probabilities are in [ ]

Single-equation Test	Portmanteau(5)	AR(1-2) test F-test	Normality test Chi^2-test	ARCH (1-1) test F-test	Hetero test Chi^2-test
GDPK	3.15206	0.31125	0.10238	0.48857	0.70365
		[0.7354]	[0.9501]	[0.4913]	[0.7392]
KAPK	5.85348	2.7015	0.80644	3.961	0.67618
		[0.0875]	[0.6682]	[0.0581]	[0.7610]
EMK	4.63874	0.61796	2.4667	0.50378	0.36172
		[0.5474]	[0.2913]	[0.4847]	[0.9630]
HKK	3.55447	1.3283	0.18239	1.1426	0.54619
		[0.2837]	[0.9128]	[0.2957]	[0.8596]
OPENK	3.17583	0.35614	0.41483	0.46167	1.0425
		[0.7040]	[0.8127]	[0.5033]	[0.4874]
FDIK	5.86381	0.98966	3.3885	0.054394	1.1521
		[0.3864]	[0.1837]	[0.8176]	[0.4207]
TTECHK	8.45246	2.1866	1.7166	0.50057	0.38107
		[0.1342	[0.4239]	[0.4861]	[0.9553]
Vector Test	Portmanteau(5)	AR(1-2) test (Chi^2-test)	Normality test (Chi^2-test)		Hetero test (Chi^2-test)
	276.047	2.1574	12.13		444.3
		[0.0023]**	[0.5958]		[0.1988]

Heteroskedasticity Tests have no cross terms (only levels and squares), there is not enough observations for cross term Heteroskedasticity tests

A4.3.10. Variance decomposition of unrestricted VAR of South Korea

Variance Decomposition of GDPK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.022886	100	0	0	0	0	0	0
2	0.030223	67.36534	18.5178	2.260224	0.250559	0.152033	11.45143	0.002613
3	0.034013	54.76685	24.52864	1.798977	0.53191	2.828707	15.41939	0.125519
4	0.036631	47.48792	23.78972	1.83507	0.989273	9.905146	15.83573	0.157138
5	0.039132	41.68517	21.0818	2.202981	1.660066	18.44128	14.79095	0.137757
6	0.041431	37.22512	18.82923	2.585722	2.472001	25.23399	13.51981	0.134135
7	0.043272	34.15101	17.44023	2.802377	3.329098	29.62427	12.51447	0.138545
8	0.044582	32.19281	16.67583	2.834401	4.157673	32.16011	11.83944	0.139733
9	0.045434	31.01654	16.27489	2.766523	4.907304	33.47206	11.42547	0.137199
10	0.04595	30.34415	16.06078	2.706802	5.544354	34.02186	11.1879	0.134161

Variance Decomposition of KAPK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.094289	76.35701	23.64299	0	0	0	0	0
2	0.111437	65.75184	21.89156	3.439719	0.064676	2.902967	5.473081	0.476162
3	0.12217	56.68421	25.60086	5.04868	0.105855	2.895658	8.655517	1.00922
4	0.127287	52.74385	27.21429	5.588	0.184419	2.877054	10.18584	1.20655
5	0.130091	50.73328	27.20944	5.59621	0.345064	4.028084	10.8629	1.225019
6	0.132176	49.28501	26.62013	5.445659	0.596575	5.781038	11.07322	1.198367
7	0.133926	48.08837	25.96291	5.304674	0.912379	7.503742	11.05921	1.16871
8	0.135361	47.12273	25.41535	5.196975	1.2545	8.902015	10.96418	1.144245
9	0.136464	46.39449	25.01402	5.11408	1.589791	9.901165	10.86053	1.125913
10	0.137256	45.88351	24.74186	5.057519	1.894355	10.53201	10.7775	1.113247

Variance Decomposition of EMK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.014911	42.86153	0.135608	57.00286	0	0	0	0
2	0.020426	32.90308	8.283657	49.2347	0.158863	2.019313	7.364229	0.036156
3	0.023074	28.57166	14.57443	42.62047	0.188736	3.193717	10.61742	0.233564
4	0.024256	26.53285	17.97071	39.74282	0.211113	2.966128	12.07587	0.500519
5	0.024778	25.64157	19.07678	38.43476	0.270901	3.207211	12.7683	0.600479
6	0.025098	25.1022	19.08911	37.51856	0.39358	4.265747	13.02028	0.610527
7	0.025362	24.65038	18.77841	36.74153	0.579982	5.619908	13.02914	0.600642
8	0.025589	24.25682	18.45092	36.10027	0.808447	6.85753	12.93588	0.590139
9	0.025772	23.93831	18.19283	35.59637	1.051431	7.81779	12.82148	0.581781
10	0.025909	23.70247	18.01325	35.22188	1.285657	8.478125	12.72297	0.575647

Variance Decomposition of HKK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.021214	3.728063	3.713306	7.90483	84.6538	0	0	0
2	0.026624	4.80467	4.9676	7.193227	79.85413	0.181838	1.378085	1.620448
3	0.031406	3.62756	5.436622	18.72765	67.55055	1.342997	1.518104	1.796517
4	0.036494	2.835522	4.416951	30.02575	53.87043	6.015207	1.156828	1.679314
5	0.041976	2.566717	3.379617	36.34271	41.90579	13.26179	0.910503	1.632874
6	0.0474	2.425231	3.223931	38.82662	33.10597	19.8994	0.86082	1.658035
7	0.052163	2.314993	3.693534	39.41914	27.34659	24.60812	0.922065	1.695555
8	0.055932	2.234994	4.376562	39.23521	23.80297	27.60789	1.023096	1.71927
9	0.058666	2.18235	5.049839	38.77504	21.71026	29.42619	1.127468	1.728855
10	0.060495	2.149141	5.624155	38.26694	20.5347	30.47613	1.218891	1.730044

Cholesky Ordering: GDPK KAPK EMK HKK OPENK FDIK TTECHK

A4.3.10. Variance decomposition of unrestricted VAR of South Korea (continued)

Variance Decomposition of OPENK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.05643	6.837478	5.393524	2.830559	3.446841	81.4916	0	0
2	0.076053	3.781514	11.59797	7.359577	1.987406	74.02685	0.37984	0.866836
3	0.085414	3.006688	12.93156	11.01938	1.62027	69.71488	0.492792	1.214435
4	0.090329	2.693429	13.03102	13.27415	1.597663	67.57604	0.547872	1.279831
5	0.093252	2.559507	12.99864	14.30687	1.699191	66.56345	0.592368	1.279974
6	0.095068	2.496055	13.04469	14.64589	1.850464	66.0587	0.630607	1.273591
7	0.096139	2.458913	13.14852	14.68354	2.01447	65.76631	0.659581	1.268667
8	0.096705	2.436631	13.25428	14.62402	2.166057	65.57657	0.678081	1.264372
9	0.096964	2.42475	13.32907	14.56033	2.289545	65.44811	0.687596	1.260604
10	0.097072	2.419355	13.3664	14.52998	2.378969	65.35633	0.690976	1.257994

Variance Decomposition of FDIK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	79.9983	1.355625	5.004603	0.183945	0.160554	3.836852	89.45842	0
2	89.58774	1.081213	5.315961	8.523638	0.312597	4.563962	72.88414	7.318485
3	91.49972	1.229282	5.24758	8.228387	0.314298	6.557551	69.9344	8.488499
4	93.61667	1.179038	5.175274	7.980989	0.375549	10.31539	66.84748	8.126285
5	94.95734	1.264935	5.255463	7.781593	0.583697	12.17329	65.02775	7.913276
6	95.59105	1.349859	5.251549	7.680237	0.83017	12.85303	64.22322	7.811938
7	95.92876	1.386731	5.222996	7.631821	1.049554	13.1366	63.81478	7.757514
8	96.15254	1.402357	5.199648	7.621549	1.227856	13.27577	63.54859	7.724228
9	96.31677	1.413023	5.182148	7.648193	1.367087	13.33403	63.35422	7.701298
10	96.44209	1.423417	5.168689	7.704486	1.471325	13.34011	63.2071	7.68487

Variance Decomposition of TTECHK:

Period	S.E.	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.006641	13.44282	5.74061	7.37834	21.83261	1.524933	0.251778	49.82891
2	0.007991	9.34049	6.142756	16.25927	18.51821	14.5289	0.186985	35.02339
3	0.008408	10.59596	6.828555	16.99747	17.22661	16.07843	0.472851	31.80012
4	0.008504	11.76658	6.677134	16.71255	16.94569	15.81754	0.961881	31.11863
5	0.008554	11.98119	6.959472	16.53518	16.78056	15.64667	1.337654	30.75928
6	0.008591	11.92639	7.201399	16.4705	16.64251	15.72456	1.531351	30.50328
7	0.00863	11.82316	7.211027	16.45187	16.49291	16.19024	1.60333	30.22747
8	0.008676	11.69788	7.135103	16.44862	16.33385	16.85994	1.61607	29.90854
9	0.008723	11.57252	7.073404	16.44694	16.19813	17.50807	1.607113	29.59383
10	0.008764	11.46617	7.04546	16.43328	16.10725	18.02621	1.594003	29.32764

Cholesky Ordering: GDPK KAPK EMK HKK OPENK FDIK TTECHK

A4.3.11. Impulse response effects to Cholesky one S.D innovation of the VAR of South Korea

Response of GDPK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.022886	0	0	0	0	0	0
2	0.009569	-0.013006	0.004544	0.001513	-0.001178	0.010227	-0.000155
3	0.004274	-0.010706	0.000409	0.001966	-0.005598	0.00859	-0.001195
4	0.001896	-0.005953	-0.001952	0.002668	-0.010009	0.005839	-0.00081
5	0.001062	-0.001901	-0.003018	0.003485	-0.012226	0.003743	-3.15E-05
6	0.00081	0.00062	-0.003263	0.004125	-0.012278	0.002362	0.000439
7	0.000697	0.001831	-0.002844	0.004461	-0.011025	0.001503	0.00054
8	0.000634	0.002211	-0.001966	0.004506	-0.009193	0.000996	0.000428
9	0.000624	0.002122	-0.000878	0.00432	-0.007192	0.000726	0.000234
10	0.000663	0.001777	0.000211	0.003971	-0.005235	0.000613	2.47E-05
Response of KAPK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.082392	0.045847	0	0	0	0	0
2	0.037104	-0.024831	0.020668	0.002834	0.018987	0.02607	-0.00769
3	0.017183	-0.033205	0.018066	0.002787	0.008467	0.024743	-0.009566
4	0.009228	-0.024253	0.012322	0.003752	-0.005827	0.018932	-0.006697
5	0.006351	-0.013984	0.006458	0.00534	-0.014682	0.013714	-0.00344
6	0.004943	-0.006771	0.002074	0.00677	-0.018118	0.009806	-0.001429
7	0.003854	-0.002464	-0.000262	0.007708	-0.018328	0.007003	-0.00051
8	0.002983	-3.87E-05	-0.000875	0.008137	-0.016888	0.005032	-0.000183
9	0.002393	0.001223	-0.000389	0.008137	-0.014587	0.003686	-0.000136
10	0.00206	0.001708	0.000651	0.007799	-0.011845	0.002808	-0.00023
Response of EMK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.009762	-0.000549	0.011258	0	0	0	0
2	0.006479	-0.005853	0.00887	0.000814	0.002903	0.005543	0.000388
3	0.003853	-0.00656	0.004637	0.000585	0.002929	0.00508	-0.001045
4	0.001995	-0.005304	0.002627	0.000487	0.000668	0.00381	-0.001304
5	0.00115	-0.003375	0.001465	0.000649	-0.001497	0.00271	-0.000861
6	0.000833	-0.001767	0.000601	0.000903	-0.002679	0.001904	-0.000399
7	0.000662	-0.000738	3.54E-05	0.001119	-0.003046	0.001339	-0.000133
8	0.000521	-0.000159	-0.000215	0.00125	-0.002959	0.000946	-2.50E-05
9	0.000408	0.000147	-0.000222	0.0013	-0.00265	0.000676	2.85E-06
10	0.000335	0.000288	-8.57E-05	0.001283	-0.002233	0.000497	-5.28E-06
Response of HKK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	-0.004096	0.004088	-0.005964	0.019518	0	0	0
2	-0.004157	0.004301	0.003926	0.013605	0.001135	-0.003125	-0.003389
3	-0.001312	0.004291	0.011564	0.010011	0.003458	-0.002281	-0.002497
4	0.001408	0.002281	0.014669	0.007154	0.008177	-0.000658	-0.002155
5	0.002731	-0.00085	0.015507	0.004573	0.012392	0.000797	-0.002531
6	0.003044	-0.00359	0.015231	0.002332	0.014609	0.001816	-0.002912
7	0.002916	-0.005298	0.014152	0.00055	0.014917	0.002398	-0.002981
8	0.002632	-0.006035	0.012444	-0.000744	0.013932	0.00263	-0.002766
9	0.002278	-0.006073	0.010348	-0.001595	0.012209	0.002607	-0.002391
10	0.001882	-0.005659	0.008119	-0.002073	0.010127	0.002409	-0.001952

A4.3.11. Impulse response effects to Cholesky one S.D innovation of the VAR of South Korea (continued)

Response of OPENK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.014756	-0.013105	0.009494	0.010477	0.050941	0	0
2	0.000998	-0.02234	0.018318	0.002279	0.04107	0.004687	-0.007081
3	-0.000794	-0.016511	0.019448	-0.001804	0.028361	0.003739	-0.006202
4	0.000643	-0.010947	0.016708	-0.003486	0.020682	0.002958	-0.003978
5	0.001675	-0.008191	0.01269	-0.004171	0.016568	0.002609	-0.002623
6	0.001737	-0.006972	0.00892	-0.004414	0.01349	0.002341	-0.001949
7	0.001297	-0.006028	0.005788	-0.004353	0.01041	0.001993	-0.001468
8	0.000772	-0.004921	0.003231	-0.004046	0.007344	0.001565	-0.00099
9	0.000326	-0.0037	0.001164	-0.003563	0.004566	0.001111	-0.00053
10	-1.70E-05	-0.002513	-0.000441	-0.002984	0.002254	0.00068	-0.000136
Response of FDIK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	9.314306	-17.8964	-3.431035	3.205466	15.66997	75.66436	0
2	0.14644	-10.31388	-25.92937	-3.84888	10.98881	11.16061	-24.2359
3	-4.017487	-3.561005	-2.189243	-1.106687	-13.517	2.322056	-11.10383
4	0.643367	3.771912	3.250133	2.569001	-18.84245	1.876133	-1.232945
5	3.275054	4.507168	1.482555	4.440486	-13.91416	2.217718	1.156632
6	3.047551	2.447124	0.367228	4.819408	-8.764232	2.237795	0.543674
7	2.065451	0.876947	0.715574	4.552515	-5.86588	1.988018	-0.210448
8	1.428553	0.294002	1.526661	4.115297	-4.30265	1.679281	-0.507031
9	1.196955	0.141592	2.209266	3.647528	-3.098589	1.43351	-0.560575
10	1.143715	0.003041	2.661467	3.166305	-1.945953	1.2731	-0.576574
Response of TTECHK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.002435	0.001591	-0.001804	0.003103	0.00082	-0.000333	0.004688
2	-0.000187	-0.001179	-0.00267	0.001481	0.002933	-9.13E-05	0.00062
3	-0.001236	-0.000952	-0.001279	0.000596	0.001446	-0.000464	-0.000345
4	-0.001009	2.83E-05	-0.000262	0.000274	0.000267	-0.000601	-0.000144
5	-0.000508	0.000514	0.000117	0.000157	0.000103	-0.000532	6.40E-05
6	-0.000188	0.000472	0.000239	6.71E-05	0.000396	-0.000389	7.79E-05
7	-5.90E-05	0.000236	0.000312	-2.69E-05	0.000673	-0.000253	1.13E-05
8	-1.88E-05	2.41E-05	0.00036	-0.000111	0.000796	-0.00015	-4.41E-05
9	-4.67E-06	-0.000106	0.000365	-0.000173	0.000794	-7.98E-05	-6.68E-05
10	2.31E-06	-0.000169	0.000325	-0.000211	0.000722	-3.57E-05	-6.68E-05

Cholesky Ordering: GDPK KAPK EMK HKK OPENK FDIK TTECHK

4.3.12. Impulse response effects to generalized one S.D innovation of the VAR of South Korea

Response of GDPK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.022886	0.019998	0.014983	-0.004419	0.005984	0.002665	0.008391
2	0.009569	0.002038	0.010174	-0.004239	0.005504	0.013332	-0.000903
3	0.004274	-0.001471	0.003501	-0.001194	-0.001016	0.009982	-0.002156
4	0.001896	-0.001238	-1.36E-05	0.001491	-0.00699	0.005305	-0.001055
5	0.001062	3.98E-06	-0.001513	0.003484	-0.010179	0.001963	0.000663
6	0.00081	0.001009	-0.001957	0.004676	-0.010799	8.96E-05	0.001934
7	0.000697	0.0015	-0.001758	0.005123	-0.009846	-0.000766	0.002496
8	0.000634	0.001629	-0.001151	0.005002	-0.008141	-0.001014	0.002518
9	0.000624	0.001577	-0.000333	0.00451	-0.006168	-0.000913	0.002235
10	0.000663	0.001443	0.000528	0.003809	-0.004192	-0.000616	0.001807
Response of KAPK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.082392	0.094289	0.052253	-0.007074	0.010897	-0.000663	0.041193
2	0.037104	0.020349	0.04081	-0.015152	0.036612	0.037479	-0.001027
3	0.017183	-0.00113	0.026112	-0.012231	0.023405	0.033827	-0.012209
4	0.009228	-0.003729	0.016238	-0.006467	0.005555	0.022887	-0.010418
5	0.006351	-0.00125	0.009549	-0.000823	-0.006267	0.0139	-0.00521
6	0.004943	0.001027	0.005051	0.003386	-0.011885	0.007998	-0.000949
7	0.003854	0.00217	0.002416	0.005947	-0.013578	0.004354	0.001521
8	0.002983	0.002588	0.001294	0.007149	-0.013093	0.002171	0.002657
9	0.002393	0.002686	0.001228	0.007369	-0.011381	0.000977	0.002996
10	0.00206	0.002631	0.001777	0.006924	-0.008993	0.000478	0.002866
Response of EMK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.009762	0.008263	0.014911	-0.005156	0.004574	0.000777	0.00039
2	0.006479	0.002816	0.011155	-0.004124	0.007317	0.007527	-0.000701
3	0.003853	0.000177	0.006265	-0.002774	0.006064	0.007119	-0.001777
4	0.001995	-0.000836	0.003484	-0.001698	0.002889	0.00506	-0.002055
5	0.00115	-0.000636	0.001983	-0.000687	0.000101	0.003122	-0.001411
6	0.000833	-0.000131	0.001064	0.000161	-0.001522	0.001778	-0.000567
7	0.000662	0.00022	0.000487	0.000749	-0.002192	0.000955	4.16E-05
8	0.000521	0.000378	0.000184	0.00108	-0.002302	0.000471	0.000365
9	0.000408	0.000428	9.39E-05	0.001208	-0.002116	0.000197	0.000493
10	0.000335	0.000433	0.000144	0.001196	-0.001771	6.22E-05	0.00051
Response of HKK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	-0.004096	-0.001591	-0.007335	0.021214	0.0006	-0.000354	0.010218
2	-0.004157	-0.001541	8.44E-05	0.013045	0.002125	-0.003803	0.002701
3	-0.001312	0.00094	0.007714	0.00704	0.005586	-0.002688	0.000863
4	0.001408	0.00234	0.011913	0.002625	0.011016	0.000291	-5.76E-05
5	0.002731	0.001974	0.013527	-0.000843	0.015556	0.003208	-0.001574
6	0.003044	0.000914	0.013624	-0.003416	0.017813	0.005177	-0.003134
7	0.002916	-2.80E-05	0.012789	-0.005056	0.017942	0.006129	-0.00417
8	0.002632	-0.000634	0.01134	-0.005855	0.016622	0.00631	-0.004573
9	0.002278	-0.000962	0.009528	-0.005987	0.014473	0.005974	-0.004486
10	0.001882	-0.001107	0.00757	-0.005644	0.01193	0.005316	-0.004089

A4.3.12. Impulse response effects to generalized one S.D innovation of the VAR of South Korea (continued)

Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
Response of OPENK:							
1	0.014756	0.006521	0.017311	0.001596	0.05643	0.014641	0.010877
2	0.000998	-0.00999	0.015306	-0.007551	0.046029	0.016898	-0.009059
3	-0.000794	-0.008722	0.014772	-0.010156	0.032166	0.011787	-0.011436
4	0.000643	-0.00476	0.013439	-0.010139	0.023544	0.008517	-0.008957
5	0.001675	-0.002519	0.010979	-0.009308	0.018658	0.00703	-0.006681
6	0.001737	-0.001872	0.008128	-0.008248	0.014932	0.006059	-0.005346
7	0.001297	-0.001797	0.005441	-0.007045	0.011302	0.005	-0.004426
8	0.000772	-0.001718	0.003126	-0.005729	0.007767	0.003809	-0.003535
9	0.000326	-0.001514	0.001228	-0.004382	0.004601	0.002618	-0.002614
10	-1.70E-05	-0.001237	-0.000252	-0.003103	0.001986	0.001544	-0.001735
Response of FDIK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	9.314306	-0.562881	4.166553	-1.333126	20.75539	79.9983	-0.304706
2	0.14644	-4.887065	-19.10105	1.733168	7.276479	15.99068	-13.4837
3	-4.017487	-5.242086	-4.151947	-0.313217	-12.99945	-0.073016	-11.87248
4	0.643367	2.396247	2.736162	2.052504	-16.69358	-2.721707	-1.834131
5	3.275054	5.053392	3.097492	3.904926	-11.67721	-1.140554	2.939753
6	3.047551	3.852917	2.182335	4.214101	-6.726598	0.384578	3.045036
7	2.065451	2.23125	1.860191	3.757654	-3.993269	0.927341	1.927532
8	1.428553	1.391261	2.077061	3.13798	-2.557969	0.945484	1.128913
9	1.196955	1.114777	2.446418	2.531027	-1.468196	0.907989	0.726722
10	1.143715	1.000886	2.758078	1.944708	-0.422688	0.968167	0.465412
Response of TTECHK:							
Period	GDPK	KAPK	EMK	HKK	OPENK	FDIK	TTECHK
1	0.002435	0.002901	0.000174	0.003199	0.00128	-2.53E-05	0.006641
2	-0.000187	-0.000736	-0.002094	0.001922	0.002699	0.000904	0.001871
3	-0.001236	-0.001543	-0.001739	0.000963	0.001098	-7.57E-06	-9.73E-05
4	-0.001009	-0.000868	-0.000859	0.000526	-2.29E-05	-0.000618	-0.000203
5	-0.000508	-0.000194	-0.000263	0.000309	-0.00011	-0.000656	6.31E-05
6	-0.000188	6.48E-05	3.97E-05	0.000122	0.000251	-0.000426	0.000134
7	-5.90E-05	6.32E-05	0.000188	-5.55E-05	0.000585	-0.000181	4.14E-05
8	-1.88E-05	-4.68E-06	0.000258	-0.000195	0.000748	-1.32E-05	-7.59E-05
9	-4.67E-06	-5.56E-05	0.000276	-0.000281	0.00077	8.07E-05	-0.000152
10	2.31E-06	-8.00E-05	0.000253	-0.000319	0.000707	0.000123	-0.000183

A4.3.13. Vector Error Correction model of South Korea

Standard errors in ( ) & t-statistics in [ ]

Cointegration Restrictions: $\beta(1,6)=1$, $\beta(2,1)=1$, $\beta(3,2)=1$, $\beta(2,2)=-1$, $\beta(2,3)=-1$, $\beta(3,1)=-1$, $\beta(1,3)=0$, $\beta(1,4)=0$, $\beta(1,5)=0$, $\beta(3,5)=0$, $\alpha(1,1)=0$, $\alpha(3,1)=0$, $\alpha(5,3)=0$, $\alpha(5,1)=0$, $\alpha(4,1)=0$, $\alpha(1,2)=0$			
Convergence achieved after 1299 iterations, Restrictions identify all cointegrating vectors			
LR test for binding restrictions (rank = 3): Chi-square(7)= 2.44065; Probability: 0.9315			
Cointegrating Eq:	CointEq1	CointEq2	CointEq3
GDPK(-1)	-98.46702	1	-1
	-80.3925		
	[-1.22483]		
KAPK(-1)	-436.9603	-1	1
	-27.9943		
	[-15.6089]		
EMK(-1)	0	-1	2.941169
			-0.36171
			[8.13129]
HKK(-1)	0	-1.644595	-0.838896
		-0.26418	-0.09739
		[-6.22526]	[-8.61417]
OPENK(-1)	0	1.478753	0
		-0.20098	
		[7.35778]	
FDIK(-1)	1	0.001473	-0.002294
		-0.00025	-9.20E-05
		[5.78049]	[-24.8233]
TTECHK(-1)	-682.7964	-8.2889	4.365825
	-1717.29	-4.8198	-4.11636
	[-0.39760]	[-1.71976]	[1.06060]
TREND	52.23943	0.018962	-0.096019
	-5.14816	-0.01048	-0.011
	[10.1472]	[1.80907]	[-8.72785]
C	15888.6	16.06069	-46.04927

A4.3.13. Vector Error Correction model of South Korea (continued)

Standard errors in ( ) & t-statistics in [ ]

Error	D(GDPK)	D(KAPK)	D(EMK)	D(HKK)	D(OPENK)	D(FDIK)	D(TTECHK)
CointEq1	0	-0.001241	0	0	0	-3.854742	-0.000391
	0	-0.00057	0	0	0	-0.90436	-5.50E-05
	[NA]	[-2.16915]	[NA]	[NA]	[NA]	[-4.26238]	[-7.12979]
CointEq2	0	0.237416	0.019059	0.083107	0.069795	383.0251	0.052697
	0	-0.07455	-0.00749	-0.01332	-0.03053	-117.863	-0.00755
	[NA]	[3.18454]	[2.54386]	[6.24007]	[2.28589]	[3.24976]	[6.98221]
CointEq3	-0.070404	-0.560411	-0.030036	0.084267	0	-1123.552	-0.132833
	-0.01365	-0.1982	-0.00894	-0.01437	0	-301.204	-0.01851
	[-5.15930]	[-2.82753]	[-3.36121]	[5.86499]	[NA]	[-3.73020]	[-7.17549]
C	0.099731	0.186526	0.045466	0.023715	0.07683	-61.89695	0.004939
	-0.00706	-0.03024	-0.00406	-0.0061	-0.01716	-23.1259	-0.00194
	[14.1338]	[6.16764]	[11.1910]	[3.88852]	[4.47687]	[-2.67652]	[2.54963]
DUMMY	-0.132693	-0.413858	-0.084252	-0.003896	-0.081917	270.4925	-0.015143
	-0.02274	-0.09747	-0.01309	-0.01965	-0.05531	-74.5296	-0.00624
	[-5.83508]	[-4.24621]	[-6.43475]	[-0.19820]	[-1.48111]	[3.62933]	[-2.42553]
R-squared	0.54875	0.37504	0.582695	0.659512	0.146733	0.522555	0.426222
Adj. R-squared	0.490525	0.2944	0.52885	0.615578	0.036634	0.46095	0.352186
Sum sq. resids	0.019496	0.358124	0.006463	0.014563	0.115321	209406.6	0.001469
S.E. equation	0.025078	0.107482	0.014439	0.021675	0.060992	82.18912	0.006885
F-statistic	9.424534	4.650797	10.82156	15.01146	1.332738	8.482251	5.756957
Log likelihood	84.29775	31.9053	104.1716	89.54793	52.30212	-207.115	130.8337
Akaike AIC	-4.405431	-1.494739	-5.509535	-4.697107	-2.627896	11.78417	-6.990759
Schwarz SC	-4.185497	-1.274806	-5.289602	-4.477174	-2.407962	12.0041	-6.770826
Mean Dependent	0.066558	0.083061	0.024403	0.022741	0.056351	5.726184	0.001153
S.D. dependent	0.035134	0.127955	0.021036	0.034958	0.062141	111.9437	0.008554
Determinant resid covariance (dof adj.)			2.71E-17				
Determinant resid covariance			9.50E-18				
Log likelihood			347.0563				
Akaike information criterion			-16.00313				
Schwarz criterion			-13.40791				

A4.3.14. Roots of companion matrix

Root	Modulus
1	1
1	1
1	1
1	1
0.851379	0.851379
0.144391 - 0.079753i	0.164952
0.144391 + 0.079753i	0.164952

A4.3.15. Cointegrating vectors

obs	COINTEQ01	COINTEQ02	COINTEQ03
1970	NA	NA	NA
1971	-76.11356	0.18426	0.25265
1972	-94.80425	0.170636	0.29173
1973	166.6284	0.578373	-0.245065
1974	-126.771	0.221925	0.435057
1975	-204.5153	-0.2046	0.645511
1976	-133.9896	-0.117607	0.427405
1977	-164.4	0.035865	0.523327
1978	-203.6067	-0.030955	0.551892
1979	-287.7504	-0.363499	0.784974
1980	-311.6887	-0.510751	0.767303
1981	-176.1775	-0.215553	0.452529
1982	-123.9512	-0.296823	0.287919
1983	-116.6957	-0.295559	0.266913
1984	-142.4504	-0.445944	0.249625
1985	-164.0061	-0.673664	0.215575
1986	-129.1225	-0.733495	0.209226
1987	-95.72654	-0.419579	0.105898
1988	-117.4852	-0.380809	0.224649
1989	-131.1214	-0.375192	0.252602
1990	-166.2334	-0.463998	0.388934
1991	-202.0507	-0.639416	0.433451
1992	-203.4341	-0.576903	0.461584
1993	-193.5071	-0.564384	0.409895
1994	-162.595	-0.468467	0.281521
1995	-178.0564	-0.527901	0.332336
1996	-161.2777	-0.38959	0.312075
1997	-122.7943	-0.320459	0.2249
1998	1.876328	0.007831	-0.043355
1999	483.9405	0.784455	-1.264559
2000	700.3853	1.172032	-1.756956
2001	592.4902	1.047961	-1.386713
2002	356.3586	0.718597	-0.82902
2003	307.3886	0.732663	-0.693209
2004	379.5965	0.892329	-0.866824
2005	661.6954	1.345771	-1.489092
2006	539.9647	1.122449	-1.214688

A4.3.16. Perron (1997) break test for cointegrating vectors

Perron (1997) break test for Cointegrating Vectors CV1

Series	Obs	Mean	Std Error	Minimum	Maximum
CV1	36	0.000000	290.229080	-311.688682	700.385286

Table: Phillip Perron Test (1997) for GER: Model IO1 and Method UR

break date TB = 97:01 statistic t(alpha==1) = -7.51595.

Critical values at	1%	5%	10%	50%	90%	95%	99%
for 60 obs.	-5.92	-5.23	-4.92	-3.91	-3.00	-2.74	-2.25

number of lag retained : 1

explained variable : CV1

	coefficient	student
CONSTANT	-114.09671	-2.72267
DU	614.30704	6.72873
D(Tb)	-451.78404	-3.96423
TIME	-1.96288	-0.84020
CV1 {1}	0.05997	0.47949

Perron (1997) break test for Cointegrating Vectors: CV2

Series	Obs	Mean	Std Error	Minimum	Maximum
CV2	37	0.021201	0.610255	-0.733495	1.345771

Table:
Phillip Perron Test (1997) for GER
Model IO1 and Method UR

break date TB = 97:01 statistic t(alpha==1) = -2.17807

critical values at	1%	5%	10%	50%	90%	95%	99%
for 60 obs.	-5.92	-5.23	-4.92	-3.91	-3.00	-2.74	-2.25

number of lag retained : 2

explained variable : CV2

	coefficient	student
CONSTANT	-0.13113	-1.59459
DU	0.97468	5.24840
D(Tb)	-0.52650	-2.68992
TIME	-0.00345	-0.43589
CV2 {1}	0.56634	2.84451

Perron (1997) break test for Cointegrating Vectors: CV3

Series	Obs	Mean	Std Error	Minimum	Maximum
CV3	37	-0.034177	0.712092	-1.756956	0.784974

Table: Phillip Perron Test (1997) for GER: Model IO1 and Method UR

break date TB = 97:01 statistic t(alpha==1) = -5.31520

critical values at	1%	5%	10%	50%	90%	95%	99%
for 60 obs.	-5.92	-5.23	-4.92	-3.91	-3.00	-2.74	-2.25

number of lag retained : 5

explained variable : CV3

	coefficient	student
CONSTANT	0.45119	4.58697
DU	-1.19050	-13.18200
D(Tb)	1.01047	9.31520
TIME	-0.00906	-2.86143
CV3 {1}	0.18336	1.19341

A4.3.17. Formation of capital stocks in Korea

Capital stock1 is calculated with depreciation rate 0.10; capital stock 2 is calculated with depreciation rate 0.20.

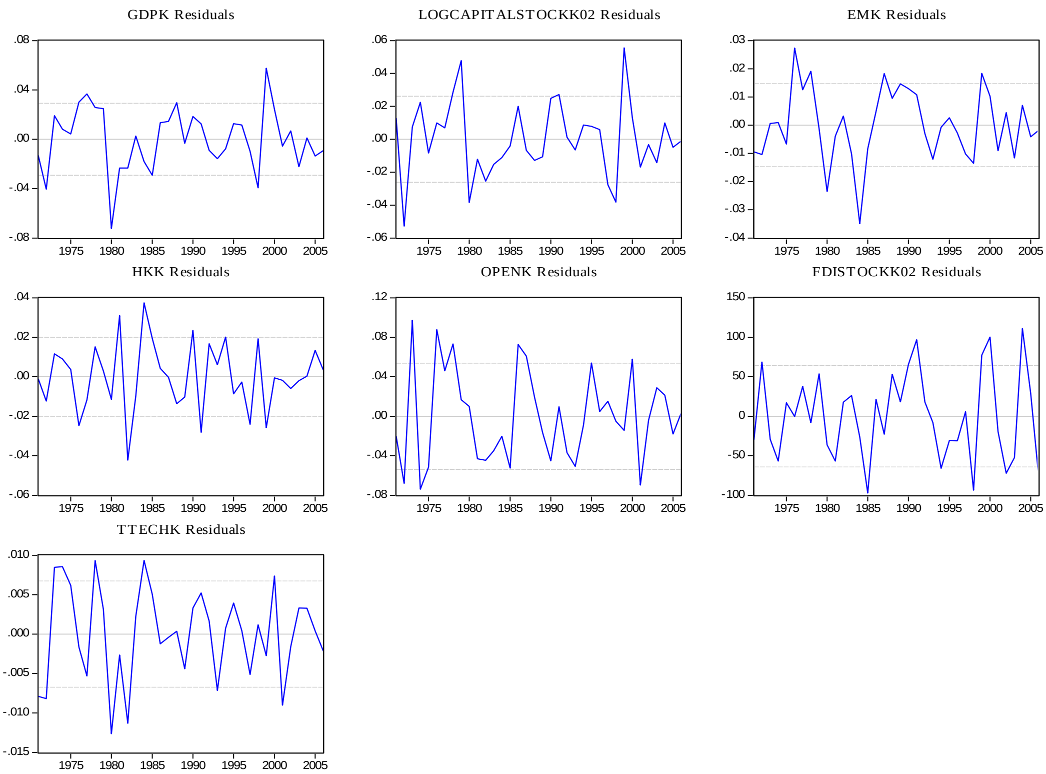
A4.3.17.1. Covariance of capital formation and arbitrary capital stock series

Covariance Correlation	KAPK	LOGCAPITALSTOCKK02	LOGKAPSTOCKK01
KAPK	0.903528 1		
LOGCAPITALSTOCKK02	1.044355 0.992318	1.225892 1	
LOGKAPSTOCKK01	1.142132 0.989455	1.343912 0.999529	1.474683 1

A4.3.17.2. Correlation of FDI and arbitrary FDI stock series

Covariance Correlation	FDISTOCKK01	FDISTOCKK02	KFDI
FDISTOCKK01	659080.3 1		
FDISTOCKK02	469287 0.992844	338982.2 1	
FDIK	113635.9 0.791156	86600.27 0.840711	31301.71 1

A4.3.17.3. Residuals of VAR in first difference with arbitrary capital stock in figures



A 4.3.17.4. Residuals of VAR in first difference with arbitrary capital stock

Period	GDPK	LOGKAPSTOCK02	EMK	HKK	OPENK	FDISTOCKKK02	TTECHK
1970	-0.013101	0.012999	-0.009444	-0.001033	-0.020103	-29.80346	-0.007891
1971	-0.04043	-0.052723	-0.010427	-0.012284	-0.067991	68.53058	-0.008182
1972	0.019125	0.007495	0.00063	0.011642	0.097112	-29.27019	0.008465
1973	0.008165	0.022474	0.000963	0.009029	-0.073838	-56.62686	0.008536
1974	0.00439	-0.008383	-0.006671	0.003688	-0.051534	17.0606	0.006175
1975	0.03012	0.009985	0.027341	-0.024749	0.087599	-0.359992	-0.001648
1976	0.036758	0.006912	0.01256	-0.011766	0.046131	37.8546	-0.005313
1977	0.02572	0.028527	0.019103	0.015159	0.073264	-8.323267	0.009308
1978	0.024872	0.047734	-0.001209	0.002952	0.01672	53.57751	0.003133
1979	-0.072258	-0.038304	-0.023488	-0.011435	0.010008	-36.22095	-0.012612
1980	-0.023318	-0.012175	-0.003932	0.030968	-0.04302	-56.84389	-0.002658
1981	-0.023238	-0.025515	0.003231	-0.042233	-0.044657	17.68796	-0.011287
1982	0.002609	-0.015256	-0.010225	-0.009746	-0.035031	26.21924	0.002254
1983	-0.017997	-0.011097	-0.034926	0.03749	-0.020359	-26.46408	0.009344
1984	-0.029133	-0.004066	-0.00839	0.019449	-0.052426	-97.33233	0.005043
1985	0.013488	0.020042	0.004856	0.004274	0.072653	21.34562	-0.001238
1986	0.014543	-0.00668	0.018282	-0.000273	0.060966	-22.76605	-0.000413
1987	0.029627	-0.01287	0.009516	-0.013639	0.019246	53.1312	0.000359
1988	-0.003173	-0.010669	0.014615	-0.010337	-0.016542	18.36266	-0.004396
1989	0.018504	0.024859	0.01296	0.0235	-0.045235	65.52113	0.00331
1990	0.012428	0.027201	0.010803	-0.028167	0.009663	96.89875	0.005201
1991	-0.008949	0.001252	-0.002974	0.016743	-0.036887	18.03991	0.001656
1992	-0.015718	-0.006476	-0.012078	0.006148	-0.050838	-8.080034	-0.007155
1993	-0.00764	0.008638	-0.000716	0.020065	-0.008853	-65.96469	0.000756
1994	0.012724	0.007831	0.002603	-0.008653	0.053949	-30.83469	0.003939
1995	0.011627	0.00595	-0.002789	-0.002698	0.004805	-31.17145	0.000423
1996	-0.009748	-0.027686	-0.010193	-0.024094	0.015197	5.832199	-0.005109
1997	-0.039341	-0.038145	-0.013498	0.019245	-0.005103	-93.63902	0.001173
1998	0.057602	0.055524	0.018348	-0.025852	-0.014396	77.25292	-0.002739
1999	0.024233	0.013044	0.010233	-0.000526	0.057823	100.1553	0.007355
2000	-0.005583	-0.01692	-0.009083	-0.001798	-0.069669	-19.35728	-0.009011
2001	0.006851	-0.003242	0.004482	-0.005958	-0.004159	-72.11279	-0.001596
2002	-0.022217	-0.014289	-0.011643	-0.002	0.028778	-52.40056	0.003301
2003	0.001093	0.009939	0.007038	0.000271	0.021338	110.9729	0.00328
2004	-0.013609	-0.004861	-0.004133	0.013318	-0.017931	28.79519	0.000402
2005	-0.009028	-0.00105	-0.001744	0.003299	0.003318	-79.66668	-0.002165
2006	-0.013101	0.012999	-0.009444	-0.001033	-0.020103	-29.80346	-0.007891

APPENDIX TO CHAPTER FIVE

A5.1. Variance-covariance matrix of exogenous variables in level

	interest	inflat	bc	rmb	gee	gtran	pc	tax	wage	libdummy
interest	0.001324	0.001834	0.012606	0.006546	0.010475	-0.00724	0.213454	-0.00828	-0.01681	0.001106
inflat	0.001834	0.003819	0.012298	0.009116	0.009125	-0.0115	0.212567	-0.00957	-0.02256	0.00087
bc	0.012606	0.012298	1.225322	0.668149	1.130476	0.257176	9.388998	-0.33742	-0.25566	0.389372
rmb	0.006546	0.009116	0.668149	0.41985	0.581929	0.111919	4.69093	-0.19787	-0.14401	0.224974
gee	0.010475	0.009125	1.130476	0.581929	1.07572	0.275065	8.783529	-0.29291	-0.20278	0.358373
gtran	-0.007241	-0.0115	0.257176	0.111919	0.275065	0.189584	1.112872	-0.00204	0.090533	0.099541
pc	0.213454	0.212567	9.388998	4.69093	8.783529	1.112872	96.39924	-3.04216	-3.15106	2.546251
tax	-0.008276	-0.00957	-0.33742	-0.19787	-0.292905	-0.00204	-3.04216	0.133151	0.14242	-0.09941
wage	-0.016814	-0.02256	-0.25566	-0.14401	-0.202783	0.090533	-3.15106	0.14242	0.301768	-0.03827
libdummy	0.001106	0.00087	0.389372	0.224974	0.358373	0.099541	2.546251	-0.09941	-0.03827	0.137765

Det=4.1384E-17

A5.2 Eigen-values of the companion matrix from 2SLS estimations in level

Root	Modulus
-11.17047	11.17047
1.5591867	1.559187
0.982871	0.982871
0.4894756	0.489476
-0.173855	0.173855
0.0718504	0.07185
-1.27E-07	1.27E-07
0	0
0	0

A5.3. Results of unrestricted system in first difference

A5.3.1. Stability condition

Roots and modulus of the companion matrix

Root	Modulus
0.720766	0.720766
-0.0206755+0.568414i	0.56879
-0.0206755-0.568414	0.56879
0.391135	0.391135
-0.326527+0.109163i	0.344292
-0.326527-0.109163i	0.344292
0.278448	0.278448
0.0189334	0.0189334
0	0

A5.3.2. Wald Test on significance from the unrestricted system

System Test:			
Test Statistic	Value	df	Probability
Chi-square	19.81371	14	0.1361
Individual Test:	Normalized Restriction (= 0)		
Equations	Variables	Value	Std. Err.
Equation of DGDP			
	DHK	0.123943	0.082440
	DFDI	-0.001461	0.002547
	DSAV(-1)	-0.030972	0.091534
	dtax(-1)	-0.025014	0.024623
Equation of DKAP			
	DGDP	0.026732	0.026622
	DOPEN	-0.000500	0.076633
	DKAP(-1)	-0.129445	0.083855
	DOPEN(-1)	0.070531	0.073124
	DFDI(-1)	0.000354	0.001889
	dinterest(-1)	-0.001254	0.007364
Equation of DEM			
	dinflat	-0.021003	0.049241
Equation of DHK			
	DTTECH	-0.063953	0.053836
Equation of DTTECH			
	DFDI	-0.019918	0.015010
Equation of DSAV			
	dpc(-1)	-0.013894	0.009268

A5.3.3. Residuals of the unrestricted system in first difference

obs	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
1970	NA	NA	NA	NA	NA	NA	NA	NA	NA
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	-0.005275	0.014985	0.003392	-0.000530	0.136126	0.026554	-0.168425	0.067404	0.020245
1974	-0.019716	-0.000444	-0.003569	0.028905	0.171789	0.636924	0.394340	0.000125	-0.044195
1975	0.011590	0.037717	-0.001364	0.060519	-0.111967	-2.136059	0.104456	-0.000721	-0.046965
1976	-0.042681	-0.059097	-0.005218	0.002445	0.039131	1.481838	0.101312	0.020552	-0.038849
1977	0.020975	0.035607	-0.007495	-0.074811	-0.046285	-0.220419	0.066984	-0.019036	0.007896
1978	-0.015464	0.025382	-0.001265	-0.042297	0.202799	0.564169	-0.005907	0.111667	-0.017193
1979	0.013867	0.016049	0.000179	-0.008516	0.041124	-1.244848	-0.100125	-0.001980	0.113400
1980	0.004625	-0.018779	0.008979	-0.019475	-0.103023	0.479434	-0.043350	0.029036	0.041934
1981	-0.024793	-0.032256	0.005830	-0.040905	0.003553	0.278732	0.027041	-0.031778	-0.007123
1982	0.004933	-0.003591	0.009369	0.027389	-0.028852	-0.620017	-0.506889	0.019311	-0.024763
1983	0.023511	0.056238	-0.005072	-0.003078	-0.096276	-0.945771	-0.025103	-0.022636	0.024334
1984	0.001155	-0.151502	0.013993	0.044087	0.113870	1.544802	0.250332	-0.029172	0.063164
1985	0.008509	0.008809	0.008140	-0.032145	0.007053	-0.916567	0.187018	-0.028736	0.037779
1986	0.004705	0.053685	-0.010382	-0.019946	-0.070139	0.062131	-0.100705	-0.009523	0.082271
1987	0.027500	-0.000817	0.003935	0.003150	-0.067402	0.740248	-0.149769	0.019294	0.036409
1988	0.012521	-0.042432	0.005630	-0.019502	-0.042466	-0.354369	-0.116062	-0.079831	-0.092203
1989	-0.018318	0.026105	-0.019060	0.017747	0.018291	0.422211	0.031482	0.034939	0.003130
1990	-0.009061	-0.040828	0.087501	0.024147	0.016085	0.177229	0.108002	-0.012192	0.084445
1991	0.006588	0.021426	-0.004922	-0.001530	0.012109	-0.096293	0.195728	0.021403	0.041735
1992	0.024347	0.060321	-0.004189	0.034057	-0.017231	-0.854322	-0.069799	-0.028959	0.049658
1993	0.013191	0.057346	-0.005650	0.009421	-0.055648	-0.643829	0.040239	0.030713	-0.002878
1994	-0.002946	-0.006251	-0.034631	0.004040	-0.009001	-0.075046	-0.093954	-0.030772	-0.050831
1995	0.005567	0.018768	-0.010415	-0.041312	0.090931	0.305570	0.026004	0.009059	-0.028807
1996	0.028217	0.099575	-0.008015	-0.025922	0.009770	-0.687220	-0.042487	0.003019	-0.034998
1997	-0.000219	-0.015953	0.017025	0.042957	0.027271	-0.241820	-0.179557	0.054221	0.000552
1998	-0.002799	-0.018082	-0.000940	-0.027024	-0.081138	1.530264	-0.028870	0.009288	-0.046545
1999	0.018141	0.014311	0.017006	-0.038327	-0.144411	-0.890435	-0.090621	-0.048016	-0.010704
2000	-0.003473	-0.046765	-0.000256	0.010242	0.144430	1.028328	-0.027356	-0.083196	-0.056856
2001	-0.033078	-0.076543	-0.006158	0.037522	0.036317	1.620185	0.034259	-0.010108	-0.034257
2002	-0.012881	-0.018045	-0.010832	0.022144	0.016808	-0.391627	-0.078212	0.021442	0.032959
2003	-0.014420	0.018339	-0.007687	-0.002278	-0.071468	-0.281422	0.043515	0.029896	0.000869
2004	-0.009708	0.009167	-0.008427	-0.004409	-0.041601	-0.056272	0.190654	-0.012005	-0.062190
2005	-0.012704	-0.031959	-0.013577	0.009881	-0.040082	-0.153237	0.024580	0.020142	-0.033280
2006	-0.002403	-0.010484	-0.011855	0.023353	-0.060471	-0.089046	0.001245	0.005633	-0.008143

A5.4 Results of the final restricted system in first difference.

A5.4.1. Residuals of the restricted system

Year	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
1970	NA	NA	NA	NA	NA	NA	NA	NA	NA
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	-0.003679	0.036819	0.002262	-0.004307	0.130327	-0.080355	-0.158465	0.072484	0.030420
1974	-0.024165	0.025826	-0.002844	0.019848	0.180960	0.882068	0.346720	7.34E-05	-0.021099
1975	0.015057	0.061626	-0.000641	0.068221	-0.119321	-1.957840	0.091135	0.004322	-0.029331
1976	-0.040577	-0.046649	-0.004782	-0.009208	0.036296	1.342544	0.097015	9.27E-05	-0.067185
1977	0.013036	0.064079	-0.007580	-0.069826	-0.044192	-0.200598	0.100287	-0.009211	-0.014747
1978	-0.030777	-0.005802	-0.001431	-0.061777	0.244816	0.637610	0.023041	0.123022	-0.026605
1979	-0.001140	0.031493	-0.000330	-0.017513	0.054501	-1.355981	0.020686	0.040789	0.175269
1980	0.000935	0.009281	0.009937	-0.034481	-0.076357	0.454762	-0.127820	0.020604	0.047672
1981	-0.025721	-0.013082	0.007870	-0.041085	-0.026994	0.654229	-0.035699	-0.000772	-0.020137
1982	0.024492	0.016654	0.011515	0.033352	-0.056175	-0.793140	-0.515188	0.008217	-0.022615
1983	0.013920	0.054880	0.000545	0.008643	-0.026279	-1.152080	-0.010889	-0.020703	0.001400
1984	0.010092	-0.159316	0.014547	0.050572	0.074111	1.449010	0.233675	-0.031613	0.055284
1985	0.021128	0.035286	0.009539	-0.047822	-0.036589	-1.016543	0.217279	-0.047020	0.042759
1986	0.001545	0.040549	0.003701	-0.010978	-0.132773	-0.081782	-0.098133	-0.012593	0.082025
1987	0.022789	-0.032166	0.005699	0.024522	-0.076771	0.859441	-0.158420	0.027274	0.020382
1988	0.025679	-0.038098	0.005653	-0.019660	-0.009173	-0.615437	-0.093801	-0.074913	-0.109920
1989	-0.012226	0.042666	-0.005179	-0.004441	0.043867	0.325496	0.034717	0.033422	-0.014121
1990	-0.011775	-0.048943	0.109331	0.004683	0.031587	0.109035	0.119531	-0.008131	0.076041
1991	0.006110	0.032882	-0.012532	-0.004683	0.017788	-0.058279	0.227192	-0.013394	0.012311
1992	0.028714	0.052737	-0.011439	0.025851	-0.017970	-0.836635	-0.031648	-0.024090	0.011072
1993	0.018140	0.050942	-0.008138	0.000479	-0.050825	-0.756484	0.035884	0.058552	0.011398
1994	-0.006784	-0.025930	-0.008319	0.022284	0.011289	0.014414	-0.102618	-0.027493	-0.040631
1995	0.010052	0.021852	-0.009609	-0.037479	0.073958	0.402038	0.001577	0.002602	-0.025751
1996	0.026354	0.099397	-0.007270	-0.004484	-0.000326	-0.415656	-0.046271	-0.025080	-0.026602
1997	0.006215	-0.001574	-0.009978	0.032238	0.042253	-0.323151	-0.192765	0.026446	0.020622
1998	-0.006638	0.002742	-0.015318	-0.032400	-0.082970	1.241274	-0.037975	-0.024271	-0.026353
1999	0.005962	0.026519	0.000811	-0.032157	-0.129663	-0.909865	-0.074195	-0.061664	-0.023191
2000	-0.001894	-0.028674	-0.012317	0.039345	0.140608	1.321310	-0.021331	-0.094696	-0.063176
2001	-0.030073	-0.054922	-0.007287	0.029605	0.033402	1.800219	0.013610	-0.014188	-0.014148
2002	-0.019438	-0.021733	-0.011029	0.030911	0.026562	-0.386124	-0.079561	0.026474	0.028212
2003	-0.019479	0.017061	-0.010920	0.002526	-0.076921	-0.370565	0.039884	0.044647	0.013146
2004	-0.012023	0.002522	-0.009931	-0.003991	-0.040229	-0.083096	0.180062	-0.003385	-0.058625
2005	-0.008769	-0.037201	-0.012067	0.001661	-0.035284	-0.143955	0.006992	0.025267	-0.026273
2006	0.004940	-0.010135	-0.012472	0.041549	-0.060202	0.044114	-0.004507	0.025700	0.002497

A5.4.2. Stability condition: roots and modulus of the companion matrix

Root	Modulus
0.496934	0.496934
-0.201604 + 0.296018i	0.358149
-0.201604– 0.296018i	0.358149
0.159528	0.159528
0.14455	0.14455
-0.114272	0.114272
1.16833E-6	1.17E-06
0	0
0	0

A5.4.3 Diagnostic test on residuals: ARCH test, normality, and unit root test

Residuals	ARCH(1,1) test		ADF test		Normality test	
	$Chi^2(1)$	prob	t-Statistic	Prob.*	J_B Stat	Prob
DGDP	3.841459	0.328108	-2.99467	0.0477	1.332104	0.513733
DKAP	3.841459	0.965507	-6.94988	0	15.21883	0.000496
DEM	3.841459	0.867712	-5.70101	0	681.5697	0
DHK	3.841459	0.611855	-4.67005	0	0.467294	0.791641
DOPEN	3.841459	0.096327	-5.53379	0	4.543091	0.103153
DFDI	3.841459	0.547662	-8.49859	0	0.278669	0.869937
DTTECH	3.841459	0.723979	-4.9068	0	11.69848	0.002882
DSAV	3.841459	0.931079	-5.13031	0	2.508852	0.28524
DWEALTH	3.841459	0.630108	-4.67698	0	16.47935	0.000264

A5.4.5. Diagnostic test on residuals: serial correlation test

	DGDP		DKAP		DEM		DHK		DOPEN	
Lags	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob
1	0.2054	0.65	1.665	0.197	0.0061	0.938	0.9078	0.341	0.0936	0.76
2	2.5431	0.28	2.2156	0.33	0.2389	0.887	1.77	0.413	1.2775	0.528
3	3.672	0.299	4.2333	0.237	0.5064	0.917	1.9436	0.584	3.9384	0.268
4	4.0541	0.399	5.3955	0.249	0.5852	0.965	1.977	0.74	3.9384	0.414
5	5.2433	0.387	8.6705	0.123	0.7334	0.981	2.1506	0.828	8.9436	0.111
6	7.9482	0.242	9.6655	0.139	1.2447	0.975	4.2135	0.648	10.376	0.11
7	8.4687	0.293	10.235	0.176	1.3527	0.987	4.3218	0.742	10.48	0.163
8	8.4808	0.388	10.355	0.241	1.3559	0.995	5.673	0.684	13.487	0.096
9	9.4835	0.394	16.281	0.061	1.6653	0.996	6.4073	0.699	17.37	0.043
10	9.6308	0.473	16.706	0.081	1.7042	0.998	6.8668	0.738	17.427	0.065
	DFDI		DTTECH		DSAV		DWEALTH			
Lags	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob	Q-Stat	Prob		
1	5.5215	0.019	0.9249	0.336	0.7196	0.396	1.5106	0.219		
2	5.6392	0.06	1.2337	0.54	1.0654	0.587	3.6759	0.159		
3	6.3662	0.095	4.1161	0.249	1.322	0.724	7.1451	0.067		
4	6.4915	0.165	4.7488	0.314	1.623	0.805	7.3448	0.119		
5	8.4316	0.134	4.7577	0.446	1.756	0.882	8.171	0.147		
6	8.6638	0.193	4.7579	0.575	1.8729	0.931	13.928	0.03		
7	8.7025	0.275	4.7891	0.686	3.5241	0.833	16.929	0.018		
8	8.7033	0.368	8.0304	0.431	3.5733	0.893	18.104	0.02		
9	10.505	0.311	8.109	0.523	3.5772	0.937	26.206	0.002		
10	11.082	0.351	8.494	0.581	4.3654	0.929	26.647	0.003		

Note: Q(k) is the Ljung-Box Q statistic of serial correlation at lag order k. J-B Stat is the Jarque-Bera statistic of normality. ADF test is the Augmented Dickey-Fuller test for stationary. ARCH is the ARCH LM test for ARCH with lag order 1.

A5.4.6. GMM estimation results of the restricted system.

A5.4.6.1. Estimation of output

Equation of DGDP	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.064518	0.006358	10.14741	0
DKAP	-0.10678	0.04826	-2.212505	0.0279
DEM	-0.58753	0.156867	-3.745409	0.0002
DTTECH	0.051804	0.01562	3.316492	0.0011
DSAV	0.310042	0.065396	4.741016	0
DHK(-1)	-0.07632	0.027989	-2.726714	0.0069
Dlibdummy	0.241238	0.108076	2.23212	0.0265
R-squared	0.677593	Mean dependent var		0.086612
Adjusted R-squared	0.605947	S.D. dependent var		0.032336
S.E. of regression	0.020298	Sum squared resid		0.011125
Prob(F-statistic)	1.847762			

A5.4.6.2.Estimation of capital formation

Equation of DKAP	Coefficient	Std. Error	t-Statistic	Prob.
DFDI	0.007992	0.00422	1.893731	0.0595
DSAV	0.508758	0.120115	4.235591	0
dinterest	0.022037	0.008148	2.704709	0.0073
dlibdummy	0.52805	0.191711	2.754407	0.0063
dtax	0.296591	0.105487	2.811628	0.0053
R-squared	0.624933	Mean dependent var		0.093206
Adjusted R-squared	0.5732	S.D. dependent var		0.078331
S.E. of regression	0.051173	Sum squared resid		0.075943
Prob(F-statistic)	2.369629			

A5.4.6.3. Estimation of employment

Equation of DEM	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.018706	0.005814	3.217647	0.0015
DEM(-1)	0.159528	0.116064	1.374487	0.1706
R-squared	0.025502	Mean dependent var		0.022251
Adjusted R-squared	-0.004952	S.D. dependent var		0.021234
S.E. of regression	0.021286	Sum squared resid		0.014499
Prob(F-statistic)	2.014624			

A5.4.6.4. Estimation of human capital

Equation of DHK	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.118571	0.031296	3.788687	0.0002
DFDI	0.013288	0.006949	1.912298	0.057
DSAV	-0.515259	0.221536	-2.325842	0.0209
DGDP(-1)	-0.727354	0.284395	-2.557553	0.0112
DHK(-1)	0.676131	0.085362	7.920796	0
DTTECH(-1)	0.090232	0.034491	2.61606	0.0095
DSAV(-1)	0.370664	0.181298	2.044503	0.042
dgtran	0.157659	0.07378	2.136864	0.0336
dgee	-0.293559	0.164301	-1.786715	0.0752
dgtran(-1)	0.006782	0.002676	2.534077	0.0119
dgee(-1)	-0.233235	0.132925	-1.754632	0.0806
R-squared	0.827863	Mean dependent var		0.02316
Adjusted R-squared	0.753021	S.D. dependent var		0.078578
S.E. of regression	0.039051	Sum squared resid		0.035075
Prob(F-statistic)	1.637371			

A5.4.6.5. Estimation of openness

Equation of DOPEN	Coefficient	Std. Error	t-Statistic	Prob.
DGDP	1.018797	0.655076	1.555235	0.1212
DKAP	0.585985	0.437985	1.337911	0.1822
DGDP(-1)	0.955254	0.473661	2.016744	0.0448
DEM(-1)	-2.828256	0.448402	-6.307418	0
dinterest	-0.028923	0.016022	-1.805193	0.0723
dinflat	1.527575	0.411691	3.710484	0.0003
dlibdummy	-1.213515	0.597448	-2.031162	0.0433
dinterest(-1)	-0.02881	0.007809	-3.689222	0.0003
dpc(-1)	-0.042768	0.007217	-5.925771	0
dinflat(-1)	0.559525	0.344369	1.624784	0.1055
R-squared	0.550505	Mean dependent var		0.130233
Adjusted R-squared	0.381944	S.D. dependent var		0.127784
S.E. of regression	0.100459	Sum squared resid		0.242208
Prob(F-statistic)	1.814745			

A5.4.6.6. Estimation of FDI

Equation of DFDI	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-3.921246	0.741941	-5.285115	0
DGDP	55.36268	10.92059	5.069569	0
DHK	2.962761	0.427896	6.924023	0
DTTECH	-1.642193	1.167767	-1.406268	0.1609
DHK(-1)	-20.77836	3.347456	-6.207209	0
DTTECH(-1)	-1.955718	0.663393	-2.948052	0.0035
dpc	-2.110393	0.194813	-10.8329	0
drmb	-0.970493	0.233748	-4.151875	0
dwage	-3.395933	0.611876	-5.550035	0
dtax	0.748263	0.301567	2.48125	0.0138
dinterest(-1)	-0.178005	0.098678	-1.803903	0.0725
drmb(-1)	-0.91826	0.26781	-3.428771	0.0007
dwage(-1)	2.567548	0.499331	5.141972	0
dgtran(-1)	-5.274284	1.252781	-4.210061	0
R-squared	0.845777	Mean dependent var		0.089343
Adjusted R-squared	0.745532	S.D. dependent var		2.218901
S.E. of regression	1.11932	Sum squared resid		25.05754
Prob(F-statistic)	2.771324			

A5.4.6.7. Estimation of technology transfer

Equation of DTTECH	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.483906	0.208055	-2.325852	0.0209
DGDP	0.33328	0.139356	2.391577	0.0175
DGDP(-1)	3.199334	1.049832	3.047472	0.0026
DKAP(-1)	-1.141145	0.533606	-2.138551	0.0335
DOPEN(-1)	-0.675207	0.243134	-2.7771	0.0059
drmb	0.218722	0.049537	4.415299	0
drmb(-1)	-0.130916	0.037982	-3.446795	0.0007
dgee(-1)	2.357488	0.627006	3.759915	0.0002
R-squared	0.624416	Mean dependent var		0.140948
Adjusted R-squared	0.523297	S.D. dependent var		0.249214
S.E. of regression	0.172066	Sum squared resid		0.769779
Prob(F-statistic)	1.651532			

A5.4.6.8. Estimation of saving

Equation of DSAV	Coefficient	Std. Error	t-Statistic	Prob.
DGDP	2.204907	0.30218	7.296678	0
DEM	1.242072	0.373534	3.32519	0.001
DWEALTH	-0.562443	0.228928	-2.456853	0.0147
DGDP(-1)	-0.534367	0.413687	-1.291717	0.1977
dtax(-1)	0.218526	0.110054	1.985624	0.0482
R-squared	0.709989	Mean dependent var		0.105943
Adjusted R-squared	0.669988	S.D. dependent var		0.077733
S.E. of regression	0.044655	Sum squared resid		0.057828
Prob(F-statistic)	1.621845			

A5.4.6.9 Estimation of financial wealth

Equation of DWEALTH	Coefficient	Std. Error	t-Statistic	Prob.
constant	0.106587	0.040544	2.628889	0.0091
DGDP	1.007693	0.496396	2.030019	0.0435
DSAV	-0.433163	0.271031	-1.598203	0.1113
dinflat(-1)	-0.347165	0.23108	-1.50236	0.1343
R-squared	0.291273	Mean dependent var		0.147386
Adjusted R-squared	0.2204	S.D. dependent var		0.060657
S.E. of regression	0.053557	Sum squared resid		0.08605
Prob(F-statistic)	1.585549			

A5.5. Multiplier effects of exogenous variables

A5.5.1. Multiplier effect of the change in the interest rate (dinterest)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	-0.004957	0.014450	-1.76E-18	0.002000	-0.025506	-0.265808	-0.001652	-0.010736	-0.000345
1	0.000240	0.000700	-1.09E-18	0.003299	-0.032890	-0.168538	-0.015048	0.004023	-0.001500
2	0.001927	0.002291	2.63E-20	0.000547	0.003536	0.031735	0.022821	0.004005	0.000208
3	-0.000604	-0.002020	-5.17E-19	0.002787	4.24E-05	-0.082760	0.000963	-0.002670	0.000548
4	-7.45E-05	-0.000370	-4.33E-19	0.000446	-0.000869	-0.063129	0.000319	0.000265	-0.000190
5	5.91E-05	3.57E-05	-1.07E-19	0.000296	9.96E-06	-0.007034	0.000790	0.000181	-1.87E-05
6	-4.16E-05	-0.000143	-7.36E-20	0.000237	-6.97E-05	-0.009508	0.000128	-0.000132	1.52E-05
7	-4.70E-06	-3.30E-05	-4.16E-20	7.23E-05	-6.38E-05	-0.005346	7.57E-05	1.92E-05	-1.30E-05
8	2.66E-07	-1.09E-05	-1.58E-20	4.27E-05	-1.06E-05	-0.001616	6.58E-05	3.90E-06	-1.42E-06
9	-2.97E-06	-1.25E-05	-9.12E-21	2.43E-05	-1.01E-05	-0.001141	1.95E-05	-6.62E-06	-1.25E-07
10	-5.60E-07	-4.06E-06	-4.64E-21	9.97E-06	-5.79E-06	-0.000564	1.14E-05	8.86E-07	-9.48E-07
11	-2.50E-07	-1.98E-06	-2.10E-21	5.41E-06	-1.95E-06	-0.000238	6.66E-06	-1.45E-07	-1.89E-07
12	-2.53E-07	-1.27E-06	-1.11E-21	2.78E-06	-1.24E-06	-0.000136	2.69E-06	-3.72E-07	-9.41E-08
13	-7.74E-08	-5.20E-07	-5.51E-22	1.29E-06	-6.26E-07	-6.58E-05	1.46E-06	1.11E-08	-8.29E-08
14	-4.14E-08	-2.67E-07	-2.66E-22	6.66E-07	-2.72E-07	-3.11E-05	7.55E-07	-3.50E-08	-2.66E-08
15	-2.56E-08	-1.44E-07	-1.36E-22	3.32E-07	-1.50E-07	-1.63E-05	3.47E-07	-2.62E-08	-1.45E-08
16	-1.03E-08	-6.59E-08	-6.70E-23	1.61E-07	-7.36E-08	-7.97E-06	1.80E-07	-4.27E-09	-8.55E-09
17	-5.46E-09	-3.35E-08	-3.30E-23	8.15E-08	-3.51E-08	-3.91E-06	9.00E-08	-4.52E-09	-3.54E-09
18	-2.89E-09	-1.71E-08	-1.66E-23	4.04E-08	-1.81E-08	-1.98E-06	4.35E-08	-2.40E-09	-1.87E-09
19	-1.32E-09	-8.21E-09	-8.20E-24	1.99E-08	-8.92E-09	-9.75E-07	2.20E-08	-8.23E-10	-9.76E-10
20	-6.80E-10	-4.14E-09	-4.06E-24	9.98E-09	-4.38E-09	-4.83E-07	1.09E-08	-5.38E-10	-4.52E-10
21	-3.43E-10	-2.07E-09	-2.03E-24	4.95E-09	-2.21E-09	-2.42E-07	5.39E-09	-2.63E-10	-2.32E-10
22	-1.65E-10	-1.02E-09	-1.01E-24	2.45E-09	-1.09E-09	-1.20E-07	2.70E-09	-1.16E-10	-1.17E-10
23	-8.36E-11	-5.08E-10	-4.99E-25	1.22E-09	-5.41E-10	-5.95E-08	1.34E-09	-6.41E-11	-5.64E-11
24	-4.16E-11	-2.53E-10	-2.49E-25	6.07E-10	-2.70E-10	-2.96E-08	6.63E-10	-3.11E-11	-2.85E-11
25	-2.05E-11	-1.25E-10	-1.23E-25	3.01E-10	-1.34E-10	-1.47E-08	3.31E-10	-1.49E-11	-1.42E-11
26	-1.02E-11	-6.23E-11	-6.13E-26	1.50E-10	-6.65E-11	-7.30E-09	1.64E-10	-7.73E-12	-6.98E-12
27	-5.09E-12	-3.09E-11	-3.05E-26	7.45E-11	-3.31E-11	-3.63E-09	8.15E-11	-3.78E-12	-3.49E-12
28	-2.52E-12	-1.54E-11	-1.51E-26	3.70E-11	-1.64E-11	-1.80E-09	4.05E-11	-1.86E-12	-1.73E-12
29	-1.26E-12	-7.64E-12	-7.53E-27	1.84E-11	-8.17E-12	-8.96E-10	2.01E-11	-9.40E-13	-8.59E-13

A5.5.2. Multiplier effects of the change in private credit (dpc)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	0.003949	-0.011513	-1.08E-17	-0.030786	-0.002723	-1.985114	0.001316	0.008554	0.000275
1	0.005458	0.011389	3.17E-18	-0.013754	-0.026761	0.850190	0.029431	0.009030	0.001588
2	0.002265	0.002965	2.18E-18	-0.003765	0.009259	0.304225	0.023290	0.001049	0.001828
3	-0.000581	-0.001421	3.21E-19	-0.000173	0.000739	0.004233	-0.002583	-0.002859	0.000653
4	0.000157	0.000501	1.53E-19	-0.001175	-0.000102	0.014974	-0.000685	0.000750	-0.000167
5	8.43E-05	0.000271	1.91E-19	-0.000339	0.000395	0.029368	2.63E-05	7.19E-05	5.38E-05
6	-2.38E-05	-1.01E-05	6.16E-20	-0.000127	5.04E-05	0.005811	-0.000314	-0.000111	2.42E-05
7	1.31E-05	5.34E-05	3.24E-20	-0.000111	2.19E-05	0.003805	-9.43E-05	4.52E-05	-6.37E-06
8	4.77E-06	2.20E-05	2.03E-20	-4.11E-05	3.03E-05	0.002681	-3.22E-05	1.06E-06	4.35E-06
9	-1.39E-07	5.33E-06	8.31E-21	-1.99E-05	7.54E-06	0.000900	-3.03E-05	-3.67E-06	1.45E-06
10	1.16E-06	5.50E-06	4.34E-21	-1.19E-05	4.27E-06	0.000521	-1.12E-05	2.62E-06	3.86E-08
11	4.03E-07	2.30E-06	2.31E-21	-5.17E-06	2.87E-06	0.000285	-5.30E-06	4.97E-08	3.84E-07
12	1.13E-07	9.52E-07	1.06E-21	-2.61E-06	1.06E-06	0.000122	-3.24E-06	-4.02E-08	1.31E-07
13	1.14E-07	6.05E-07	5.42E-22	-1.38E-06	5.79E-07	6.51E-05	-1.40E-06	1.67E-07	4.25E-08
14	4.45E-08	2.72E-07	2.74E-22	-6.47E-07	3.13E-07	3.30E-05	-7.02E-07	1.59E-08	3.79E-08
15	1.96E-08	1.30E-07	1.32E-22	-3.26E-07	1.39E-07	1.55E-05	-3.73E-07	1.10E-08	1.50E-08
16	1.23E-08	7.04E-08	6.67E-23	-1.65E-07	7.25E-08	7.99E-06	-1.75E-07	1.28E-08	6.85E-09
17	5.40E-09	3.33E-08	3.33E-23	-8.02E-08	3.68E-08	3.97E-06	-8.81E-08	3.00E-09	4.14E-09
18	2.64E-09	1.65E-08	1.64E-23	-4.02E-08	1.75E-08	1.94E-06	-4.47E-08	1.90E-09	1.84E-09
19	1.42E-09	8.43E-09	8.19E-24	-2.01E-08	8.91E-09	9.78E-07	-2.17E-08	1.21E-09	9.07E-10
20	6.68E-10	4.10E-09	4.07E-24	-9.89E-09	4.44E-09	4.85E-07	-1.09E-08	4.42E-10	4.81E-10
21	3.33E-10	2.04E-09	2.01E-24	-4.94E-09	2.17E-09	2.40E-07	-5.43E-09	2.50E-10	2.28E-10
22	1.70E-10	1.02E-09	1.00E-24	-2.45E-09	1.09E-09	1.20E-07	-2.67E-09	1.33E-10	1.14E-10
23	8.25E-11	5.04E-10	4.99E-25	-1.22E-09	5.42E-10	5.94E-08	-1.33E-09	5.87E-11	5.77E-11
24	4.12E-11	2.51E-10	2.48E-25	-6.06E-10	2.68E-10	2.95E-08	-6.64E-10	3.10E-11	2.81E-11
25	2.06E-11	1.25E-10	1.23E-25	-3.01E-10	1.34E-10	1.47E-08	-3.29E-10	1.56E-11	1.41E-11
26	1.02E-11	6.20E-11	6.12E-26	-1.49E-10	6.64E-11	7.29E-09	-1.64E-10	7.44E-12	7.03E-12
27	5.07E-12	3.09E-11	3.04E-26	-7.43E-11	3.30E-11	3.62E-09	-8.14E-11	3.80E-12	3.46E-12
28	2.52E-12	1.53E-11	1.51E-26	-3.69E-11	1.64E-11	1.80E-09	-4.04E-11	1.89E-12	1.73E-12
29	1.25E-12	7.62E-12	7.51E-27	-1.83E-11	8.15E-12	8.94E-10	-2.01E-11	9.24E-13	8.59E-13

A5.5.3. Multiplier effects of the change in exchange rate (drmb)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	0.02636	0.029278	8.38E-19	-0.029027	0.044012	0.02924	0.227507	0.05709	0.001833
1	-0.016324	-0.038972	-8.71E-18	0.011561	-0.014287	-1.440426	-0.115151	-0.053976	0.006931
2	0.004687	0.012479	6.57E-20	-0.019474	-0.003505	0.181101	0.003457	0.021684	-0.004669
3	0.000989	0.002935	2.46E-18	-0.001754	0.007205	0.441756	0.003452	-0.00117	0.001503
4	-0.000707	-0.001163	3.40E-19	-0.000925	-0.000458	-0.003537	-0.005286	-0.002231	0.000253
5	0.000302	0.000929	3.20E-19	-0.001439	0.000176	0.042848	-0.000526	0.001153	-0.000196
6	3.86E-05	0.000194	2.31E-19	-0.000314	0.000441	0.032471	-0.000201	-0.000129	9.50E-05
7	-1.98E-05	1.16E-05	6.98E-20	-0.000192	2.35E-05	0.00592	-0.000402	-7.02E-05	1.04E-05
8	2.01E-05	7.43E-05	4.42E-20	-0.000132	4.51E-05	0.005637	-8.58E-05	5.76E-05	-4.67E-06
9	2.92E-06	2.02E-05	2.40E-20	-4.63E-05	3.40E-05	0.003025	-5.00E-05	-7.90E-06	6.36E-06
10	4.60E-07	7.99E-06	9.91E-21	-2.61E-05	7.94E-06	0.001068	-3.65E-05	-1.06E-06	9.24E-07
11	1.54E-06	6.94E-06	5.48E-21	-1.42E-05	6.07E-06	0.000677	-1.25E-05	3.00E-06	2.48E-07
12	3.63E-07	2.51E-06	2.76E-21	-6.17E-06	3.31E-06	0.000333	-6.99E-06	-2.99E-07	4.95E-07
13	1.74E-07	1.25E-06	1.29E-21	-3.27E-06	1.25E-06	0.000148	-3.88E-06	1.21E-07	1.23E-07
14	1.40E-07	7.40E-07	6.69E-22	-1.66E-06	7.43E-07	8.11E-05	-1.66E-06	1.81E-07	6.30E-08
15	4.88E-08	3.19E-07	3.31E-22	-7.84E-07	3.71E-07	3.95E-05	-8.81E-07	6.60E-09	4.64E-08
16	2.58E-08	1.63E-07	1.61E-22	-4.01E-07	1.68E-07	1.90E-05	-4.50E-07	2.14E-08	1.67E-08
17	1.49E-08	8.54E-08	8.16E-23	-2.00E-07	8.99E-08	9.80E-06	-2.12E-07	1.40E-08	8.93E-09
18	6.37E-09	4.01E-08	4.04E-23	-9.76E-08	4.42E-08	4.81E-06	-1.08E-07	3.27E-09	5.00E-09
19	3.31E-09	2.03E-08	1.99E-23	-4.91E-08	2.13E-08	2.37E-06	-5.41E-08	2.68E-09	2.18E-09
20	1.72E-09	1.02E-08	9.99E-24	-2.44E-08	1.09E-08	1.19E-06	-2.64E-08	1.38E-09	1.13E-09
21	8.06E-10	4.98E-09	4.95E-24	-1.21E-08	5.38E-09	5.89E-07	-1.33E-08	5.31E-10	5.82E-10
22	4.11E-10	2.50E-09	2.46E-24	-6.02E-09	2.65E-09	2.92E-07	-6.60E-09	3.20E-10	2.75E-10
23	2.06E-10	1.25E-09	1.22E-24	-2.99E-09	1.33E-09	1.46E-07	-3.26E-09	1.56E-10	1.40E-10
24	1.00E-10	6.14E-10	6.07E-25	-1.48E-09	6.59E-10	7.23E-08	-1.63E-09	7.16E-11	7.01E-11
25	5.04E-11	3.07E-10	3.02E-25	-7.38E-10	3.27E-10	3.59E-08	-8.08E-10	3.84E-11	3.42E-11
26	2.51E-11	1.52E-10	1.50E-25	-3.66E-10	1.63E-10	1.79E-08	-4.01E-10	1.87E-11	1.72E-11
27	1.24E-11	7.55E-11	7.45E-26	-1.82E-10	8.08E-11	8.87E-09	-2.00E-10	9.09E-12	8.54E-12
28	6.19E-12	3.76E-11	3.70E-26	-9.05E-11	4.02E-11	4.41E-09	-9.91E-11	4.65E-12	4.22E-12
29	3.07E-12	1.87E-11	1.84E-26	-4.50E-11	2.00E-11	2.19E-09	-4.92E-11	2.28E-12	2.11E-12

A5.5.4. Multiplier effects of the change in inflation (dinflat)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	0	0	0	0	1.527575	0	0	0	0
1	0.024078	0.179	1.67E-17	-0.124752	0.688947	2.644063	-1.023404	0.310303	-0.457313
2	-0.063789	-0.061702	1.30E-17	0.029426	-0.078143	2.157055	-0.613671	-0.155164	0.002932
3	0.009754	0.042138	9.56E-18	-0.066629	-0.026304	1.058904	-0.077656	0.066192	-0.018842
4	0.004397	0.015225	1.13E-17	-0.012881	0.022719	1.737695	0.002348	0.002631	0.003291
5	-0.002137	-0.002632	2.61E-18	-0.004569	0.000481	0.163032	-0.019361	-0.007733	0.001197
6	0.000871	0.003092	1.46E-18	-0.00563	0.000659	0.170711	-0.003867	0.003396	-0.000593
7	0.000225	0.001005	9.85E-19	-0.001686	0.001651	0.133858	-0.001111	-0.000128	0.000282
8	-4.95E-05	0.00014	3.50E-19	-0.000856	0.000247	0.034488	-0.001557	-0.000266	6.55E-05
9	6.75E-05	0.000281	1.94E-19	-0.000561	0.000186	0.023665	-0.000462	0.000181	-1.05E-05
10	1.72E-05	0.0001	1.06E-19	-0.000222	0.000141	0.013221	-0.000225	-1.05E-05	2.19E-05
11	3.33E-06	3.86E-05	4.60E-20	-0.000116	4.24E-05	0.005142	-0.000153	-4.93E-06	5.49E-06
12	5.85E-06	2.88E-05	2.43E-20	-6.26E-05	2.60E-05	0.002943	-6.01E-05	1.03E-05	1.43E-06
13	1.88E-06	1.19E-05	1.23E-20	-2.84E-05	1.45E-05	0.001489	-3.10E-05	-5.67E-08	1.92E-06
14	8.11E-07	5.65E-06	5.84E-21	-1.45E-05	5.93E-06	0.00068	-1.70E-05	4.25E-07	6.33E-07
15	5.85E-07	3.22E-06	2.98E-21	-7.40E-06	3.26E-06	0.000359	-7.66E-06	6.94E-07	2.89E-07
16	2.33E-07	1.47E-06	1.49E-21	-3.55E-06	1.66E-06	0.000178	-3.92E-06	9.21E-08	1.95E-07
17	1.16E-07	7.29E-07	7.26E-22	-1.79E-06	7.68E-07	8.58E-05	-2.01E-06	8.58E-08	7.95E-08
18	6.50E-08	3.79E-07	3.65E-22	-8.96E-07	3.99E-07	4.37E-05	-9.59E-07	5.89E-08	3.99E-08
19	2.93E-08	1.82E-07	1.81E-22	-4.39E-07	1.98E-07	2.16E-05	-4.85E-07	1.76E-08	2.19E-08
20	1.48E-08	9.09E-08	8.96E-23	-2.20E-07	9.63E-08	1.06E-05	-2.42E-07	1.14E-08	1.00E-08
21	7.64E-09	4.58E-08	4.48E-23	-1.09E-07	4.88E-08	5.34E-06	-1.19E-07	6.09E-09	5.06E-09
22	3.65E-09	2.24E-08	2.22E-23	-5.41E-08	2.42E-08	2.64E-06	-5.95E-08	2.51E-09	2.59E-09
23	1.84E-09	1.12E-08	1.10E-23	-2.70E-08	1.19E-08	1.31E-06	-2.96E-08	1.40E-09	1.25E-09
24	9.23E-10	5.58E-09	5.49E-24	-1.34E-08	5.97E-09	6.54E-07	-1.46E-08	7.00E-10	6.26E-10
25	4.52E-10	2.76E-09	2.72E-24	-6.65E-09	2.96E-09	3.24E-07	-7.30E-09	3.26E-10	3.14E-10
26	2.26E-10	1.37E-09	1.35E-24	-3.31E-09	1.47E-09	1.61E-07	-3.63E-09	1.70E-10	1.54E-10
27	1.13E-10	6.84E-10	6.73E-25	-1.64E-09	7.31E-10	8.02E-08	-1.80E-09	8.41E-11	7.70E-11
28	5.56E-11	3.39E-10	3.34E-25	-8.17E-10	3.63E-10	3.98E-08	-8.95E-10	4.10E-11	3.83E-11
29	2.77E-11	1.69E-10	1.66E-25	-4.06E-10	1.80E-10	1.98E-08	-4.45E-10	2.08E-11	1.90E-11

A5.5.5. Multiplier effects of the change in relative wages (dwage)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	0.006355	-0.018526	-1.74E-17	-0.049539	-0.004381	-3.19434	0.002118	0.013764	0.000442
1	0.003978	0.032333	1.83E-17	0.015322	0.02907	3.783212	0.045757	0.004125	0.002222
2	-0.00821	-0.016429	-1.58E-18	0.013835	-0.014192	-0.744971	-0.046535	-0.020591	0.000646
3	0.001497	0.003592	-7.83E-19	-0.002842	-0.004213	-0.126208	0.002564	0.009042	-0.002408
4	0.000177	0.000161	2.06E-19	0.001759	0.001704	0.06312	0.003594	-0.000675	0.00047
5	-0.000361	-0.000939	-3.19E-19	0.000809	-0.00075	-0.05974	-0.00089	-0.000908	2.89E-05
6	8.16E-05	0.00013	-1.06E-19	2.14E-05	-0.000186	-0.011226	0.000449	0.000432	-0.000105
7	-6.33E-06	-4.87E-05	-2.78E-20	0.000172	4.30E-05	-0.00155	0.000236	-7.13E-05	2.45E-05
8	-1.76E-05	-5.55E-05	-3.21E-20	6.92E-05	-5.65E-05	-0.004804	4.40E-07	-3.37E-05	-3.16E-06
9	3.11E-06	-4.91E-07	-1.21E-20	2.02E-05	-1.39E-05	-0.001282	4.62E-05	1.92E-05	-5.17E-06
10	-1.38E-06	-7.16E-06	-5.26E-21	1.78E-05	-2.63E-06	-0.000566	1.95E-05	-5.18E-06	8.57E-07
11	-1.03E-06	-4.25E-06	-3.42E-21	7.54E-06	-4.85E-06	-0.000452	5.20E-06	-1.25E-06	-4.93E-07
12	2.86E-09	-9.46E-07	-1.47E-21	3.28E-06	-1.53E-06	-0.000165	4.84E-06	7.32E-07	-3.14E-07
13	-1.62E-07	-8.51E-07	-7.20E-22	1.99E-06	-6.61E-07	-8.41E-05	2.07E-06	-3.52E-07	-1.04E-08
14	-8.04E-08	-4.19E-07	-3.91E-22	9.04E-07	-4.82E-07	-4.86E-05	8.74E-07	-5.99E-08	-5.50E-08
15	-1.90E-08	-1.61E-07	-1.82E-22	4.37E-07	-1.90E-07	-2.11E-05	5.40E-07	1.56E-08	-2.59E-08
16	-1.79E-08	-9.95E-08	-9.12E-23	2.33E-07	-9.47E-08	-1.08E-05	2.45E-07	-2.53E-08	-7.06E-09
17	-8.17E-09	-4.76E-08	-4.66E-23	1.11E-07	-5.33E-08	-5.64E-06	1.18E-07	-5.06E-09	-6.04E-09
18	-3.27E-09	-2.19E-08	-2.26E-23	5.51E-08	-2.40E-08	-2.66E-06	6.31E-08	-1.30E-09	-2.73E-09
19	-2.03E-09	-1.18E-08	-1.13E-23	2.80E-08	-1.21E-08	-1.35E-06	3.00E-08	-2.10E-09	-1.14E-09
20	-9.47E-10	-5.72E-09	-5.66E-24	1.37E-08	-6.26E-09	-6.77E-07	1.49E-08	-6.13E-10	-6.88E-10
21	-4.44E-10	-2.79E-09	-2.78E-24	6.81E-09	-2.99E-09	-3.30E-07	7.58E-09	-2.92E-10	-3.21E-10
22	-2.40E-10	-1.43E-09	-1.39E-24	3.41E-09	-1.50E-09	-1.66E-07	3.70E-09	-2.05E-10	-1.52E-10
23	-1.15E-10	-6.99E-10	-6.91E-25	1.68E-09	-7.56E-10	-8.25E-08	1.84E-09	-7.94E-11	-8.13E-11
24	-5.63E-11	-3.46E-10	-3.42E-25	8.38E-10	-3.70E-10	-4.07E-08	9.22E-10	-4.08E-11	-3.90E-11
25	-2.88E-11	-1.74E-10	-1.70E-25	4.17E-10	-1.85E-10	-2.03E-08	4.55E-10	-2.26E-11	-1.92E-11
26	-1.41E-11	-8.58E-11	-8.47E-26	2.07E-10	-9.22E-11	-1.01E-08	2.26E-10	-1.01E-11	-9.80E-12
27	-6.99E-12	-4.26E-11	-4.20E-26	1.03E-10	-4.55E-11	-5.01E-09	1.13E-10	-5.18E-12	-4.79E-12
28	-3.51E-12	-2.13E-11	-2.09E-26	5.11E-11	-2.27E-11	-2.49E-09	5.59E-11	-2.66E-12	-2.38E-12
29	-1.73E-12	-1.05E-11	-1.04E-26	2.54E-11	-1.13E-11	-1.24E-09	2.78E-11	-1.27E-12	-1.19E-12

A5.5.6. Multiplier effect of the change in liberalization (dlibdummy)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	0.389454	1.124061	1.38E-16	-0.157117	-0.158057	20.88256	0.129797	0.843474	0.027088
1	-0.121176	-0.299448	-7.64E-18	0.168709	0.073101	-3.246654	0.029612	-0.537587	0.110754
2	0.015181	0.037496	-1.45E-17	-0.093324	-0.078316	-2.851216	-0.090269	0.118488	-0.036027
3	0.012032	0.028947	1.27E-17	-0.011108	0.043723	2.645978	0.06267	0.015334	0.005483
4	-0.005693	-0.011822	8.03E-19	0.003775	-0.001233	-0.153135	-0.025957	-0.020831	0.003286
5	0.001205	0.00358	4.20E-19	-0.006446	-0.002113	0.025688	-0.003489	0.006632	-0.001658
6	0.000463	0.001365	9.72E-19	-0.001029	0.002423	0.161154	0.001352	0.000152	0.000401
7	-0.000234	-0.000363	1.86E-19	-0.000321	-8.72E-06	0.007742	-0.00179	-0.000835	0.000126
8	8.81E-05	0.000293	1.17E-19	-0.000515	3.78E-05	0.014017	-0.0003	0.000356	-6.56E-05
9	2.09E-05	8.85E-05	8.67E-20	-0.000137	0.000157	0.012154	-7.14E-05	-1.71E-05	2.84E-05
10	-6.63E-06	6.32E-06	2.85E-20	-7.04E-05	1.69E-05	0.002644	-0.000143	-2.91E-05	5.93E-06
11	6.50E-06	2.57E-05	1.64E-20	-4.93E-05	1.53E-05	0.002018	-3.77E-05	1.88E-05	-1.58E-06
12	1.46E-06	8.50E-06	9.12E-21	-1.84E-05	1.27E-05	0.001155	-1.84E-05	-1.43E-06	2.09E-06
13	1.83E-07	3.05E-06	3.85E-21	-9.77E-06	3.37E-06	0.000422	-1.35E-05	-6.36E-07	4.60E-07
14	5.37E-07	2.54E-06	2.06E-21	-5.39E-06	2.21E-06	0.000251	-4.99E-06	1.03E-06	9.33E-08
15	1.57E-07	9.99E-07	1.05E-21	-2.38E-06	1.26E-06	0.000128	-2.61E-06	-4.00E-08	1.75E-07
16	6.50E-08	4.71E-07	4.93E-22	-1.23E-06	4.92E-07	5.70E-05	-1.47E-06	3.02E-08	5.25E-08
17	5.16E-08	2.78E-07	2.53E-22	-6.31E-07	2.77E-07	3.06E-05	-6.44E-07	6.58E-08	2.35E-08
18	1.95E-08	1.24E-07	1.26E-22	-3.00E-07	1.42E-07	1.51E-05	-3.33E-07	5.80E-09	1.71E-08
19	9.69E-09	6.16E-08	6.15E-23	-1.52E-07	6.46E-08	7.25E-06	-1.71E-07	7.21E-09	6.64E-09
20	5.60E-09	3.24E-08	3.10E-23	-7.61E-08	3.40E-08	3.72E-06	-8.11E-08	5.29E-09	3.36E-09
21	2.47E-09	1.54E-08	1.54E-23	-3.72E-08	1.69E-08	1.83E-06	-4.11E-08	1.39E-09	1.89E-09
22	1.25E-09	7.70E-09	7.60E-24	-1.87E-08	8.15E-09	9.02E-07	-2.06E-08	9.71E-10	8.42E-10
23	6.53E-10	3.90E-09	3.80E-24	-9.29E-09	4.14E-09	4.54E-07	-1.01E-08	5.28E-10	4.29E-10
24	3.09E-10	1.90E-09	1.89E-24	-4.59E-09	2.05E-09	2.25E-07	-5.05E-09	2.08E-10	2.21E-10
25	1.56E-10	9.50E-10	9.35E-25	-2.29E-09	1.01E-09	1.11E-07	-2.51E-09	1.19E-10	1.05E-10
26	7.85E-11	4.74E-10	4.66E-25	-1.14E-09	5.07E-10	5.55E-08	-1.24E-09	5.98E-11	5.32E-11
27	3.83E-11	2.34E-10	2.31E-25	-5.65E-10	2.51E-10	2.75E-08	-6.20E-10	2.75E-11	2.67E-11
28	1.92E-11	1.17E-10	1.15E-25	-2.81E-10	1.24E-10	1.37E-08	-3.08E-10	1.45E-11	1.30E-11
29	9.56E-12	5.80E-11	5.71E-26	-1.40E-10	6.21E-11	6.81E-09	-1.53E-10	7.15E-12	6.53E-12

A5.5.7. Multiplier effects of the change in tax revenues (dtax)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	-0.0014	0.004082	3.84E-18	0.010915	0.000965	0.703843	-0.000467	-0.003033	-9.74E-05
1	0.087824	0.573236	3.29E-17	-0.186301	0.424045	4.052327	0.01948	0.480112	-0.119467
2	-0.08477	-0.119861	5.46E-18	0.12494	-0.072706	0.639412	-0.687738	-0.24564	0.02098
3	0.005152	0.028179	-3.09E-18	-0.056826	-0.059216	-0.996857	-0.08362	0.071046	-0.025583
4	0.007507	0.019959	9.22E-18	-0.007371	0.024265	1.694047	0.026811	0.01262	0.002099
5	-0.003556	-0.007111	8.94E-19	0.002532	-0.000619	-0.061845	-0.016326	-0.013006	0.00205
6	0.000684	0.002111	2.88E-19	-0.003922	-0.001463	0.009873	-0.002617	0.003994	-0.001041
7	0.000303	0.000888	6.09E-19	-0.000666	0.001483	0.100019	0.000869	0.000174	0.00023
8	-0.000146	-0.000228	1.19E-19	-0.000184	7.87E-06	0.005301	-0.001092	-0.000531	8.27E-05
9	5.22E-05	0.000176	7.03E-20	-0.000315	1.68E-05	0.008239	-0.000195	0.000216	-4.10E-05
10	1.38E-05	5.65E-05	5.34E-20	-8.53E-05	9.70E-05	0.007513	-4.04E-05	-7.04E-06	1.69E-05
11	-4.24E-06	3.43E-06	1.75E-20	-4.25E-05	1.08E-05	0.001634	-8.72E-05	-1.89E-05	3.92E-06
12	3.92E-06	1.56E-05	9.95E-21	-3.02E-05	9.08E-06	0.00122	-2.35E-05	1.15E-05	-1.03E-06
13	9.40E-07	5.31E-06	5.60E-21	-1.13E-05	7.82E-06	0.000711	-1.11E-05	-7.36E-07	1.27E-06
14	1.01E-07	1.84E-06	2.36E-21	-5.95E-06	2.08E-06	0.000259	-8.29E-06	-4.46E-07	2.95E-07
15	3.27E-07	1.55E-06	1.26E-21	-3.30E-06	1.34E-06	0.000153	-3.07E-06	6.38E-07	5.35E-08
16	9.78E-08	6.16E-07	6.45E-22	-1.46E-06	7.73E-07	7.83E-05	-1.59E-06	-1.93E-08	1.07E-07
17	3.92E-08	2.87E-07	3.02E-22	-7.54E-07	3.01E-07	3.49E-05	-8.99E-07	1.57E-08	3.27E-08
18	3.16E-08	1.70E-07	1.55E-22	-3.87E-07	1.69E-07	1.87E-05	-3.95E-07	4.07E-08	1.42E-08
19	1.20E-08	7.59E-08	7.74E-23	-1.84E-07	8.69E-08	9.26E-06	-2.03E-07	3.72E-09	1.05E-08
20	5.90E-09	3.77E-08	3.77E-23	-9.32E-08	3.96E-08	4.44E-06	-1.05E-07	4.29E-09	4.09E-09
21	3.43E-09	1.98E-08	1.90E-23	-4.66E-08	2.08E-08	2.27E-06	-4.97E-08	3.27E-09	2.04E-09
22	1.51E-09	9.41E-09	9.43E-24	-2.28E-08	1.03E-08	1.12E-06	-2.52E-08	8.52E-10	1.16E-09
23	7.66E-10	4.71E-09	4.65E-24	-1.14E-08	4.99E-09	5.52E-07	-1.26E-08	5.89E-10	5.16E-10
24	4.00E-10	2.38E-09	2.33E-24	-5.69E-09	2.54E-09	2.78E-07	-6.16E-09	3.25E-10	2.62E-10
25	1.89E-10	1.16E-09	1.15E-24	-2.81E-09	1.26E-09	1.37E-07	-3.09E-09	1.27E-10	1.35E-10
26	9.53E-11	5.81E-10	5.72E-25	-1.40E-09	6.18E-10	6.81E-08	-1.54E-09	7.29E-11	6.45E-11
27	4.80E-11	2.90E-10	2.85E-25	-6.97E-10	3.10E-10	3.40E-08	-7.60E-10	3.67E-11	3.25E-11
28	2.34E-11	1.43E-10	1.42E-25	-3.46E-10	1.54E-10	1.69E-08	-3.79E-10	1.68E-11	1.63E-11
29	1.17E-11	7.14E-11	7.03E-26	-1.72E-10	7.62E-11	8.37E-09	-1.88E-10	8.87E-12	7.99E-12

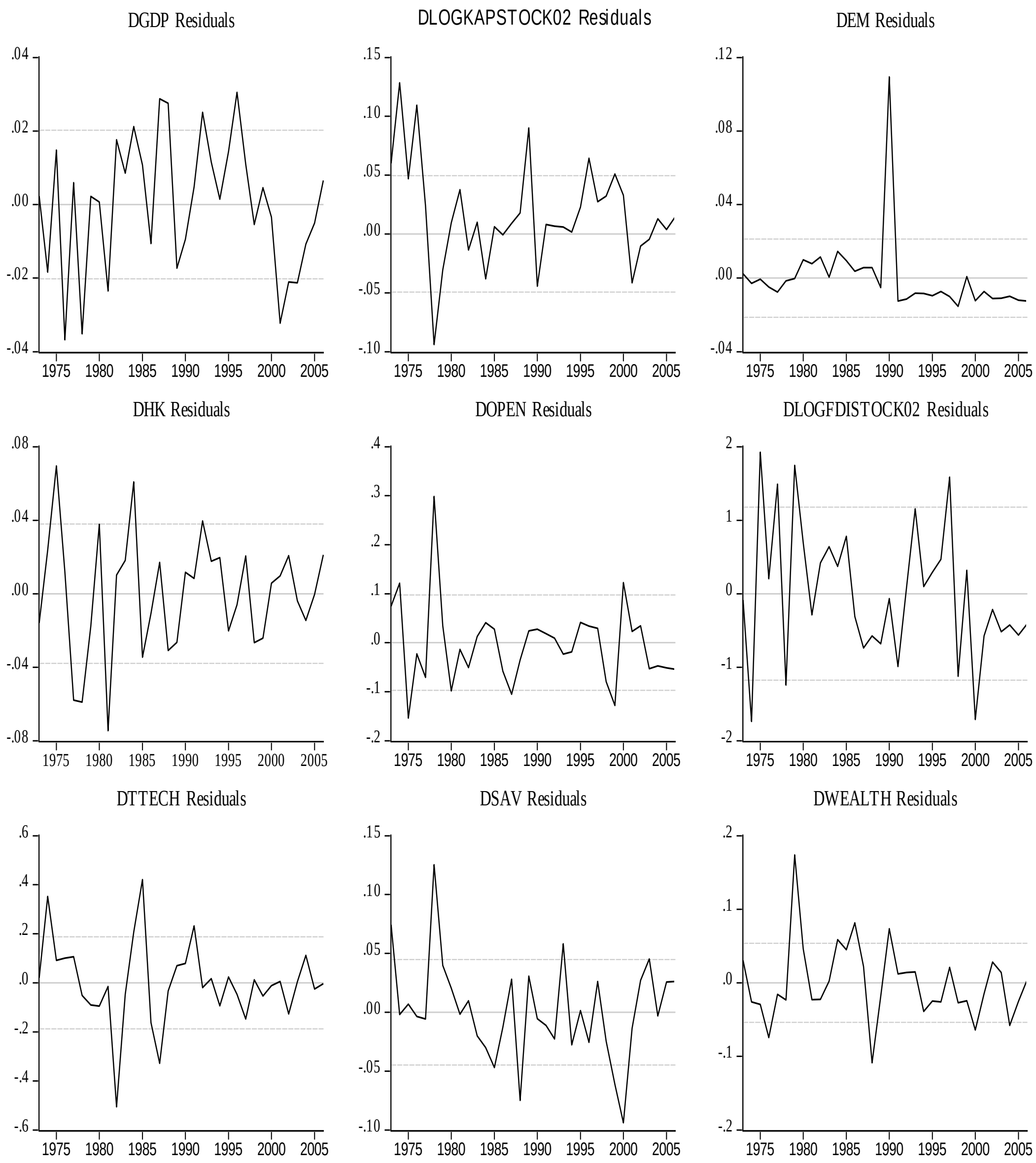
A5.5.8. Multiplier effects of the change in government expenditure on infrastructure (dgtran)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	-0.000874	0.002548	2.40E-18	0.164473	0.000603	0.439376	-0.000291	-0.001893	-6.08E-05
1	-0.011148	-0.086235	-5.20E-17	-0.000252	-0.062725	-9.29295	-0.009827	-0.023526	-0.001043
2	0.016062	0.027215	-3.81E-18	-0.014491	0.021663	0.689395	0.110448	0.042663	-0.002294
3	-0.003359	-0.010034	-1.39E-18	0.012964	0.006042	-0.069999	0.004587	-0.018623	0.004682
4	-0.000683	-0.002022	-1.94E-18	0.000143	-0.00509	-0.309841	-0.003604	0.000893	-0.001075
5	0.000627	0.001199	-9.56E-20	8.77E-05	0.000688	0.032862	0.003766	0.00184	-0.000166
6	-0.000221	-0.000621	-1.42E-19	0.000847	9.80E-06	-0.01907	9.88E-05	-0.000921	0.000176
7	-2.11E-05	-9.28E-05	-1.25E-19	9.59E-05	-0.000287	-0.018647	-1.15E-05	0.00011	-6.91E-05
8	2.17E-05	2.40E-05	-2.46E-20	7.57E-05	1.61E-05	-0.000935	0.000239	6.19E-05	-4.93E-06
9	-1.36E-05	-4.39E-05	-1.97E-20	6.80E-05	-1.88E-05	-0.002636	2.67E-05	-4.48E-05	5.70E-06
10	-1.06E-06	-8.27E-06	-1.15E-20	1.79E-05	-1.89E-05	-0.001501	1.89E-05	7.32E-06	-4.24E-06
11	3.04E-07	-2.40E-06	-4.05E-21	1.14E-05	-2.11E-06	-0.00039	1.89E-05	1.41E-06	-3.02E-07
12	-9.15E-07	-3.62E-06	-2.46E-21	6.70E-06	-2.76E-06	-0.000313	4.83E-06	-2.20E-06	2.94E-08
13	-1.31E-07	-1.04E-06	-1.25E-21	2.59E-06	-1.62E-06	-0.000153	3.02E-06	3.62E-07	-2.89E-07
14	-5.89E-08	-5.11E-07	-5.53E-22	1.45E-06	-4.85E-07	-6.18E-05	1.84E-06	-3.48E-08	-4.43E-08
15	-7.33E-08	-3.53E-07	-2.99E-22	7.50E-07	-3.38E-07	-3.68E-05	6.98E-07	-1.17E-07	-2.31E-08
16	-1.95E-08	-1.36E-07	-1.48E-22	3.40E-07	-1.70E-07	-1.77E-05	3.91E-07	9.59E-09	-2.38E-08
17	-1.09E-08	-7.09E-08	-7.06E-23	1.79E-07	-7.12E-08	-8.24E-06	2.04E-07	-9.77E-09	-6.72E-09
18	-7.10E-09	-3.90E-08	-3.63E-23	8.91E-08	-4.05E-08	-4.39E-06	9.18E-08	-7.69E-09	-3.82E-09
19	-2.69E-09	-1.74E-08	-1.79E-23	4.29E-08	-1.97E-08	-2.13E-06	4.82E-08	-8.14E-10	-2.36E-09
20	-1.46E-09	-8.96E-09	-8.80E-24	2.18E-08	-9.31E-09	-1.04E-06	2.42E-08	-1.25E-09	-9.25E-10
21	-7.83E-10	-4.58E-09	-4.43E-24	1.08E-08	-4.87E-09	-5.31E-07	1.16E-08	-6.66E-10	-5.00E-10
22	-3.50E-10	-2.19E-09	-2.19E-24	5.32E-09	-2.39E-09	-2.61E-07	5.90E-09	-2.05E-10	-2.64E-10
23	-1.82E-10	-1.11E-09	-1.09E-24	2.67E-09	-1.17E-09	-1.29E-07	2.93E-09	-1.47E-10	-1.20E-10
24	-9.22E-11	-5.54E-10	-5.42E-25	1.32E-09	-5.92E-10	-6.48E-08	1.44E-09	-7.10E-11	-6.21E-11
25	-4.41E-11	-2.71E-10	-2.69E-25	6.56E-10	-2.92E-10	-3.20E-08	7.22E-10	-3.03E-11	-3.13E-11
26	-2.24E-11	-1.36E-10	-1.34E-25	3.27E-10	-1.45E-10	-1.59E-08	3.58E-10	-1.73E-11	-1.50E-11
27	-1.11E-11	-6.76E-11	-6.65E-26	1.62E-10	-7.23E-11	-7.93E-09	1.77E-10	-8.34E-12	-7.62E-12
28	-5.47E-12	-3.34E-11	-3.30E-26	8.06E-11	-3.58E-11	-3.93E-09	8.85E-11	-3.96E-12	-3.79E-12
29	-2.74E-12	-1.67E-11	-1.64E-26	4.01E-11	-1.78E-11	-1.95E-09	4.39E-11	-2.08E-12	-1.86E-12

A5.5.9. Multiplier effects of the change in government expenditure on education (dgee)

Period	DGDP	DKAP	DEM	DHK	DOPEN	DFDI	DTTECH	DSAV	DWEALTH
	0.001628	-0.004745	-4.46E-18	-0.306246	-0.001122	-0.818114	0.000542	0.003525	0.000113
1	0.30497	0.475866	1.06E-16	-0.546384	0.591107	17.57031	2.470508	0.659349	0.02171
2	-0.036594	-0.112142	3.75E-17	0.090763	0.188327	4.729251	0.021352	-0.294712	0.090783
3	-0.009923	-0.017286	-7.32E-18	-0.054008	-0.055196	-2.440688	-0.119573	0.004362	-0.011889
4	0.012989	0.033344	1.04E-17	-0.030864	0.023294	1.935158	0.029576	0.035143	-0.002133
5	-0.00239	-0.003549	4.03E-18	-0.000986	0.007893	0.469609	-0.013018	-0.014353	0.003809
6	1.54E-05	0.001232	9.52E-19	-0.005719	-0.001546	0.044498	-0.008921	0.001722	-0.00073
7	0.000646	0.002021	1.11E-18	-0.002573	0.001857	0.164567	-9.73E-05	0.001388	4.97E-05
8	-9.21E-05	5.74E-05	4.42E-19	-0.000716	0.000557	0.048936	-0.001525	-0.000656	0.000191
9	3.87E-05	0.00023	1.84E-19	-0.000617	8.65E-05	0.019352	-0.000723	0.000149	-2.55E-05
10	3.81E-05	0.000155	1.20E-19	-0.000273	0.000166	0.01584	-0.000185	5.52E-05	1.45E-05
11	4.89E-07	3.48E-05	5.28E-20	-0.000116	5.73E-05	0.006	-0.000167	-2.59E-05	1.17E-05
12	5.26E-06	2.91E-05	2.54E-20	-6.99E-05	2.29E-05	0.002938	-7.51E-05	1.10E-05	5.15E-07
13	2.96E-06	1.51E-05	1.38E-20	-3.23E-05	1.69E-05	0.001718	-3.08E-05	2.69E-06	1.82E-06
14	6.88E-07	5.73E-06	6.49E-21	-1.54E-05	6.88E-06	0.000755	-1.89E-05	-6.01E-07	9.53E-07
15	6.13E-07	3.48E-06	3.22E-21	-8.23E-06	3.32E-06	0.000382	-8.78E-06	8.42E-07	2.53E-07
16	2.96E-07	1.70E-06	1.65E-21	-3.95E-06	1.88E-06	0.0002	-4.15E-06	2.07E-07	2.08E-07
17	1.16E-07	7.76E-07	8.01E-22	-1.95E-06	8.55E-07	9.44E-05	-2.23E-06	4.18E-08	9.85E-08
18	7.12E-08	4.17E-07	4.00E-22	-9.92E-07	4.28E-07	4.76E-05	-1.07E-06	7.25E-08	4.04E-08
19	3.39E-08	2.03E-07	2.00E-22	-4.85E-07	2.22E-07	2.40E-05	-5.26E-07	2.30E-08	2.42E-08
20	1.57E-08	9.86E-08	9.86E-23	-2.41E-07	1.06E-07	1.17E-05	-2.68E-07	1.01E-08	1.15E-08
21	8.45E-09	5.05E-08	4.92E-23	-1.21E-07	5.32E-08	5.86E-06	-1.31E-07	7.22E-09	5.39E-09
22	4.08E-09	2.48E-08	2.45E-23	-5.96E-08	2.68E-08	2.92E-06	-6.52E-08	2.87E-09	2.87E-09
23	1.99E-09	1.23E-08	1.21E-23	-2.97E-08	1.31E-08	1.44E-06	-3.27E-08	1.43E-09	1.39E-09
24	1.02E-09	6.16E-09	6.04E-24	-1.48E-08	6.55E-09	7.19E-07	-1.61E-08	8.01E-10	6.81E-10
25	4.99E-10	3.04E-09	3.00E-24	-7.32E-09	3.27E-09	3.58E-07	-8.02E-09	3.61E-10	3.47E-10
26	2.47E-10	1.51E-09	1.49E-24	-3.64E-09	1.61E-09	1.77E-07	-4.00E-09	1.83E-10	1.70E-10
27	1.24E-10	7.53E-10	7.41E-25	-1.81E-09	8.04E-10	8.83E-08	-1.98E-09	9.42E-11	8.43E-11
28	6.13E-11	3.73E-10	3.68E-25	-8.99E-10	4.00E-10	4.39E-08	-9.85E-10	4.50E-11	4.23E-11
29	3.05E-11	1.86E-10	1.83E-25	-4.47E-10	1.98E-10	2.18E-08	-4.90E-10	2.27E-11	2.09E-11

A5.6. The residuals from the model with the variable of arbitrary capital stock.



A5.6. The residuals from the model with the variable of arbitrary capital stock.

Period	DGDP	DLOGKAPSTOCK02	DEM	DHK	DOPEN	DLOGFDISTOCK02	DTTECH	DSAV	DWEALTH
1970	NA	NA	NA	NA	NA	NA	NA	NA	NA
1971	NA	NA	NA	NA	NA	NA	NA	NA	NA
1972	NA	NA	NA	NA	NA	NA	NA	NA	NA
1973	-0.003679	0.036819	0.002262	-0.004307	0.130327	-0.080355	-0.158465	0.072484	0.03042
1974	-0.024165	0.025826	-0.002844	0.019848	0.18096	0.882068	0.34672	7.34E-05	-0.021099
1975	0.015057	0.061626	-0.000641	0.068221	-0.119321	-1.95784	0.091135	0.004322	-0.029331
1976	-0.040577	-0.046649	-0.004782	-0.009208	0.036296	1.342544	0.097015	9.27E-05	-0.067185
1977	0.013036	0.064079	-0.00758	-0.069826	-0.044192	-0.200598	0.100287	-0.009211	-0.014747
1978	-0.030777	-0.005802	-0.001431	-0.061777	0.244816	0.63761	0.023041	0.123022	-0.026605
1979	-0.00114	0.031493	-0.00033	-0.017513	0.054501	-1.355981	0.020686	0.040789	0.175269
1980	0.000935	0.009281	0.009937	-0.034481	-0.076357	0.454762	-0.12782	0.020604	0.047672
1981	-0.025721	-0.013082	0.00787	-0.041085	-0.026994	0.654229	-0.035699	-0.000772	-0.020137
1982	0.024492	0.016654	0.011515	0.033352	-0.056175	-0.79314	-0.515188	0.008217	-0.022615
1983	0.01392	0.05488	0.000545	0.008643	-0.026279	-1.15208	-0.010889	-0.020703	0.0014
1984	0.010092	-0.159316	0.014547	0.050572	0.074111	1.44901	0.233675	-0.031613	0.055284
1985	0.021128	0.035286	0.009539	-0.047822	-0.036589	-1.016543	0.217279	-0.04702	0.042759
1986	0.001545	0.040549	0.003701	-0.010978	-0.132773	-0.081782	-0.098133	-0.012593	0.082025
1987	0.022789	-0.032166	0.005699	0.024522	-0.076771	0.859441	-0.15842	0.027274	0.020382
1988	0.025679	-0.038098	0.005653	-0.01966	-0.009173	-0.615437	-0.093801	-0.074913	-0.10992
1989	-0.012226	0.042666	-0.005179	-0.004441	0.043867	0.325496	0.034717	0.033422	-0.014121
1990	-0.011775	-0.048943	0.109331	0.004683	0.031587	0.109035	0.119531	-0.008131	0.076041
1991	0.00611	0.032882	-0.012532	-0.004683	0.017788	-0.058279	0.227192	-0.013394	0.012311
1992	0.028714	0.052737	-0.011439	0.025851	-0.01797	-0.836635	-0.031648	-0.02409	0.011072
1993	0.01814	0.050942	-0.008138	0.000479	-0.050825	-0.756484	0.035884	0.058552	0.011398
1994	-0.006784	-0.02593	-0.008319	0.022284	0.011289	0.014414	-0.102618	-0.027493	-0.040631
1995	0.010052	0.021852	-0.009609	-0.037479	0.073958	0.402038	0.001577	0.002602	-0.025751
1996	0.026354	0.099397	-0.00727	-0.004484	-0.000326	-0.415656	-0.046271	-0.02508	-0.026602
1997	0.006215	-0.001574	-0.009978	0.032238	0.042253	-0.323151	-0.192765	0.026446	0.020622
1998	-0.006638	0.002742	-0.015318	-0.0324	-0.08297	1.241274	-0.037975	-0.024271	-0.026353
1999	0.005962	0.026519	0.000811	-0.032157	-0.129663	-0.909865	-0.074195	-0.061664	-0.023191
2000	-0.001894	-0.028674	-0.012317	0.039345	0.140608	1.32131	-0.021331	-0.094696	-0.063176
2001	-0.030073	-0.054922	-0.007287	0.029605	0.033402	1.800219	0.01361	-0.014188	-0.014148
2002	-0.019438	-0.021733	-0.011029	0.030911	0.026562	-0.386124	-0.079561	0.026474	0.028212
2003	-0.019479	0.017061	-0.01092	0.002526	-0.076921	-0.370565	0.039884	0.044647	0.013146
2004	-0.012023	0.002522	-0.009931	-0.003991	-0.040229	-0.083096	0.180062	-0.003385	-0.058625
2005	-0.008769	-0.037201	-0.012067	0.001661	-0.035284	-0.143955	0.006992	0.025267	-0.026273
2006	0.00494	-0.010135	-0.012472	0.041549	-0.060202	0.044114	-0.004507	0.0257	0.002497

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