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Price and Volatility Behaviour of Four Asian Stock Markets

by

Mei Wa Wong

A thesis submitted for the degree of PhD in 1999

Abstract

The past ten years have witnessed many changes in the Asian economies and stock markets, particularly in the Four Tigers, Hong Kong, Singapore, South Korea and Taiwan. They enjoyed economic growth well above the world average during the late 1980s and early 1990s. There were sharp increases in their stock market capitalisations against the background of low growth and low interest rates in the US and European countries in the early 1990s. This coincided with the time when measures to liberalise these markets were implemented to allow or attract foreign direct investments in their stock markets. Then by mid 1997, both their economies and stock markets began to slump. This ten year time period thus provides a good opportunity to examine how such economic and institutional changes affected the price and volatility behaviour of the Four Tigers and their relationships with other markets. Overall, the findings of the thesis suggest that with the increase in foreign participation in the four individual markets, the influence of noise trading activities has been reduced through more and better informed trading. However, their relationships with three world major markets, the US, the UK and Japan, are not getting much stronger. There is no evidence to suggest that their prices are being increasingly led by the world markets, nor is their volatility becoming more sensitive to foreign news. Their price and volatility relationships with three regional markets, Thailand, Malaysia and Indonesia, were not particularly strong either, until recently, when the Asian financial crisis has made them more responsive to shocks from one another. The message to the governments of the Four Tigers is clear. Foreign direct equity investments have not destabilised their stock markets. Instead, the mismanagement of their own and/or their trading partners' economies should be held more responsible.

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Price and Volatility Behaviour of Four Asian Stock Markets

A thesis submitted for the degree of Ph.D.

by

Mei Wa Wong

Department of Economics and Finance, University of Durham

Year : 1999

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Declaration

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Introduction

The spectacular growth of Asia's four newly industrialised countries commonly known as Asia's Four Tigers, Hong Kong, Singapore, South Korea and Taiwan during the 1980s and early 1990s attracted much attention in the western world. It was often referred to as the 'Miracle growth of East Asia.' Such a rapid economic growth period coincided with the time when their stock markets were liberalised for the first time or modernised to attract foreign portfolio investment. Stock markets of the Four Tigers had all experienced a boom period after receiving substantial inflow of foreign portfolio capital. However by the mid 1990s, the sharp fall in export earnings plus the accumulation of short-term foreign debt and the pressure of devaluation in other Asian countries had put a halt to the growth. This was then followed by depreciation of their currencies, large foreign capital outflow and a sharp fall in most stock markets. Now, what was once renowned as the East Asian miracle has become the Asian crisis. How has this rise and fall in economic growth affected the Four Tigers' stock markets? Would their market behaviour have been different had the markets not been opened to foreign participation? Were movements in prices and volatility of these four markets affected by regional and foreign leading markets? If so, what were the driving forces? It is the aim of this thesis to investigate these issues with the theme centred on price and volatility of the stock markets in Hong Kong, Singapore, South Korea and Taiwan.

While the economic developments of the Four Tigers over the past decade have already been widely documented, examinations into their stock markets behaviour are

still rare. Most of the previous studies on these stock markets concentrated either on their market anomalies such as day-of-the-week effects or their lead-lag relationships with other world markets. Enquiries into the nature of volatility in individual Asian stock markets and the ways in which their price volatility respond to foreign innovations following their liberalisation have not previously been undertaken. Such enquiries are important as they can help foreign investors and local government to assess the benefits of international portfolio diversification or the effects of opening up their markets to foreign investments respectively. If the four Asian stock markets and other major world leading markets are not integrated in terms of price co-movements and volatility spillovers, it is indicative that international investors can still benefit from risk diversification by investing globally. As for the local Asian governments, it is always feared that foreign participation would destabilise their stock markets by making them more vulnerable to a reversal flow of portfolio capital and sensitive to the movements of overseas markets. If this was found to be the case, the Asian governments might be very reluctant to open up their markets any further. However, what seems to have overlooked is the possibility that foreign participation may contribute positively to the Asian stock markets. With their expertise in share dealing and technology in transmitting information across international markets, foreign investors can help improve market efficiency, increase the rate of information flow and improve the quality and reliability of information. That is why foreign investments could also have positive impacts on the operation and behaviour of the local stock markets. Whether foreign participation in the Asian stock markets is desirable or not for both local governments and international investors is an interesting issue worthy of investigation. Hence the impacts of foreign investments on

the stock price behaviour and volatility of prices in the Four Tigers will be examined in this thesis.

The reasons for choosing the stock markets of Hong Kong, Singapore, South Korea and Taiwan for the investigation are twofold. First, they had the fastest growing economies in the region between mid-1980s and mid-1990s, relying heavily on export trade. They also had the largest share of foreign portfolio inflow during this period compared to other emerging markets. Therefore, they are the most interesting and informative Asian markets in an examination of possible links between economic development, foreign investment and stock market movements. Second, they broadly represent two sets of markets with different degrees of market openness and government intervention. While Hong Kong and Singapore impose no or little restrictions on foreign direct investment in their stock markets, South Korea and Taiwan remained totally restrictive until 1991/92. Subsequently, the foreign investment ceiling was raised to 10% on local companies' stocks from the start and was gradually lifted to 18% and then 20% in 1996. A study of these four markets could thus give more insights into the possible effects that differing degrees of foreign participation might have on their market behaviour as well as their reaction to foreign market news.

The issues examined in this thesis are different but inter-related, issues regarding the price and volatility behaviour of each of the four individual Asian markets as well as their interactions with the world and regional markets. These include (i) the changing nature of volatility in the four individual Asian markets; (ii) the price relationships

between the four Asian markets and the markets in the US, the UK and Japan; (iii) the response of volatility in the four Asian markets to innovations from the US, the UK and Japan; and (iv) the link between the Four Tigers and their regional markets during the recent Asian financial crisis.

Chapter One gives some background information on the four Asian markets under examination by outlining both their economic and financial market developments. Chapter Two investigates the changing nature of volatility in individual markets following their liberalisation measures. In the past, interest in individual Asian markets concentrated on market anomalies such as day-of-the week and January effects, small firm effects and price/earnings ratio effects. Comparative analysis of the impact of market liberalisation on the changing nature of market volatility was non-existent. Moreover, news asymmetries in the volatility spill-over has not been addressed for Asian markets. This chapter aims to fill this gap in the literature. Two main arguments have been put forward as possible explanations for the asymmetric response of volatility to news, namely the leverage effect (Christie 1982) and the noise traders effect. If asymmetries arise from the leverage effect, then changes in foreign investment activity would have little impact on the extent of any asymmetries. However, if the second explanation of asymmetric responses is correct, then increasing activity by well-informed foreign investors might be expected to reduce the impact of noise traders, reduce observed asymmetries and, thus, alter the nature of local stock market volatility. To examine this issue, asymmetric generalised autoregressive conditional heteroscedasticity (GARCH) models are fitted to the unpredictable return series for each of the four markets over pre- and post-

liberalisation periods. Since noise trading can manifest itself in over-reaction to negative news, a significant reduction in the impact of negative news post-liberalisation would indicate a reduction in the impact of noise trading in the four markets following liberalisation. Results in this chapter show that there is a substantial reduction in news asymmetries following liberalisation.

The fact that the nature of volatility in individual markets underwent changes with the presence or increase in foreign participation is indicative of a possible link between the four Asian markets and other foreign markets. Price movements of the four Asian markets would become more influenced by overseas markets as foreign investors respond to their price movements or news to adjust their portfolio positions in the local Asian markets. Whether such inter-relationships between local and foreign markets do exist, and if so, how close, is an empirical issue to be addressed in Chapter Three. In Chapter Three, the relationships of the four Asian markets with three leading world markets, the US, Japan and the UK are examined for their price movements. These three leading markets are chosen on the basis of their share in portfolio investment in the Four Tigers' stock markets. The proposition is that if cross-market investment is the key mechanism for strengthening inter-market relationships, then there should be strong evidence of price co-movements between the leading markets and the Four Tigers. The Johansen technique is used to investigate this issue. A seven-market model is constructed over pre- and post-liberalisation periods for the four Asian stock markets to enable comparison of results. Results show that a significant cointegrating vector exists during the post-liberalisation period, but only with the UK, Hong Kong and Taiwan entering

significantly into the relationship. While this is suggestive that cross-market investment opportunities do have a role to play in strengthening world market interdependence, there are other factors determining the way in which each individual market inter-relates to one another. These include (i) the actual size of foreign equity securities investment in the Four Tigers on the part of the three leading markets and the state of economies they are in; (ii) the level of government intervention in their stock markets on the part of the Four Tigers. The insignificance of the US, Japan, South Korea and Taiwan in entering the cointegrating relationship during the post-liberalisation period is attributed to one of these two factors.

However, as cointegration essentially deals with the existence of a stable long-run equilibrium between markets, it says little about the short-term linkages and interactions between markets without a long run cointegrating relationship. In addition, the presence or absence of a long run price relationship with the world markets gives no information regarding the relative significance of local and world news in affecting volatility of the Asian markets. An examination into the impacts of foreign news on the volatility of local markets is therefore necessary. Thus in Chapter Four, the channels and the extent of market volatility spill-over to the Four Tigers are examined under a bi-variate asymmetric GARCH framework. The impacts of news from the three leading markets on each of the four Asian markets are investigated one at a time. Each model contains positive and negative news terms of a local market and that of a foreign leading market. Six models are examined over two sample periods for each local Asian market according to the time they introduced their liberalisation measures. There is evidence of volatility spill-over to South Korea and

Taiwan before they were opened to foreign direct participation. This, together with the absence of any intensification of foreign news impacts on Hong Kong and Singapore after they introduced measures to attract more foreign investment in their stock markets, suggests that cross-market stock investment is not the key mechanism for volatility transmission. The possibility that cross-market volatility transmission is induced by pure contagion effects is also ruled out. This is supported by the absence of a uniform asymmetric response of local markets' volatility to foreign negative news. Instead, the differing asymmetric effects of foreign news on local markets' volatility indicates that the presence of trading links could be the key channel of volatility transmission. Depending on the nature of the markets' economic ties, foreign news, such as changes in foreign exchange rates, could be good news to one local market but bad news to another. Through such differing impacts of foreign news on the local markets' economic fundamentals, volatility could thus be transmitted from the major markets to the four local markets with differing intensity. Yet in general, there is little evidence that the impact of foreign news on each of the four markets is on the increase following their liberalisation.

A logical extension of the empirical work would have been an analysis of regional effects on the four Asian stock markets' behaviour. However, the emergence of the Asian financial crisis since July 1997 has brought tremendous effects not only on the Asian markets but on other world financial markets and economies too. The severity of the crisis thus warrants a detailed examination into the crisis. Hence in Chapter Five, the Four Tigers' relationships with other regional markets are examined over two periods, before and during the crisis, to see how their relationships have been

changed by the crisis. The intensity and persistence of shocks from one Asian market in affecting others are also investigated. The empirical analysis is based on variance decomposition and impulse response functions derived from the Vector Autoregression modelling method. The three most troubled markets during the crisis, Thailand, Malaysia and Indonesia, are examined together with the Four Tigers' stock markets. The main objective is to establish whether price movements in these seven Asian markets have been responding to shocks from the region before and during the crisis and if so, for how long and to what extent. Results show that three of the Four Tigers, Hong Kong, South Korea and Taiwan, are not responsive to shocks from the three regional emerging markets before the crisis. Only Singapore is found to be substantially affected by shocks from Hong Kong and Malaysia. This is attributed to its strong financial and economic ties with them. Nevertheless, the effects of all regional markets on each individual Asian market are not persistent, often lasting for just one day. During the crisis, the seven regional markets have a stronger interaction. South Korea, Taiwan and Hong Kong are increasingly affected by shocks from other markets in the region and their shocks are now more influential on others too. Not only that, the effects of shocks from each one of the seven markets have become more persistent, lasting for up to five days. Meanwhile, markets' responses to the regional shocks are slow and appear to be uncertain, not knowing which direction should be taken. This indicates that the pure contagion effect (where the shocks have no implications on the local market's fundamentals) and/or fundamentals contagion effect (where economic fundamentals of the local market have been changed by the shocks) might be at work to help spread the crisis across the region.

To sum up, this thesis has contributed to the understanding of price and volatility behaviour of four Asian stock markets over the period of 1986-1998 on four counts.

(1) There is a changing nature of volatility in the stock markets of Hong Kong, Singapore, South Korea and Taiwan following their market liberalisation in that there has been an increase in informed trading and a reduction in the impacts of noise trading.

(2) The relationships of the Four Tigers with either the world's major markets or the region's emerging markets have not been substantially strengthened with an increase in foreign investment opportunities in their markets. The ways their stock markets are inter-related with other markets are more governed by the economic ties they have with the rest of the world.

(3) Local market news and economic conditions remain the major driving forces behind the movements of the four Asian markets regardless of their institutional changes.

(4) Market contagion is at work during the Asian crisis as some markets are slow to respond to regional shocks and often with uncertainty.

Chapter One : Economic Background And Financial Market

Developments Of The Four Tigers

(I) Hong Kong

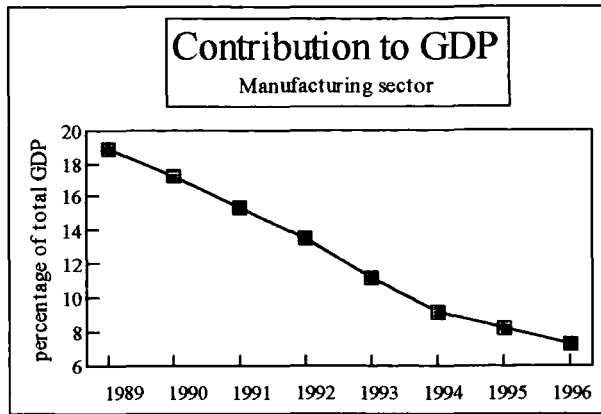
(A) *Economic background*

(A.1) Core economic sectors

(A.1.1) Service sector

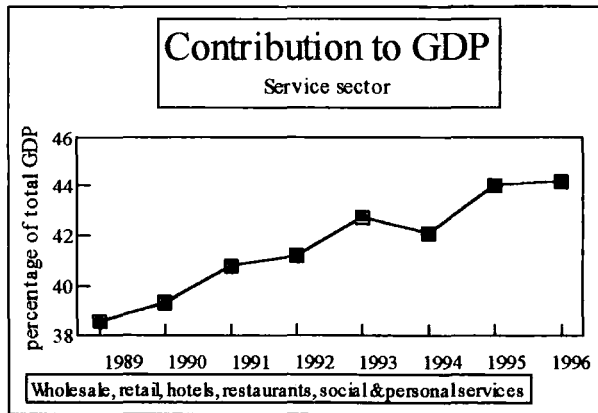
Hong Kong is essentially a trading centre that relies heavily on export trade for economic growth. During the past few decades, it started out as a low-cost labour-intensive manufacturing base. In the last ten years, however, a large share of Hong Kong's manufacturing capacity has been shifted over the border into China in order to take advantage of lower operating costs. Unlike other newly developed countries in the region, Hong Kong has not developed any high-technology industries to replace its declining labour-intensive industries. Instead, its service industries, such as finance, business, catering as well as those relating to trade, developed rapidly and became Hong Kong's core economic sector. Figures 1.1 and 1.2 reveal two contrasting pictures of these two sectors' contribution to GDP. While the manufacturing sector's contribution has declined by more than half over the past eight years, that of the service sector has been increasing steadily. Figure 1.3 shows that in 1996, 46.6% of Hong Kong's GDP was contributed by the service sector compared to 7.7% for the manufacturing sector. Thus the service sector is now even more dominant as Hong Kong's major economic sector.

Figure 1.1 *Contribution of the manufacturing sector to GDP in Hong Kong*



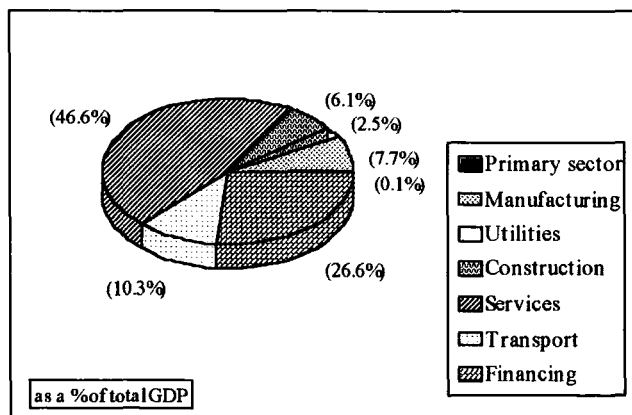
Source: EIU Country Profile : Hong Kong (1995-98)

Figure 1.2 *Contribution of the service sector to GDP in Hong Kong*



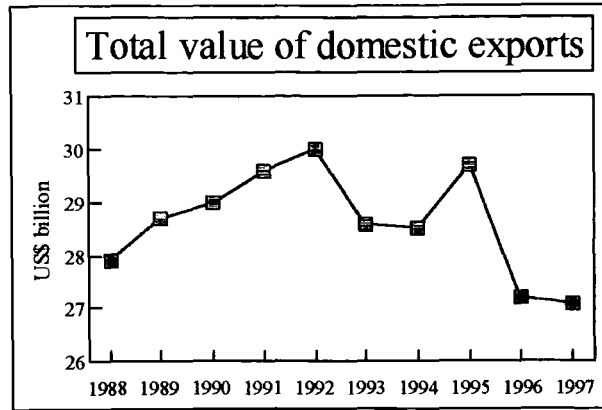
Source: EIU Country Profile : Hong Kong (1995-98)

Figure 1.3 *Gross domestic product by sector in Hong Kong (1996)*



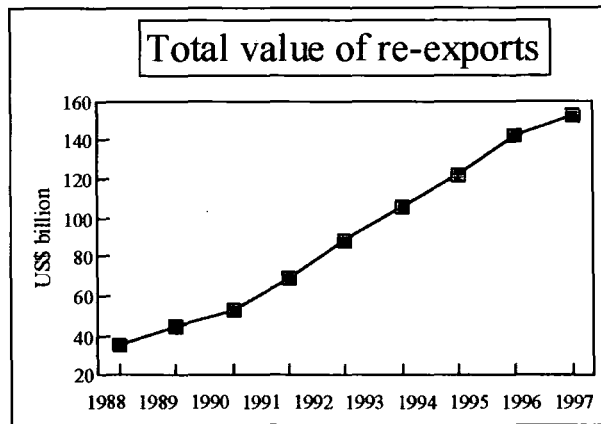
Sources: EIU Country Profile : Hong Kong (1995-98) and Annual report of Hong Kong (1990-1995)

Figure 1.4 *Total value of domestic exports in Hong Kong*



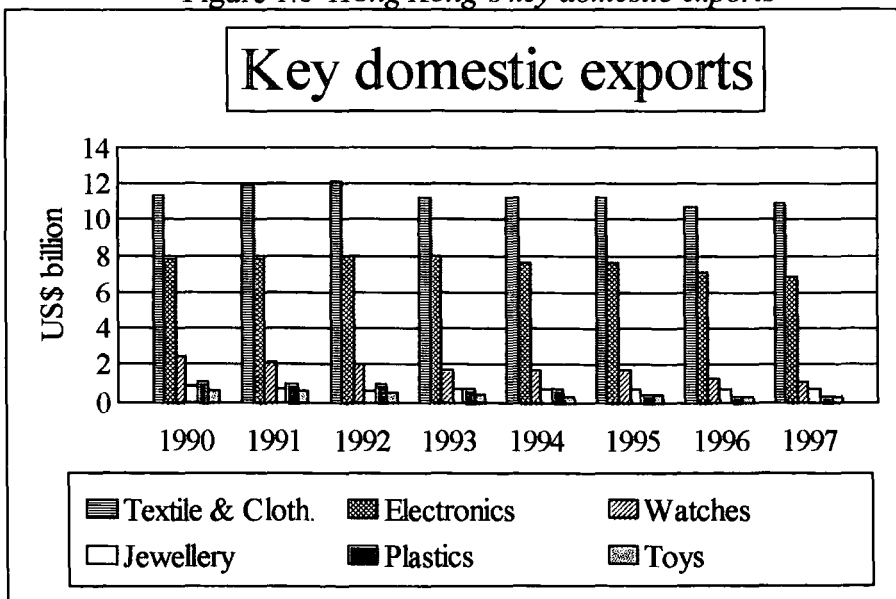
Source: EIU Country Profile : Hong Kong (1995-98)

Figure 1.5 *Total value of re-exports in Hong Kong*



Source: EIU Country Profile : Hong Kong (1995-98)

Figure 1.6 *Hong Kong's key domestic exports*



Sources : EIU Country Profile : HK (1995-98) and Annual report of HK(1990-1995)

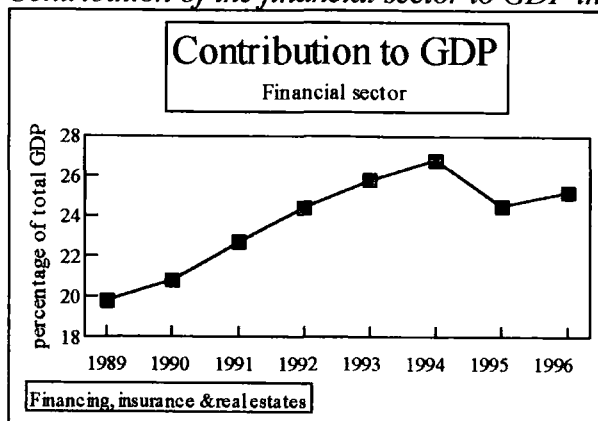
(A.1.2) Trade sector

Export trade has always been a main source of Hong Kong's earnings. It consists of domestic exports and re-exports. The total value of re-exports in 1997 amounted to US\$159 billion compared to US\$27 billion for domestic exports. Figures 1.4 and 1.5 show that the value of domestic exports was gradually falling whilst that of re-exports was rising rapidly over the past decade. The fall of the former is likely to be caused by a contraction in manufactured outputs and the growth of re-exports could be the result of continuous upgrading and expanding of Hong Kong's container port. The sharp increase in indirect trade between China and third countries through Hong Kong is also likely to have played a part. Figure 1.6 shows that now, only textile, clothing and electronic products remain as Hong Kong's significant domestic merchandise exports.

(A.1.3) Financial sector

Hong Kong is among the most important financial centres in the world. This sector is the main pillar of Hong Kong's economic growth. Together with insurance, real estate and business services, financial services account for a quarter of Hong Kong's GDP from 1992 onwards as shown in Figure 1.7, compared to 15% in 1984.

Figure 1.7 *Contribution of the financial sector to GDP in Hong Kong*



Source : EIU Country Profile : Hong Kong (1995-1998)

(A.2) Government's economic policy

(A.2.1) Laissez faire policy

Since the Second World War, the government has followed a non-interventionist economic policy. The government is of the view that the allocation of resources in the economy will normally be achieved in the most efficient way if market forces are relied on and if government intervention in the private sector is kept to a minimum. Its low tax regime, good geographical location between East and West as well as excellent infrastructure have attracted lots of high value-added direct investment into the region. These include financial services, regional headquarters and companies doing business in China.

(A.2.2) Monetary policy

Since 1983 when the Hong Kong dollar was pegged to the US dollar at US\$1:HK\$7.8, the government has lost control over monetary policy. Interest rate and monetary policy have to be made in line with the US policies. This has undermined the government's ability to tackle inflation problems. As a result, there has been a surge of money into the stock and property markets, where returns are traditionally higher than the interest rates paid on bank deposits.

(A.2.3) Fiscal policy

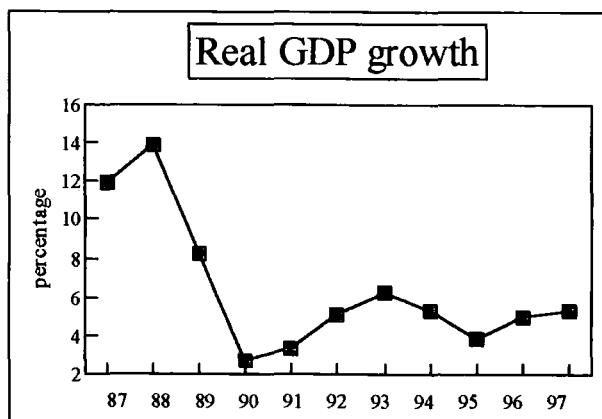
In order not to interfere with the economy, government spending is restricted to providing essential support services, such as housing, education and to a lesser extent, health care. Meanwhile, revenue is raised through a combination of direct and indirect taxes, land sales and utility charges. Stamp duty earnings from property and

stock market transactions have also become an increasingly important revenue source. Consequently there has been a budget surplus every year since 1985/86.

(A.3) Economic performance

The economy of Hong Kong is strongly cyclical, partly because it is so open to foreign trade, and partly because the government normally chooses not to iron out cyclical fluctuations. Hence, booms and recessions tended to be relatively violent until the 1990s. In general, however, the growth trend in the 1980s was upwards, with an average annual GDP growth of 7.7% in real terms. Into the 1990s, the growth dipped when China experienced a slowdown in 1989 to 1990. The negative impact of Beijing's Tien-an-men Square Massacre in 1989 on public confidence helped aggravate the situation. On average, Hong Kong's GDP was below its trend rate of about 5% per annum during the past seven years as shown in Figure 1.8.

Figure 1.8 *Real rate of GDP growth in Hong Kong*



Sources : EIU Country Profile : HK (1995-98) and Annual report of HK(1990-1995)

(A.4) Other economic indicators

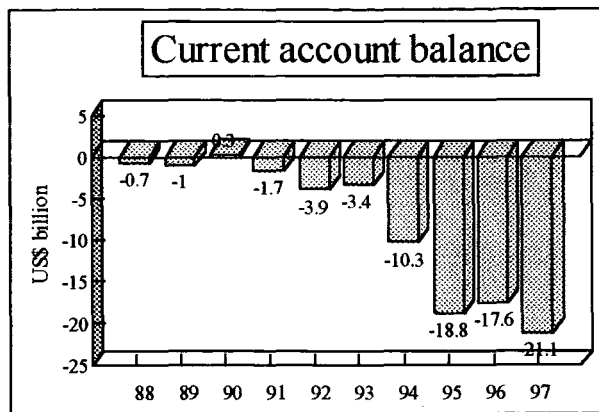
(A.4.1) Foreign exchange rate system and foreign reserves

Hong Kong abandoned its floating exchange rate system introduced in late 1974 and adopted a linked exchange rate system in late 1983. Under this system, the HK\$ was pegged at 7.8 to the US\$ with a two percent fluctuation band. The consequences of this peg are that interest rate policy has to be surrendered and relative trading competitiveness is affected by movements in the value of US currency. Despite these constraints, the government still sees this peg as necessary to maintain economic stability in Hong Kong and has no intention to modify this exchange rate system in the near future. As far as foreign reserves are concerned, Hong Kong has abundant foreign exchange reserves that are continuing to grow rapidly. By 1995 the territory's foreign exchange reserves were estimated as the seventh largest foreign exchange holdings in the world.

(A.4.2) Current account balance

Figure 1.9 shows that for almost every year since 1988, Hong Kong's current account has always been in deficit and the deficit grew larger and larger in the mid-1990s. This could be due to the faster rate of growth in imports than in total exports. The strength of the US\$ to which the Hong Kong dollar was pegged, as well as the decline of domestic manufacturing industries were responsible for widening the gap between imports and exports.

Figure 1.9 *Hong Kong's current account balance*



Source : EIU Country Profile : Hong Kong (1995 -1998)

(B) Stock market developments

(B.1) Formation

The first stock market in Hong Kong was established in 1964. Between 1969-71, three more stock exchanges were established. In order to promote Hong Kong as an international financial centre, a number of measures were introduced between 1970 and 1980. These include the abolition of foreign exchange controls, capital gains tax, as well as withholding tax on interest payments on all deposits. Then in 1986, the four Stock Exchanges were unified into the Hong Kong Stock Exchange to enhance efficiency. The Stock Index Futures Market was also established in this year.

(B.2) Market structure

All listed companies in Hong Kong are traded under common execution, settlement and clearance procedures. There is no secondary or over-the-counter market in Hong Kong. In order to list on the HKSE, a company must first be a public company and commit to remaining public. They must have an initial capitalisation of at least HK\$150 million (about US\$19.4 million) although the listing committee has

discretionary power to require higher or accept lower capitalisation. At least 25% of shares outstanding or shares valued at a minimum of HK\$24.5 million (about US\$3.2 million), whichever is greater, must be made available to the public. Smaller companies, however, are still unable to list equities at present.

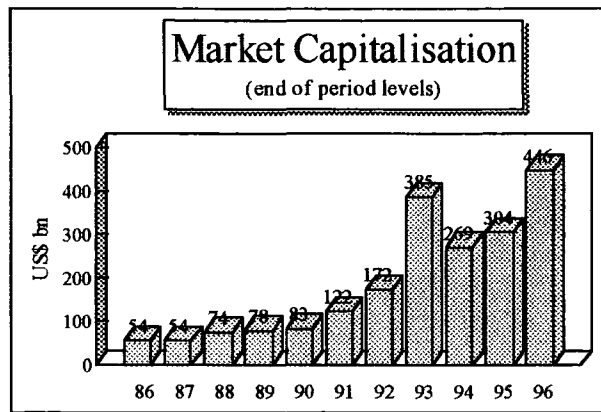
A new development in the market began to emerge as the hand-over of Hong Kong back to Chinese rule was approaching. The HKSE expanded its listings to include many China-based corporations seeking overseas capitalisation. In 1993, nine Chinese companies were listed on the exchange and many others were scheduled for the following years.

(B.3) Market characteristics

(B.3.1) Market capitalisation

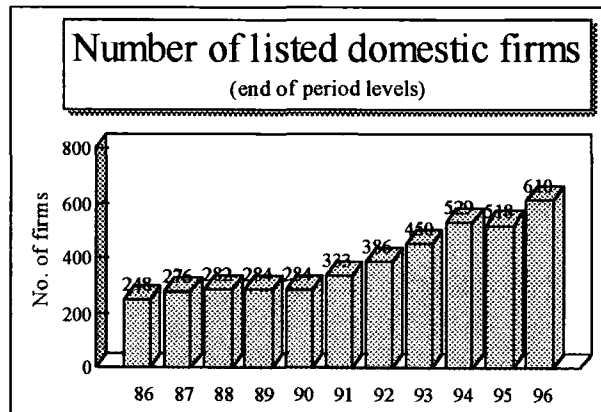
Hong Kong has the largest market capitalisation among the 'Four Tigers' and is the second largest market in the region after Japan. Figure 1.10 shows that its market capitalisation grew slowly in the late 1980s but by 1993, it climbed by more than twice from the previous year's level to US\$385 billion. In 1996, it reached another historic record of US\$446 billion. The sharp rise in market capitalisation during the past four to five years could have been attributed to an influx of foreign portfolio capital at the time when US prime interest rates were cut and unit trusts and pension funds in western countries were growing rapidly. Thus institutional investors would become increasingly interested in Asian stock markets where returns were expected to be much higher.

Figure 1.10 *Market capitalisation of the Hong Kong Stock Exchange*



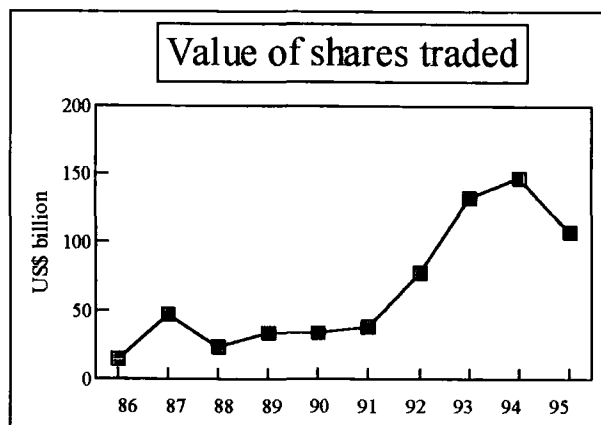
Source : IFC Emerging Market Fact book (1996)

Figure 1.11 *Number of listed domestic firms in Hong Kong*



Source : IFC Emerging Market Fact book (1996)

Figure 1.12 *Value of shares traded in the Hong Kong Stock Exchange*



Source : IFC Emerging Market Fact book (1996)

(B.3.2) Number of listed domestic firms and value of shares traded

Figures 1.11 and 1.12 show that the number of listed domestic firms as well as the value of shares traded did not change too much between 1986 and 1990. Then in 1991, they began to rise at a faster rate, especially from 1992 onwards. This could result from the fact that more and more local firms wished to raise capital from the market as foreign investors were showing more interest in the Hong Kong market. Alternatively, as the hand-over of Hong Kong back to mainland China in 1997 got closer, more China-linked companies began to list on the Exchange so that foreign investors could participate in the Chinese market indirectly. In both cases, the number of listed domestic firms as well as the value of shares traded in the market would be driven up.

(B.3.3) Foreign Portfolio Investment

Information on foreign portfolio investment in Hong Kong is very fragmentary. Neither the Stock Exchange of Hong Kong itself nor other world organisations, such as the International Financial Corporation and the World Bank, publish annual figures for the foreign capital movements in Hong Kong. Therefore, the change in foreign portfolio investment in Hong Kong from the mid-1980s to the mid-1990s can only be inferred indirectly from other sources of information. For instance, according to the World Economic Outlook published by the International Monetary Fund (October, 1993), the amount of equity investment in Asia by the developed world was less than US\$0.5 billion between 1982 and 1988. However, between 1989 and 1992, the amount rose to US\$2.9 billion. Being one of the largest and the least restrictive developing markets in Asia, the benefit of such an increase of foreign portfolio

investment in the region to Hong Kong is perceivable. Moreover, according to the Asian Company Handbook (1998), almost half of Hong Kong's listed companies in 1996 had their shares owned by foreign investors, with the percentages of their share ownership ranging from 5% to above 50%. Taken together, these figures suggest that there has been a change in foreign portfolio investment in Hong Kong from the mid-1980s to the mid-1990s.

(B.3.4) Stock market indicator

The activity of the Hong Kong Stock Exchange is measured by three main stock indices. The oldest and most widely used, is the Hang Seng Index compiled by a subsidiary of Hang Seng Bank. The index was first published in 1969 with 31 July 1964 as its basis base point, that is, Hang Seng Index = 100. The index is based on 33 companies in different industry sectors, weighted by market capitalisation and is thus strongly influenced by large capitalisation stocks.

(B.3.5) Trading system and trading hours

At present, only 620 members of the HKSE are allowed to trade on the exchange and transactions are carried out by floor-traders on behalf of their member firms. Alternatively, the trade can be conducted through the exchange's computerised trading system and there are no time limits for off-floor trading. There are also no limits on daily permissible price movements in stocks. However, the deals transacted off the floor are treated as trades for the following day for the purposes of reporting and settlement. Trading hours of the Exchange are from 9:00 a.m. to 12:30 p.m. and 1:30 p.m. to 4:30 p.m., Monday through Friday.

(B.4) Market regulation and investor protection

The Hong Kong government has kept intervention in the financial system to a minimum. In May 1989, it set up the Securities and Futures Commission in response to the weaknesses in Hong Kong's financial markets at the time of October 1987 world stock market crash. It was established as an autonomous statutory body, outside the civil service, funded largely by the market and partly by the government. The Governor of Hong Kong appointed its directors and might give policy direction to it. Now it is responsible for overseeing the operation and modernisation of the stock exchange.

To protect investors, a Stock Exchange Compensation Fund was formed to compensate investors in the case of fraud. It was formed from deposits with the Securities Commission by each Stock Exchange firm for each individual stock broker admitted as a member. This Fund will pay out compensation, up to a limit of HK\$2 million per stockbroker involved in any default, to customers who have suffered monetary loss as a result of a member's default. In addition, the insider dealing tribunal may inquire into insider dealings and report them to the public. However, insider dealing is not a criminal offence in Hong Kong.

(B.5) Cost of dealing and taxation

Table 1.1 *Cost of dealing and taxation in the Hong Kong Stock Exchange*

Commission rates on equity transactions	0.25% on contract value subject to a minimum of HK\$ 25 (around US\$3.2)
Stamp duty	0.6% on all securities transactions levied on both the buyer and seller
Tax on interest income and dividends	Nil
Tax on capital gains	Nil

Source : Annual Report of Hong Kong (1995)

(B.6) Links with other international or emerging markets

There are no formal links with overseas markets in terms of trading and settlement. However, the exchange is trying to forge closer links with the international market. It has linked up with the London stock market for the exchange of closing prices of selected Hong Kong securities traded in the United Kingdom. At present, twenty-eight Hong Kong shares are cross-listed in the London Stock Exchange.

(II) Singapore

(A) Economic background

(A.1) Core economic sectors

(A.1.1) Manufacturing sector

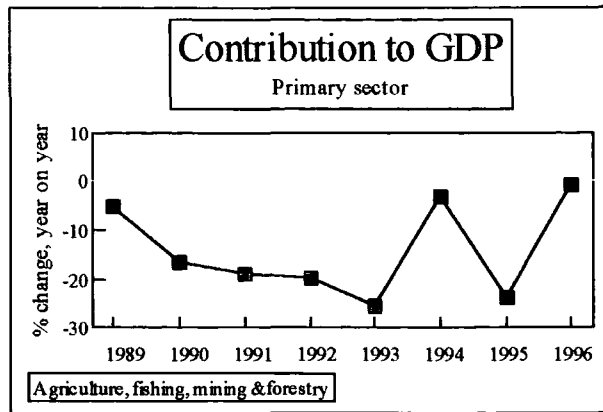
Singapore's economy is highly industrialised with emphasis placed on developing high value-added and capital intensive manufacturing industries. Its primary sector plays only a limited role in the economy whilst the service sector has just started to grow during the 1990s. Among all manufacturing industries, electronics is the most

important. Singapore is the world's major producer of disk drives. Oil refining, chemicals and pharmaceuticals are other significant manufacturing industries in the country. Figures 1.13 to 1.16 show that both the manufacturing and financial sectors grew rapidly between 1992 and 1994, whilst in recent years the rate of growth has slowed. The primary sector remained weak throughout the early 1990s. By 1996, the manufacturing and financial sectors together represent just above half of Singapore's gross domestic product whilst the primary sector's contribution is negligible.

(A.1.2) Financial sector

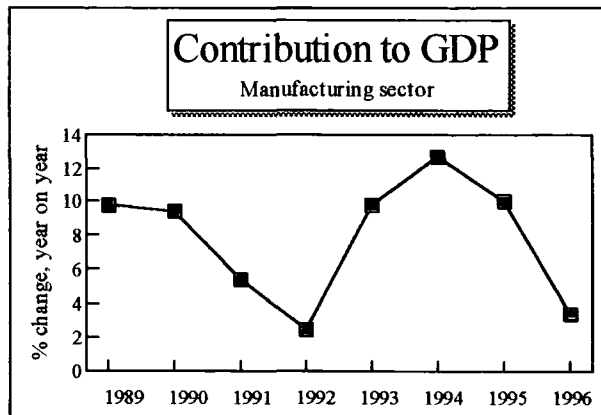
Singapore has had a well established off-shore banking system since the 1970s and its foreign exchange market is the world's fourth largest market. It is a regional centre for offshore deposit taking and foreign exchange activities. The government's tight regulatory policies might have given investors the confidence needed to undertake these financial activities in Singapore. Its local banking sectors and stock exchange, however, are less established. Four locally owned banks dominate and control the retail banking in Singapore. As for the Singapore stock exchange, there is a lack of supply and demand for market shares as many firms across the spectrum are under state control. Thus the more liberal offshore financial system is doing better than the more tightly controlled domestic one.

Figure 1.13 *Contribution of the primary sector to GDP in Singapore*



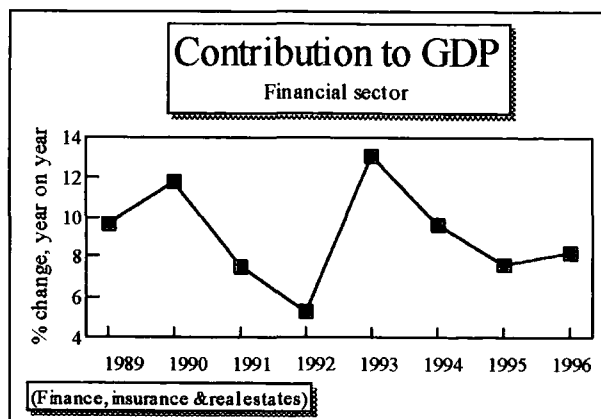
Source : EIU Country Profile : Singapore (1995 - 1998)

Figure 1.14 *Contribution of the manufacturing sector to GDP in Singapore*



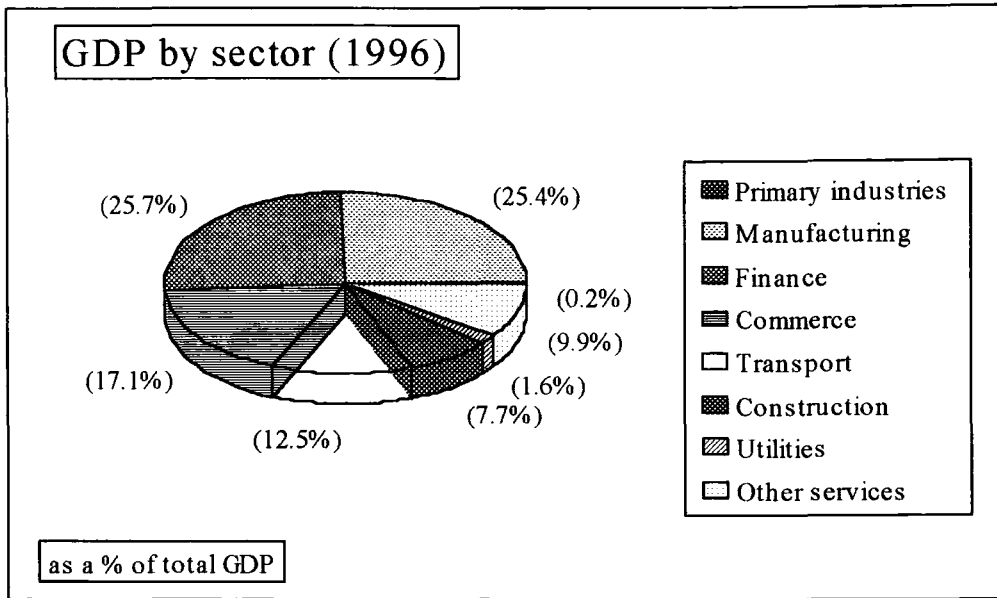
Source : EIU Country Profile : Singapore (1995 - 1998)

Figure 1.15 *Contribution of the financial sector to GDP in Singapore*



Source : EIU Country Profile : Singapore (1995 - 1998)

Figure 1.16 *Singapore's GDP by sector in 1996*

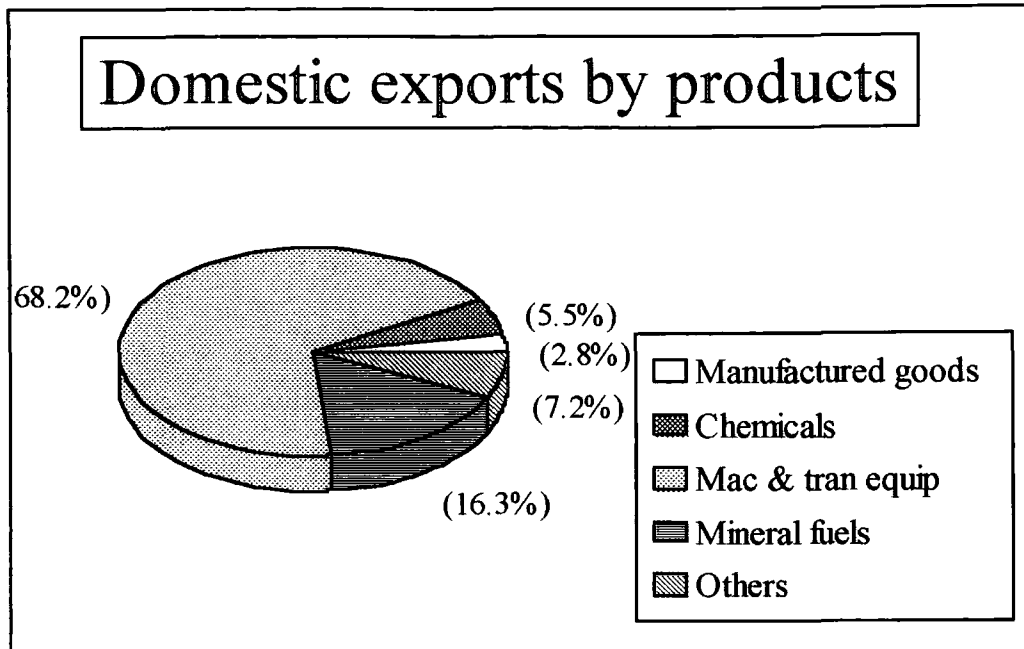


Source : EIU Country Profile : Singapore (1997)

(A.1.3) Trade sector

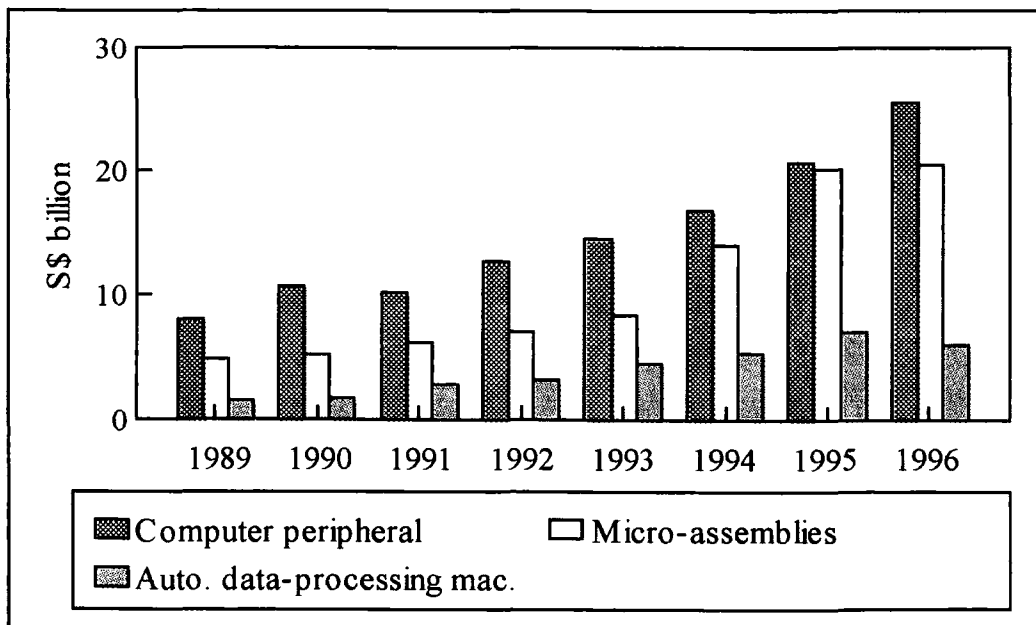
Singapore's economy is also highly dependent on entre-pot trade thanks to its excellent port facilities and good geographic location between the East and West of the world. A large volume of merchandised goods imported into Singapore are re-exported to other parts of the world. The total value of trade in goods and services was equivalent to around 250% of GDP in the early 1990s, compared with 10% to 20% for Japan and US. As far as domestic exports are concerned, the bulk of the exports is made up of machinery and transport equipment, which accounts for 68.2% of total domestic exports in 1996 as shown in Figure 1.17. Among them, electronic products such as computer peripherals, micro-assemblies and integrated circuits as well as automatic data-processing machines are the key elements of Singapore's domestic exports. In fact, Figure 1.18 suggests that there is a clear growing trend for the exports of these electronic goods and machinery since 1989. However, from 1995 there are signs of a slowing down in the pace of growth.

Figure 1.17 *Singapore's domestic exports in 1996*



Source : EIU Country Profile : Singapore (1997)

Figure 1.18 *Singapore's key exports (1989-1996)*



Source : EIU Country Profile : Singapore (1995 - 1998)

(A.2) Government's economic policy

The Singapore government has long adopted an interventionist policy in managing the country's economy through direct and indirect measures. On the one hand, it is deeply involved in the individual industries through ownership of firms in many sectors. On the other, it constantly directs the path of its economy through investment incentives so as to achieve its set targets. The Singapore government is directly involved in many industries across the spectrum, ranging from high-tech defence contractors to low-tech service industries. Several sensitive and strategically important industries, such as defence-related industries and utilities, are under direct state control. The government also controls a number of Singapore firms indirectly through its agencies such as the Government of Singapore Investment Corporation and Singapore Technologies. Through these agencies, it can retain a strong influence over its banking, shipping, engineering as well as technology sectors.

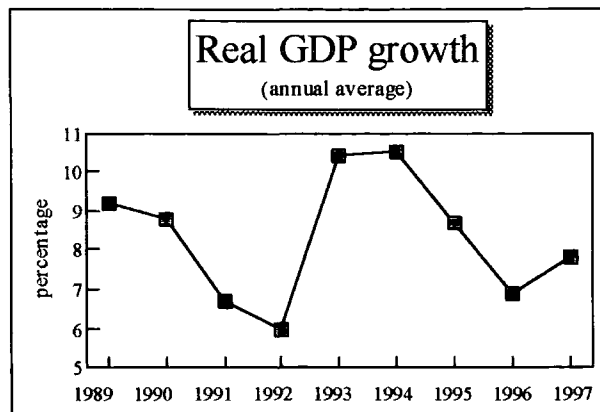
Apart from direct and indirect participation in local firms, the government also plays an active role in steering the economy through micro-economic policy. For instance, during the 1970s when the government tried to shift the economy from labour-intensive to high-technology and capital-intensive industries, it greatly increased wage costs in an attempt to force greater use of machinery. As a result, labour-intensive industries were relocated in its neighbouring countries such as Thailand and Malaysia that had lower labour costs, whilst capital-intensive industries such as electronics became the star performer. Yet the fall in global demand for some electronic products in mid-1980s had forced the government to change its direction. From 1988 onwards, it placed more emphasis on the growth of local small and medium-sized enterprises,

the service sectors and the financial sector. It also encouraged firms to expand to other countries in the Asia-Pacific region such as China and India. The resurgence in world demand for electronic products, such as disk drives, in the early 1990s once again prompted the government to direct resources to boost the industry and export of electronic goods.

(A.3) Export-led economic growth

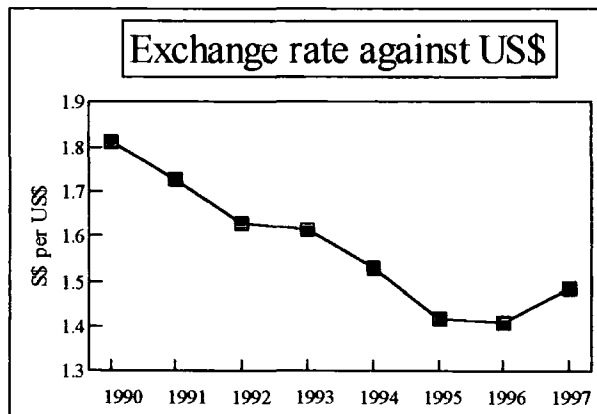
Figure 1.19 shows that since 1989 Singapore's annual rates of growth have been high with an average of around 7% per annum. Much is owed to a continuing expansion in investment and in exports. In recent years, the booming electronics sector has helped Singapore grow even faster than Hong Kong, South Korea and Taiwan. The role of the government behind such remarkable growth in Singapore is noticeable too. It offers a favourable environment to industries by providing investment incentives as well as economic stability for them to develop and grow. For instance, it has let the value of the Singapore dollar appreciate, so reducing imported inflation. The inflation rate is the lowest among neighbouring countries, staying within the range of 2%-3% per annum. Its tax rates are also stable from year to year, with changes signalled well in advance, allowing investors to plan ahead to accommodate the changes. Foreign investment too is welcomed to bring in manufacturing and service facilities, helping to boost Singapore's prosperity. All these measures have brought about sound economic growth in Singapore between the mid-1980s and the mid-1990s.

Figure 1.19 *Real rate of GDP growth in Singapore*



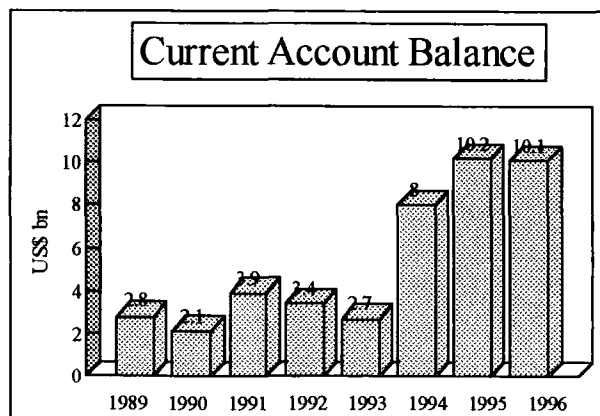
Source : EIU Country Profile : Singapore (1995 - 1998)

Figure 1.20 *Exchange rate of Singapore dollar against US dollar*



Source : EIU Country Profile : Singapore (1995 - 1998)

Figure 1.21 *Singapore's Current account balance*



Source : EIU Country Profile : Singapore (1995 - 1998)

(A.4) Other economic indicators

(A.4.1) Foreign exchange rate system and foreign reserves

In the 1980s, the Singapore dollar was held against a basket of currencies but this arrangement was later broken. Now, the value of the Singapore dollar is heavily weighted against the US dollar, as US is its major trading partner and its interest rates mirror those of the US. Since 1992, its exchange rate against the US dollar has been stable at around S\$1.4 to S\$1.6 per US\$ as shown in Figure 1.20. Apart from having a stable currency, Singapore also has substantial foreign reserves and they are on the increase year after year. Their reserves stood at US\$ 76 billion in 1996, which was the fifth largest foreign exchange holding in the world.

(A.4.2) Current account balance

Singapore has experienced a balance of payments surplus since 1989. Figure 1.21 shows that the surplus rocketed upwards since 1993 and this coincided with the time when Singapore's manufacturing sector was booming and the exports of electronic machinery was rapidly increasing.

(B) Singapore Stock Exchange

(B.1) Formation

The roots of the Singapore Stock Exchange can be traced back to 1930 with the formation of the Singapore Stockbrokers' Association to regulate activities in the interest of the public. During the following four decades, the Stock Exchange underwent a number of name changes, and eventually became incorporated as the Stock Exchange of Singapore Ltd. (SES) in May 1973. Since 1995, there have been

no foreign exchange controls nor restrictions on foreign trading in Singapore shares, although foreign share-holdings in strategic industries such as defence and banking are limited. There are no limitations on the repatriation of income, capital gains and capital.

(B.2) Market structure

The Stock Exchange of Singapore operates four markets for the trading of securities and derivatives: the Main Board, SESDAQ, Stock Options and CLOB International.

(B.2.1) Main Board

Companies have to meet minimum criteria with respect to capital, number of shareholders, turnover and dividends etc. to be admitted to the Main Board. Approximately, two-thirds of the companies listed on the Stock Exchange are included in this Board. As at 31 December 1994, a total of 197 Singapore and 32 foreign companies were listed on the Main Board with a market capitalisation of S\$256.12 billion.

(B.2.2) SESDAQ

The Stock Exchange of Singapore Dealing and Automated Quotation (SESDAQ) Board, the second securities market launched in 1987, is designed to provide an avenue for small and medium-sized Singapore-incorporated companies to raise funds for their expansion. As at 31 December 1994, 43 companies were listed on SESDAQ with a market capitalisation of S\$3.32 billion. Shares listed in the SESDAQ may be promoted to the Main Board when they satisfy the necessary requirements.

(B.2.3) Stock Options

Trading of equity options commenced on 8 March 1993. As at 1994, call and put options on four underlying stocks were traded.

(B.2.4) CLOB International

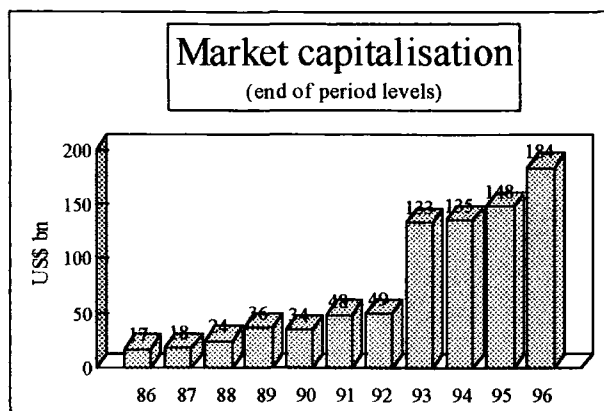
On 2 January 1990, the Exchange introduced an over-the-counter market known as the Central Limit Order Book (CLOB) International. The CLOB is a floor-less screen-based computerised trading system for all transactions carried out on the Exchange. Orders are executed on a broker-to-broker basis by means of high powered trading workstations located in brokers' offices. The CLOB system maintains an order book for every traded security and matches buy and sell orders keyed in by brokers. Each order in the order book has a limit price, this being the highest (for a buy order) or lowest (for a sell order) price at which the order can be carried out. Confirmation of trades are disseminated automatically after the trade is executed. The establishment of the CLOB International allows investors to trade in a number of international securities which are listed on foreign stock exchanges. As at 31 December 1994, 10 Hong Kong stocks, 112 Malaysian stocks and 4 other international stocks were quoted on CLOB International.

(B.3) Market characteristics

(B.3.1) Market capitalisation

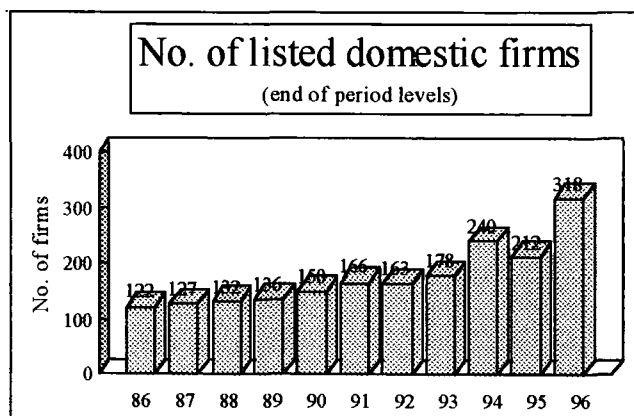
Figure 1.22 shows that Singapore had a small market capitalisation of less than US\$50 billion before 1993. Since 1993 market capitalisation began to surge. It coincided with the time when the government tried to part privatise some of its tightly

Figure 1.22 *Market capitalisation of the Stock Exchange of Singapore*



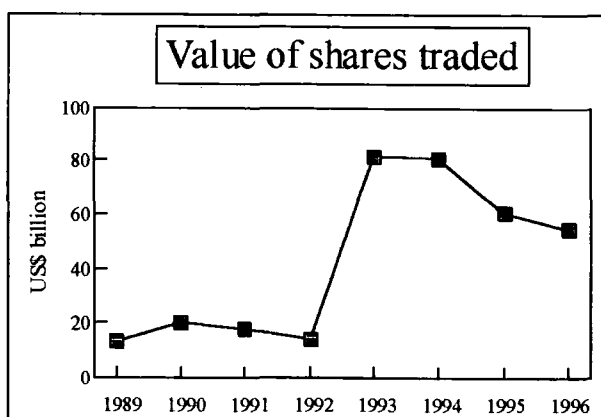
Source: IFC Emerging Market Fact Book (1996)

Figure 1.23 *Number of listed domestic firms in Singapore (1986-1996)*



Source: IFC Emerging Market Fact Book (1996)

Figure 1.24 *Total value of shares traded in the stock exchange of Singapore*



Source: IFC Emerging Market Fact Book (1996)

controlled utilities and industries, thus increasing the number of listed firms as well as the value of firms with existing listings.

(B.3.2) Number of listed domestic firms and value of shares traded

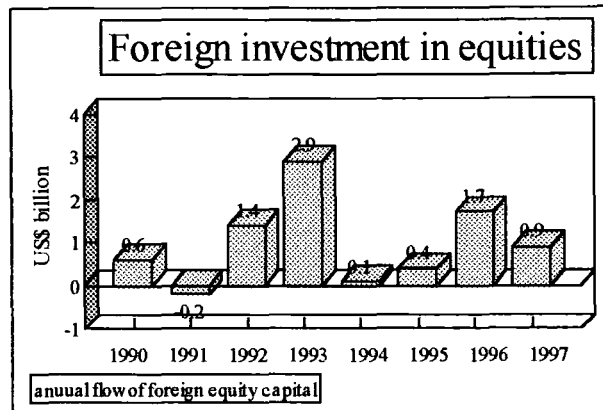
Figure 1.23 shows that the number of listed domestic firms in Singapore was on the increase year after year with the biggest changes taking place after 1993. Again this could have been the result of the government part-privatisation plan to float its state-owned industries to the stock exchange, leading many other firms to follow suit. Total value of shares traded in the market also rose dramatically from 1993 as shown in Figure 1.24.

(B.3.3) Foreign investment in Singapore's equities

Figure 1.25 shows that the Stock Exchange of Singapore received the largest net amount of foreign equity investment capital in 1993 of about US\$2.9 billion than in the previous three years. In common with other emerging markets in Asia, this was likely the result of an influx of foreign capital from the developed world at a time when returns from these markets were low due to recession. The availability of more investment opportunities in Singaporean stocks in 1993 after the part-privatisation of some state-owned companies could also have contributed to such an increase in foreign portfolio investment. Then in the subsequent two years, foreign equity investment capital fell to around US\$0.1 billion to US\$0.4 billion in 1994 and 1995. Such a fall could be the result of a shift of foreign investment from portfolio investment to direct investment in Singapore so as to take advantage of its booming

electronic industries. As a matter of fact, the amount of direct investment in Singapore doubled from US\$4 billion in 1993 to US\$8 billion in 1994 and 1995.

Figure 1.25 *Foreign investment in Singapore's equities*



Source : IMF Balance of Payments Statistics Yearbook (1998)

(B.3.4) Stock market Indicator

There are several financial indices that trace the price movement of the Singapore stock market. These are identified in Table 1.2 below. Among these indices, the Straits Times Industrial Index is the most commonly used in representing the market movement.

Table 1.2 *Stock market indicators of the Stock Exchange of Singapore*

Indices	Component Stocks
SES All Singapore Index	All Singapore shares
Straits Times Industrial Index	30 stocks in the commercial and industrial sectors
BT Composite Index	40 Component stocks representing various sectors
OCBC Index	55 component stocks from all industry groups
UOB SESDAQ Index	All SESDAQ stocks

Source : The Stock Exchange of Singapore Fact Book (1995)

(B.3.5) Trading system and trading hours

(B.3.5.1) Open out-cry system

Before 1988, transactions were executed through brokers, who acted as either principals or agents in any transaction, but they had to disclose to clients the capacity in which they were acting. No limitations were placed on daily permissible price movements in securities by then.

(B.3.5.2) Computerised trading system

In 1988, a computerised order-routing and confirmation system was implemented to allow brokers to send their orders to the trading floor and receive trade confirmation through a computer network. From 1989, a floor-less screen-based computerised trading system for all transactions carried out on the Exchange known as the Central Limit Order Book (CLOB) began in use. A brief description of the system has been given in Section B.2.4.

(B.3.5.3) Trading hours

Trading in the Singapore Stock Exchange takes place from Monday to Friday, 9:00 a.m. to 12:30 p.m. and from 2:00 p.m. to 5:00 p.m.

(B.4) Cost of dealing and Taxation

(B.4.1) Taxes

In 1987, interest income on government bonds was subject to the normal tax rate of 30%, though some specific bonds might be tax free. Share dividends were also

taxable at a rate of 33%. By 1995, taxes on interest income, share dividends and capital gains were all abolished.

(B.4.2) Brokerage fees

The scales of brokerage payable for securities transactions on the Main Board and SESDAQ as at December 1995 are listed in Table 1.3.

Table 1.3 *Brokerage fees for trading in the Stock Exchange of Singapore*

Transaction amount	Brokerage percentage
On the first S\$250,000 (approx. US\$176,429)	1.0%
On the next S\$250,000	0.9%
On the next S\$250,000	0.8%
On the next S\$250,000	0.7%
On the next S\$250,000	0.5%
On amounts exceeding S\$1.5 million	negotiable, subject to a minimum of 0.3%

subject to a minimum brokerage of S\$2 per contract

Source : The Stock Exchange of Singapore Fact Book (1995)

(B.4.3) Other transaction fees

Table 1.4 *Other transaction fees for trading in the Stock Exchange of Singapore*

Clearing fees	0.05% on the contract value, subject to a maximum of S\$100.
Contract stamp duties	0.05% on the contract value
Transfer stamp duties	0.2% on the contract value
Goods and Sales Tax	3% on brokerage and clearing fees

Source : The Stock Exchange of Singapore Fact Book (1995)

(B.5) Market Regulation and Investor Protection

(B.5.1) Market regulation

While Hong Kong has a more hands-off regulatory style, Singapore has a closer regulatory oversight towards the stock market operation. Numerous restrictions are

applied to insulate the country's financial system from foreign shocks. For instance, to protect domestic currency from too much foreign attention, overseas loans denominated in Singapore dollars are discouraged. Membership of the Stock Exchange is also limited to Singapore incorporated companies or Singapore citizens. Foreign membership is achieved by holding shares in stock-broking firms which are member companies of the Stock Exchange of Singapore. However, foreign ownership can only be as high as 49% of the equity of the stock-broking firm.

(B.5.2) Investor protection

To protect investors' interests, a fidelity fund has been established under the Security Industry Act 1986 to compensate investors who suffer financial loss due to the dishonest misuse of their funds by a stock-broking company or any of its employees. Besides, trading on or off the floor of the Stock Exchange by stock brokers or their representatives directly or indirectly for their own accounts or for discretionary accounts is prohibited.

(B.5.3) Insider trading

Insider dealing is treated as a criminal offence liable for a fine or imprisonment.

(B.6) Links with other markets

(B.6.1) Malaysia

Singapore has close ties with other countries within the Association of South East Asian Nations, in particular, Malaysia. Until 1990, the Stock Exchange of Singapore had cross-listings of shares with the Kuala Lumpur Stock Exchange and they

accounted for 60% of transactions in Malaysian shares. However, Malaysia ended this arrangement in 1990 with the aim of encouraging its local trading.

(B.6.2) Japan

The Stock Exchange of Singapore has also established a custodial linkage with the Japanese securities Clearing Corporation (JSCC) that allows Japanese Securities to be traded on a scrip-less basis on the SES, with the shares held in custody at the JSCC. Transactions to date have, however, been extremely limited.

(III) South Korea

(A) Economic background

(A.1) Core economic sectors

(A.1.1) Manufacturing sector

Manufacturing industry has been the main thrust of Korea's economy for the past two decades. As shown in Figure 1.26, it accounts for about one-third of total GDP since 1990. A diversified range of manufacturing industries including electronics, car-making, ship-building, iron and steel, electrical machinery as well as textile industries have done well in the past six years. This is a result of the government's policy to promote high technology and high-value added industries. In contrast, primary industry such as agriculture, forestry and fishing has been falling steadily over the past few years. By 1996, it only accounted for 6% of Korea's total GDP.

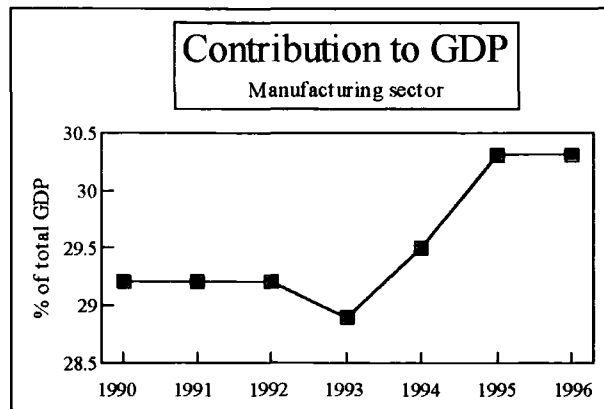
(A.1.2) Financial sector

The financial sector which consists of finance, insurance, real estate and business services has been growing steadily since 1990. It accounted for about 15% to 17% of total GDP in the past six years and was the second most important economic sector in South Korea in 1996 as shown in Figures 1.28 and 1.29. Historically, the government exercised tight control over the banking system through public ownership and detailed guidance from the Ministry of Finance. For instance, if the government targeted the development of a certain industry, it would ask the bank to grant loans to companies at very low rates of interest regardless of their productivity and operational efficiency. As far as the stock market is concerned, the finance ministry has a firm belief that it is its responsibility to intervene in the market so as to regulate its growing trend. When the market is low, the government's Stock Market Stabilisation Fund would prop up the market by buying shares and when the market seems overheated, it cools it down by dumping its shares. As there is growing demand for more openness of the financial market to foreign investment, Korea's financial sector is expected to continue its growth in the near future.

(A.1.3) External trade sector

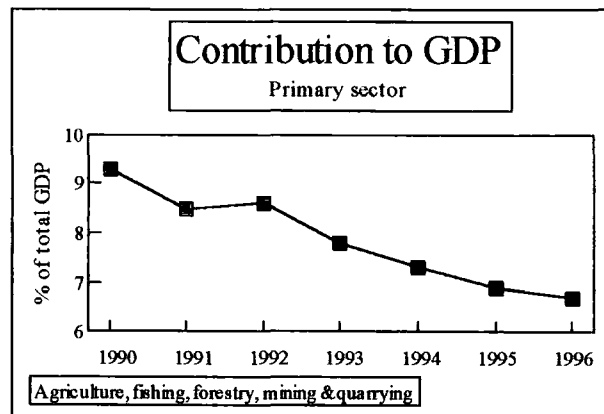
Due to the development of export-oriented industries and the rising degree of openness to international trade, Korea's external trade sector has also been growing rapidly over the past few years. The total export value of merchandised goods has nearly doubled from US\$65 billion in 1990 to US\$125 billion in 1996. Figure 1.30 shows that the biggest increase to export value was between 1993 and 1995. Machinery and equipment such as semiconductors, ships, passenger cars, telecom

Figure 1.26 *Contribution of the manufacturing sector to GDP in S. Korea*



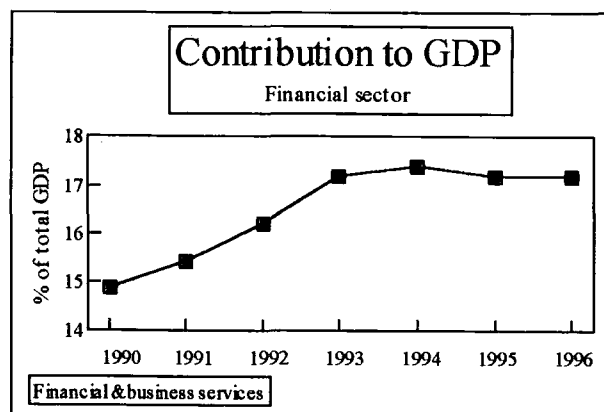
Source : EIU Country Profile : S. Korea (1995 - 1998)

Figure 1.27 *Contribution of the primary sector to GDP in S. Korea*



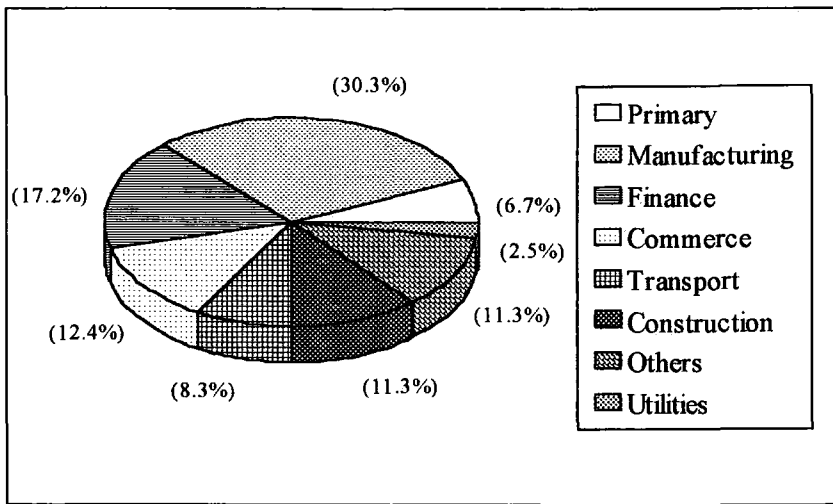
Source : EIU Country Profile : S. Korea (1995 - 1998)

Figure 1.28 *Contribution of the financial sector to GDP in S. Korea*



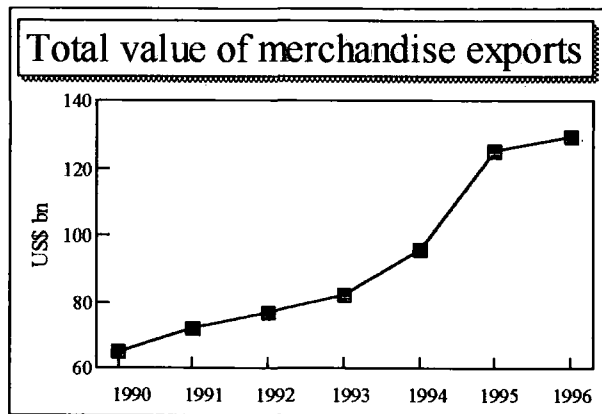
Source : EIU Country Profile : S. Korea (1995 - 1998)

Figure 1.29 S. Korea's GDP by sector in 1996



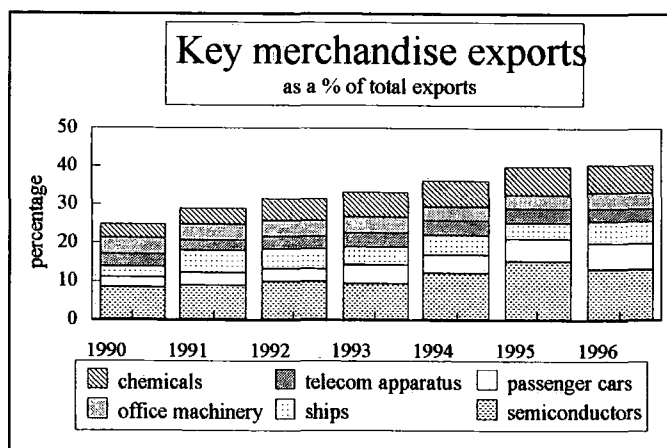
Source : EIU Country Profile : S. Korea (1997)

Figure 1.30 Total value of merchandise exports from S. Korea



Source : EIU Country Profile : S. Korea (1995 - 1998)

Figure 1.31 S. Korea's key merchandise exports



Source : EIU Country Profile : S. Korea (1995 - 1998)

apparatus and office machinery are the dominant exports of Korea with export value three times above the average as shown in Figure 1.31. Textile products and clothing such as woven fabrics, footwear and accessories come second whilst crude products such iron and steel, refined petroleum as well as rubber are the next key exports.

(A.2) Government's economic policy

The Korean government manages its economy by intervention and protection. It sets up targets for the growth of particular sectors within the economy and provides investment incentives such as low interest loans to achieve its goal. The development of high technology manufacturing industries such as car-making and electronics is one such example. Another example is the granting of export subsidies to companies in pursuit of the government's central objective of export-led industrialisation. Meanwhile, quotas and tariffs for imported goods are in place to protect domestic products and the government is reluctant to have them removed. A notable example is the ban on many Japanese consumer goods, particularly rice. Thus the Korean economy is far from being a free-market economy.

(A.3) Economic growth

Figure 1.32 shows that real GDP growth in Korea has been above 5% per annum since 1990. After a sharp fall from 9% to 5% between 1991 and 1992, real GDP growth picked up again in 1993 and kept rising until 1996. On the whole, its economic growth rate was well above those experienced in the western industrialised world of just 2% to 3% over the same period.

(A.4) Other economic indicators

(A.4.1) Foreign exchange rate regime and foreign reserves

The exchange rate of the Korean currency won is pegged to an undisclosed basket of currencies but is known to be heavily weighted on both the US dollar and Japanese yen. Figures 1.33 and 1.34 show that during 1990 and 1994, the won depreciated against both the US\$ and yen but at a faster rate for the latter. From 1995, the yen became weaker and so the won began to appreciate against it. This could be partly responsible for the slow-down of export growth in South Korea over the past three years who competed directly with Japan for export markets.

As far as South Korea's foreign reserves are concerned, they were less than half that of other Asian countries like Taiwan and Singapore in 1996. At one point, they were severely depleted to a low of US\$ 8.9 billion as the Bank of Korea tried in vain to prop up the won towards the end of 1997 when it was sharply depreciated. Now by the end of 1998 with the liquidity crisis eased, the reserves climbed up again to nearly US\$50 billion.

(A.4.2) Current account balance

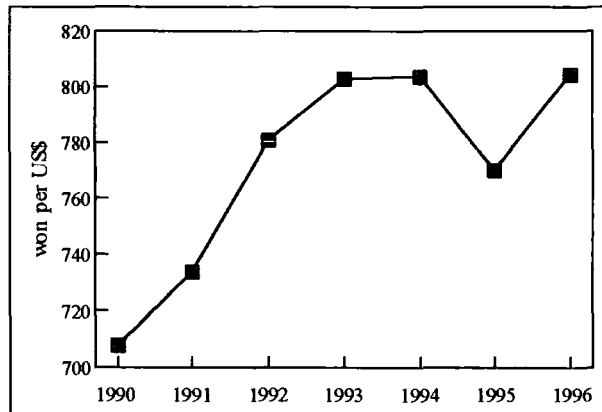
Korea experienced a current account deficit for almost every year since 1990 as shown in Figure 1.35. The main reason is that strong local investment growth required spending on imported capital equipment and new plant and hence would keep the trade balance in deficit. Between 1995 and 1996, the current account deficit began to deteriorate and reached a record high of US\$23 billion. This was due to the appreciation of the Korean won against the US dollar as well as the yen, thus

Figure 1.32 *Real rate of GDP growth in South Korea*



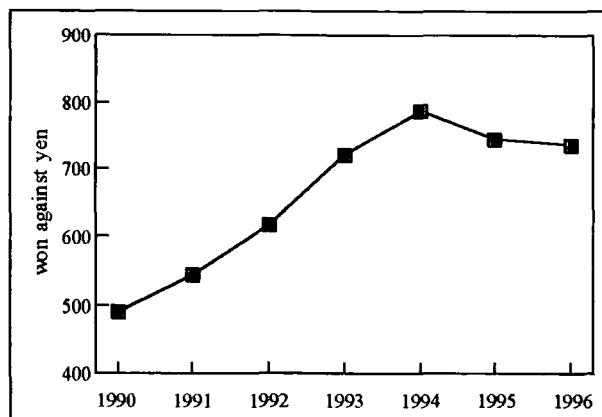
Source : EIU Country Profile : S. Korea (1995 - 1998)

Figure 1.33 *Exchange rate of the won against US dollar*



Source : EIU Country Profile : S. Korea (1995 - 1998)

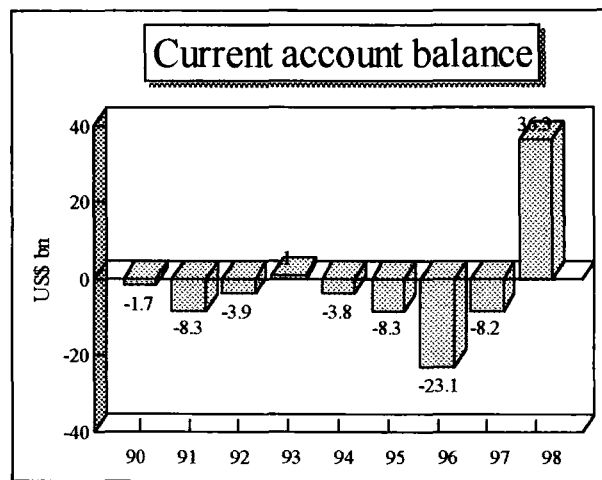
Figure 1.34 *Exchange rate of the won against the Japanese yen*



Source : EIU Country Profile : S. Korea (1995 - 1998)

weakening Korea's export competitiveness but making imports much cheaper. The fall in world demand for electronic goods in 1996 also played a part in bringing about such a huge deficit problem. In 1998, a current account surplus of US\$36 billion occurred for the first time in many years mainly because of the devaluation of the won in 1997 and a contraction in import demand.

Figure 1.35 *Current account balance in South Korea*



Source : EIU Country Profile : S. Korea (1995-1998)

(B) Korea Stock Exchange

(B.1) Formation

A predecessor of the Korean Stock Exchange (KSE) known as the Daehan Stock Exchange was formed in 1956 with only twelve listed companies. It was not developed well until 1978 when the number of listed corporations increased from 66 in 1972 to 356 by the end of 1978. In 1988, a computerised automated trading system was introduced and trade volume increased. Foreign investors were not allowed to participate in the Exchange directly or indirectly before 1984. In 1984, indirect investment was made possible through the establishment of the Korea Fund which was listed on the New York Stock Exchange. Then in January 1992, for the

first time in history, the Korean stock market was opened to foreign investors for direct investment with certain limitations on foreigners' holdings. In aggregate, foreign positions in any class of shares of a company was limited to 10%. In the subsequent years, this ceiling was lifted to 12% in 1994, 15% in 1995 and 18% in 1996.

(B.2) Market structure

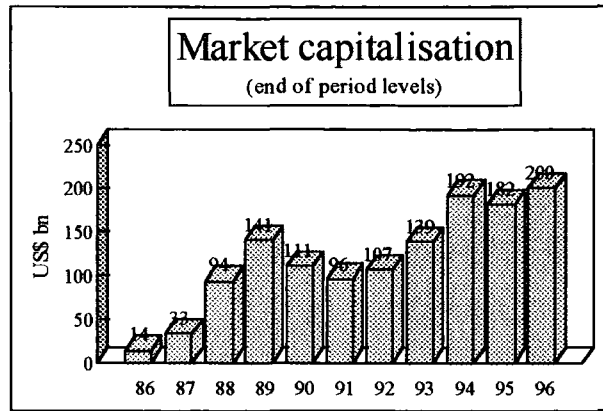
The stock market is divided into two trading sections – the first trading section and the second trading section. Newly listed stocks are automatically assigned to the second trading section for at least one year. The Exchange evaluates annual reports of all listed companies for the last business year to decide whether they meet the requirements for assignment to the first section, such as the number of share-holders, paid-in capital and debt-ratio.

(B.3) Market characteristics

(B.3.1) Market capitalisation

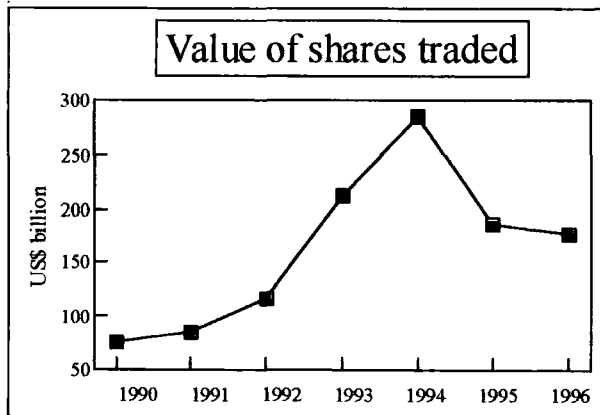
In 1990, South Korea had the second largest market capitalisation amongst regional markets after Japan. Then its position was overtaken by Taiwan and Hong Kong. Nevertheless, like many other markets in the region, South Korea's market capitalisation increased rapidly between 1993 and 1994 before dropping off slightly as shown in Figure 1.36. Now its market capitalisation is above US\$200 billion and, according to the Emerging Market Fact book, 47% of this is represented by the manufacturing sector. The total value of shares traded in the market also peaked in the year 1994 as shown in Figure 1.37.

Figure 1.36 *Market capitalisation of the Korea Stock Exchange*



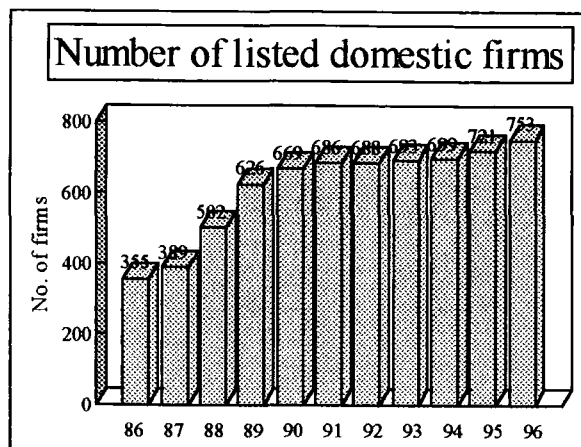
Source : IFC Emerging Market Fact book (1996)

Figure 1.37 *Total value of shares traded in the Korea Stock Exchange*



Source : EIU Country Profile : S. Korea (1995 - 1998)

Figure 1.38 *Number of listed domestic firms in the Korea Stock Exchange*



Source : IFC Emerging Market Fact book (1996)

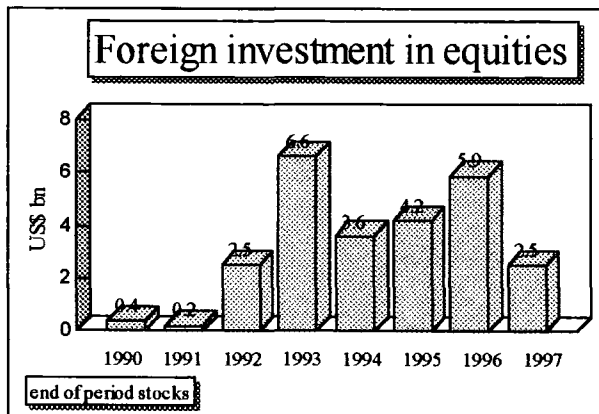
(B.3.2) Number of listed domestic firms

Figure 1.38 shows that the number of listed domestic firms in the Korea Stock Exchange grew rapidly in the late 1980s, but the pace slowed down since 1990. Many of the listed firms belonged to the manufacturing sector.

(B.3.3) Foreign investment in South Korea's equities

In the first two years following the opening of the Korea Stock Exchange to foreign direct investment in January 1992, foreign investment in equity securities increased rapidly. It rose from US\$0.4 billion in 1990 to US\$6.6 billion in 1993. Although the levels of foreign investment in equities dropped in subsequent years, they were still much higher than the levels before 1992.

Figure 1.39 *Foreign investment in South Korea's equities*



Source : IMF Balance of Payments Statistics Yearbook (1998)

(B.3.4) Stock market indicator

In 1983, a new index called the Korea Composite Stock Price Index was adopted to replace the existing Korea Stock Price Index. It is based on aggregate market value and has a base date of January 4, 1980 and a base index of 100. The index is adjusted to eliminate the influence of any corporate action and thereby reflects only movements

resulting from market activities. Hence the base aggregate market is adjusted whenever the current market value undergoes certain variations such as capitalisation changes, new listings or delistings.

(B.3.5) Trading system and trading hours

(B.3.5.1) Trading procedure

The KSE market is a typical order-driven market where buy and sell orders compete with each other for the best price and there is no market maker. Throughout the trading session, customer orders are continuously matched at a price satisfactory to both parties according to price and time priority.

(B.3.5.2) Computerised trading

In 1983, a computerised order-routing system was put into full operation. This enabled member firms to transmit orders directly to the trading floor. In 1988, a computerised stock market automated trading system was introduced. Within three years, it handled more than 95% of the total stock trading volume. In addition, most market information on prices and trading volume are electronically provided on a real time basis.

(B.3.5.3) Daily price change limits and trading hours

As there is no market maker in the Exchange to function as a stabilising force in the market, a daily price change limit has been set to avoid excessive price fluctuations. This limit is currently set at 12% of the previous day's closing price.

(B.3.5.4) Trading hours

The trading hours for the Exchange are from 9:30 a.m. to 11:30 a.m. and 1:00 p.m. to 3:00 p.m. Monday through Friday and 9:30 a.m. to 12:00 at noon on Saturdays.

(B.4) Market regulations and investor protection

(B.4.1) Insider dealing and abnormal trading activities

The Korea Stock Exchange is strictly regulated. Although insider dealing is not a criminal offence, it will be turned to the Securities Exchange Commission for investigation. A stock watch system is also in place to detect unusual price movements, sudden increase or decrease in trading and other abnormal trading activities.

(B.4.2) Trading halt

The Exchange may also request a listed company to clarify a rumour on news that has caused unusual market activity or a substantial price change in the securities concerned. In the case of a rumour or news relating to bankruptcy or receivership, the Exchange may also request the lending bank or a court having jurisdiction to verify the facts. If the share price and / or the trading activities in an issue is expected to show an abrupt movement before the opening of the trading session, or actually shows the same situation during the course of trading in response to a rumour concerning the issue, the Exchange may halt its trading to protect the investing public. Trading of that issue is resumed only when a direct disclosure relative to the matter is made by the company concerned.

(B.4.3) Compensation

Finally, in order to protect investors against fraud, Fidelity Guaranty Money and the Joint Compensation Fund have been devised to make payments for damages stemming from a settlement default.

(B.5) Cost of dealing

(B.5.1) Brokerage commission

The brokerage commission rates are freely determined by the individual companies based on the trading value without any ceilings. Actually, securities companies levy commission within the range of 0.4% and 0.5%.

(B.5.2) Securities transaction tax and tax on interest income and dividends

Transaction tax is payable by both residents and non-residents at a rate of 0.5% for all sales proceeds from listed shares. Tax rates on interest income and dividends are shown in table 1.5.

Table 1.5 *Tax rates on interest income and dividends in the Korea Stock Exchange*

	Residents	Non-residents
1. Dividend paid by listed companies	20%	25%
Dividend paid by unlisted companies	25%	25%
2. Interest from corporate bonds	25%	25%
Interest from public bonds	20%	25%
3. Capital gains from transaction of listed stocks	tax-exempt	25%
Capital gains from transaction of unlisted stocks	20%	25%

Source : Korea Stock Exchange Fact Book (1995)

(IV) Taiwan

(A) Economic background

In the past 50 years, Taiwan's economy has undergone several stages of transformation: from an agrarian base in the 1940s to an industrial base in the 1950s; from developing export-oriented industries in the 1960s and 1970s to promoting capital and technology-intensive industries in the 1980s. In the 1990s, manufacturing remains at the heart of the Taiwan economy though services are growing steadily. Thus Taiwan's economy is constantly changing to meet different internal and external demands over time.

(A.1) Core economic sectors

(A.1.1) Manufacturing sector

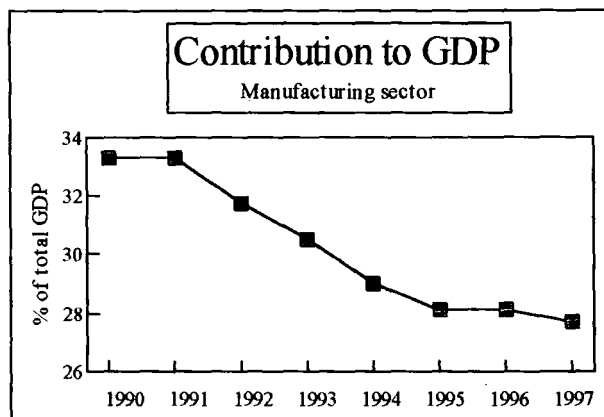
The manufacturing sector is still the most important economic sector in Taiwan despite its falling contribution to Taiwan's GDP over the past eight years as shown in Figure 1.40. High-technology and capital intensive industries such as electronic and chemical industries have been encouraged in place of labour-intensive industries. Their main manufactured products include computers, integrated circuits, television, calculators, cement and nylon fabrics. They form the bulk of Taiwan's merchandise exports as shown in Figure 1.41.

(A.1.2) Financial sector

Taiwan's financial services sector has been growing steadily since 1991 when the financial market was gradually deregulated. Foreign investors were allowed for the first time to participate directly in the stock exchange although the investment ceiling was limited to no more than 10% of any company's stocks. New banks were allowed

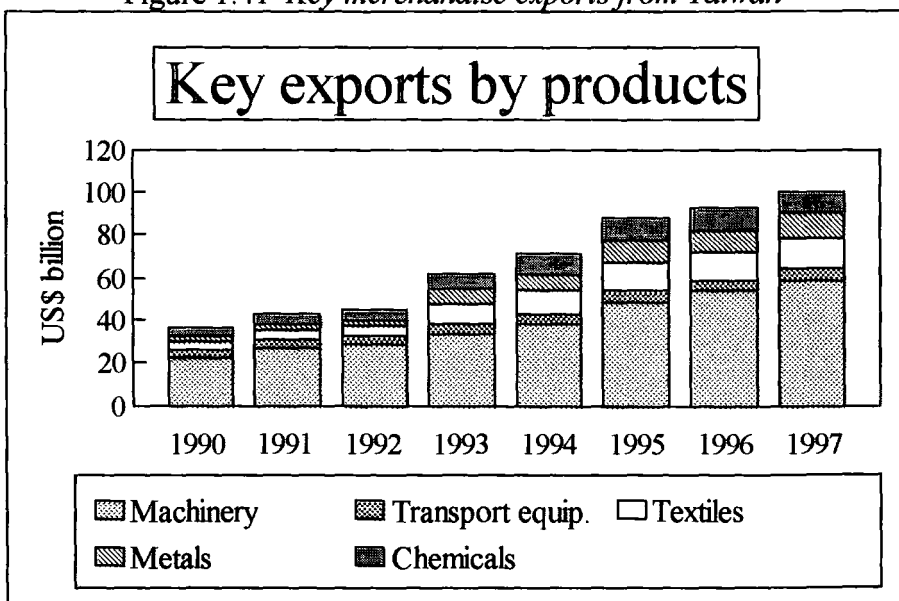
into the market and restrictions on the establishment of bank branches were removed in 1990. Now, foreign banks can open more than one branch in Taiwan. All these liberalisation measures have helped in boosting the development of financial services in Taiwan. It is now the second most important sector contributing to Taiwan's GDP and in 1997, it represented 23% of Taiwan's GDP as shown in Figure 1.42.

Figure 1.40 *Contribution of the manufacturing sector to GDP in Taiwan*



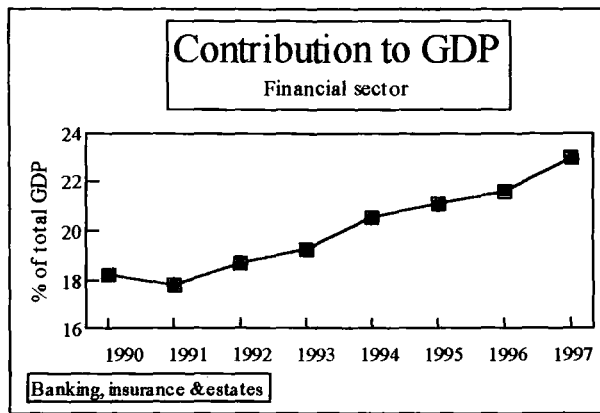
Source : EIU Country Profile : Taiwan (1995-1998)

Figure 1.41 *Key merchandise exports from Taiwan*



Source : EIU Country Profile : Taiwan (1995-1998)

Figure 1.42 *Contribution of the financial sector to GDP in Taiwan*

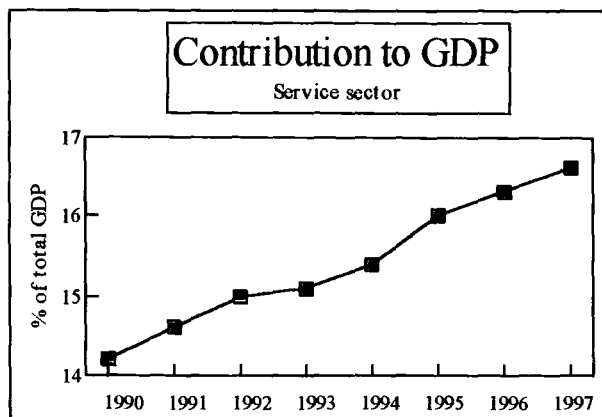


Source : EIU Country Profile : Taiwan (1995-1998)

(A.1.3) Service sector

The growth of the service sector in Taiwan began when its people demanded more consumer goods and services with their new-found wealth as a result of continuous economic growth during the 1990s. The contribution of the service sector to Taiwan's GDP has been increasing steadily over the past eight years and is now the third most important economic sector of the country. Now it accounts for 16.5% of Taiwan's GDP.

Figure 1.43 *Contribution of the service sector to GDP in Taiwan*



Source : EIU Country Profile : Taiwan (1995-1998)

(A.2) Economic policy

Taiwan's economic policy is highly protective towards its own small firms. The Taiwan government has all along acted as a facilitator to create the conditions in which Taiwan's small and medium-sized enterprises can thrive. It wants to see these small and medium-sized firms grow into larger firms so that they can exploit economies of scale and afford significant research and development programmes. Thus investment incentives were complemented by infra-structure development to help encourage business. Moreover, in order to protect them from being overwhelmed by foreign multinationals, foreign involvement in some industrial sectors such as the energy sector, telecommunications and media has been barred until the last two years.

(A.3) Economic growth

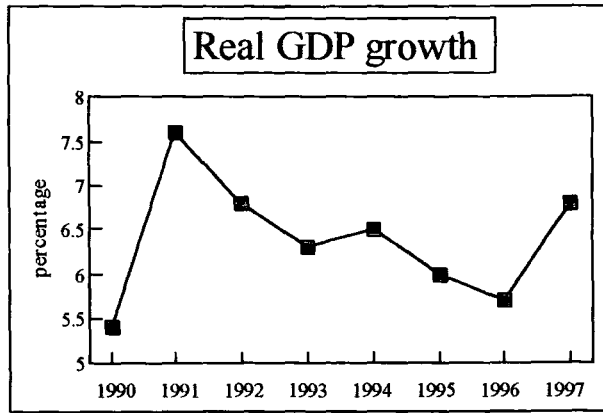
Despite being an island state with no strong diplomatic ties with any major countries, Taiwan's economy managed to grow strongly between 1990 and 1997. Its average real growth rate was 6.4% per annum as shown in Figure 1.44. Continued export growth due to the sustained economic growth of Asia as well as high domestic consumption demand could have been the forces behind the strong economic growth in Taiwan.

(A.4) Other economic indicators

(A.4.1) Low inflation rate

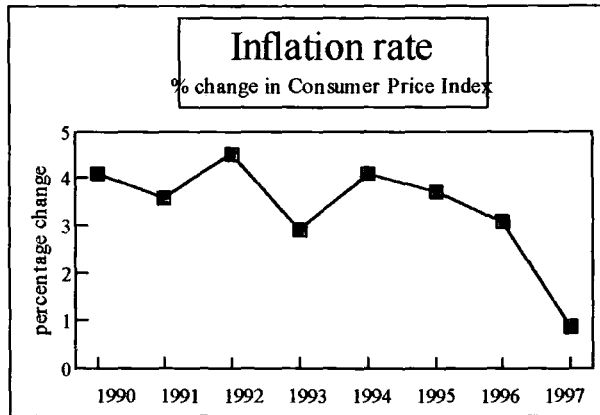
Taiwan has experienced low inflation with an average of 3.4% by international standards over the past seven years as shown in Figure 1.45 as a result of the government's effort to maintain a low inflation policy to win the support of its people.

Figure 1.44 *Real rate of GDP growth in Taiwan*



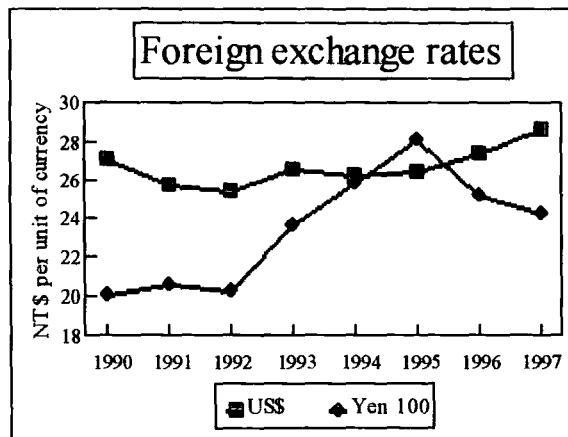
Source : EIU Country Profile : Taiwan (1995-1998)

Figure 1.45 *Inflation rate in Taiwan*



Source : EIU Country Profile : Taiwan (1995-1998)

Figure 1.46 *Exchange rate of the New Taiwan dollar against the yen and US\$*



Source : EIU Country Profile : Taiwan (1995-1998)

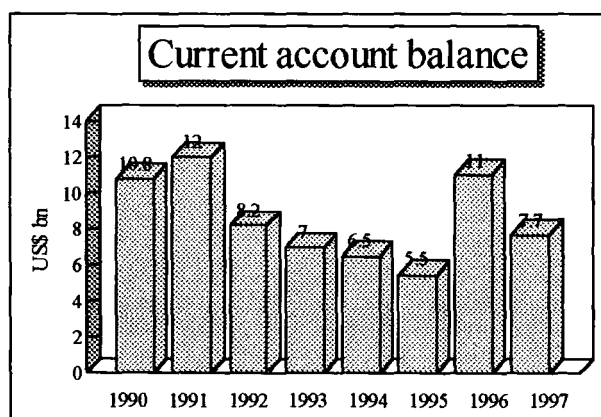
(A.4.2) Foreign exchange rate system and foreign reserves

Until 1979, Taiwan's currency was pegged to the US dollar at US\$1:NT\$38. Then in 1979, it was allowed to float in a managed band. Over the past eight years, the exchange rate of the New Taiwan dollar against the US dollar has been stable except for a small appreciation between 1990 and 1995. By contrast, it depreciated against the yen during the same period of time until mid 1995. Nevertheless, the strength of the yen has benefited Taiwan's exports in world markets in terms of price-competitiveness.

(A.4.3) Current account balance

Despite strong export growth of around 4% to 9% brought about by the strong yen in the early 1990s, the current account surplus almost halved from the peak of US\$12 billion in 1991 to US\$5.5 billion in 1995 as shown in Figure 1.47. This could have been offset by the growing demand for imports from the private sector.

Figure 1.47 *Taiwan's current account balance*



Source : EIU Country Profile : Taiwan (1995-1998)

(B) Taiwan Stock Exchange

(B.1) Formation

The Taiwan Stock Exchange was set up under the supervision of the Securities and Exchange Commission in October 1961 and commenced its operation in February 1962. There were only 18 listed companies at that time. The number of listed companies increased to 23 in 1963 and did not exceed 40 until 1971. It finally reached about 100 by 1980. The stock exchange started to soar in 1988 when new licenses for brokerage firms were issued by the government and the Computer Assisted Trading System was installed to improve trading.

(B.2) Market structure

Shares in the Taiwan Stock exchange are divided into three categories: category A, B and C. Categorisation is based upon listed companies' paid-up capital, pre-tax net profit, operating income, net worth, number of shareholders and distribution of shares. The listing criteria for categories A and B shares are summarised in Table 1.6.

Table 1.6 *Listing criteria for categories A and B shares in Taiwan*

<i>Criteria \ Categorisations</i>	<i>A</i>	<i>B</i>
Years of operation after incorporation	5 full fiscal years	5 full fiscal years
Amount of capital stock in the last 2 years	NT\$600 million	NT\$300 million
Profitability: Pre-tax profit as a % of capital in par value in the last 2 years	10% or higher	not less than 6%
Dispersion of share-holdings (1) No. of share-holders	Not less than 2000	Not less than 1000
(2) Minimum no. of shares held by public shareholders	10 million or 20% of total no. of shares issued	10 million or 20% of total no. of shares issued

Source : Taiwan Stock Exchange Fact Book (1995)

Shares of high tech companies are usually classified as Category C shares and a more relaxed set of listing criteria is applied. For instance, the applying company is not required to have five full fiscal years of operation after incorporation. It only needs to be certified by the central authority as a technology-based enterprise, having successfully developed a product with market potential. The required capital in par value is NT\$200 million and the net asset of the most recent fiscal year should be no less than two-thirds of the paid-in capital.

(B.3) Market characteristics

(B.3.1) Market capitalisation

Taiwan had the second largest market capitalisation among the Four Tigers after Hong Kong. The year 1990 was the most hectic year for the Taiwan Stock Exchange since its establishment. Volatility in the market broke historic records with the highs and lows of Taiwan's Weighted Price Index in the year differing by 10,000 points. Thus many investors were scared off and market capitalisation dropped by more than half from US\$237 billion to US\$100 billion. The down-sliding of the market continued for two more years until 1993 when it picked up again, like every other Asian market did during this time. By 1996, Taiwan's market capitalisation stood at US\$327 billion, 47% of which, according to the Emerging Market Fact-book, is represented by the financial sector.

(B.3.2) Number of listed domestic firms

Figure 1.49 shows a steady increase in the number of listed domestic firms in the Taiwan Stock Exchange although the pace of growth became faster since 1991.

According to the Taiwan Stock Exchange Fact book 1995, individual domestic investors accounted for 60% of shareholders in listed firms in aggregate by the end of 1994. Foreign ownership accounted for just 7.5%.

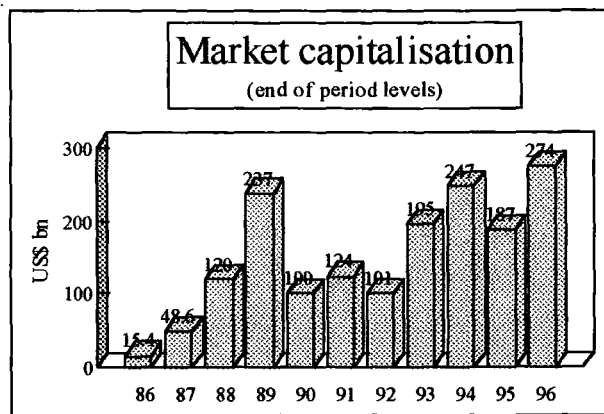
(B.3.3) Total value of shares traded

The Taiwan Stock Exchange is the most liquid market amongst the ‘Tiger’ countries. Its turnover has constantly been above US\$200 billion per annum. After a big drop from 1990 due to market volatility, trading became more active again in 1993 and 1994 as shown in Figure 1.50. This could be due to the cut in US prime interest rates which had encouraged many western investors to buy into emerging markets. Then the buying spree cooled off when US interest rates rose again in the subsequent year, inducing some of the western investors to return to their home markets. The surge in trading value in 1997 was most likely the result of the capital flight from the market in response to the financial crisis elsewhere in the Asian region.

(B.3.4) Foreign portfolio investment

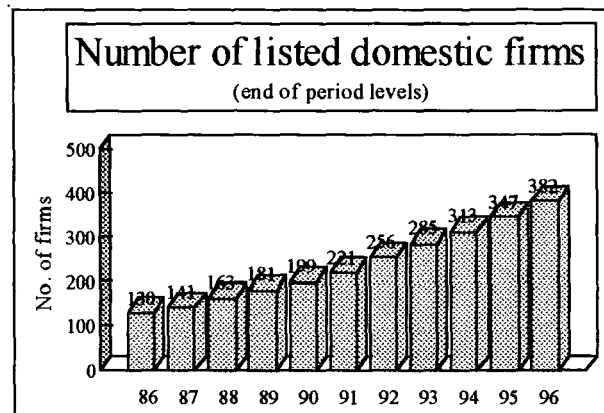
Before 1991, foreign direct portfolio investment was non-existent in Taiwan and therefore was not shown in Figure 1.51. The opening of the Taiwan Stock Exchange on 1 January 1991 for the first time to foreign institutional investors did not result in a surge of net foreign portfolio capital inflow. The volatile local market condition could have deterred foreign participation during this period. Then, from 1993 onwards, net foreign portfolio investment increased rapidly to above US\$2.5 billion per annum. In 1997 there was a net outflow of foreign portfolio investment of US\$1.6 billion when foreign investors retreated from the market due to the Asian financial crisis.

Figure 1.48 *Market capitalisation of the Taiwan Stock Exchange*



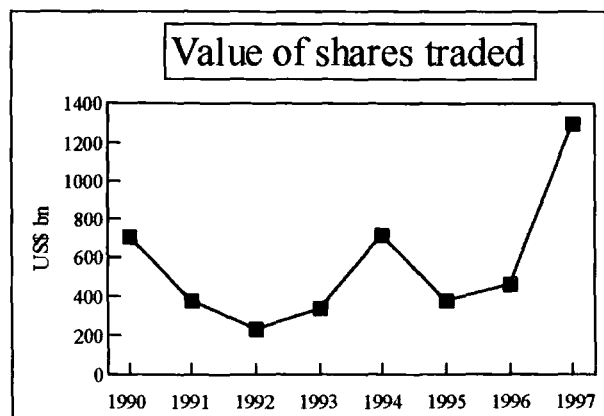
Source: IFC Emerging Market Fact Book (1996)

Figure 1.49 *Number of listed domestic firms in the Taiwan Stock Exchange*



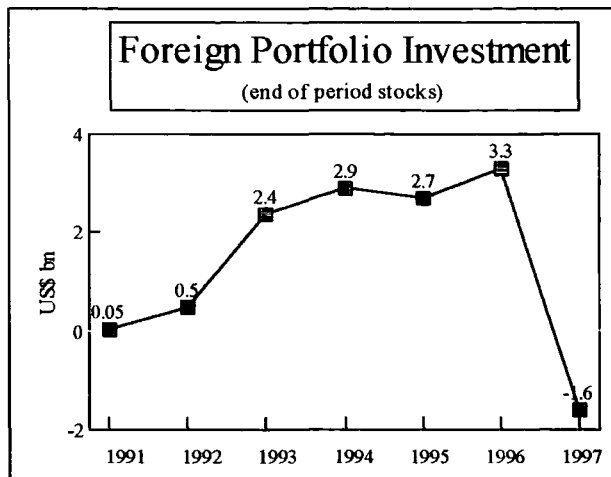
Source: IFC Emerging Market Fact Book (1996)

Figure 1.50 *Total value of shares traded in the Taiwan Stock Exchange*



Source : EIU Country Profile : Taiwan (1995-1998)

Figure 1.51 *Foreign portfolio investment in the Taiwan Stock Exchange*



Source : EIU Country Profile : Taiwan (1995 - 1998)

(B.3.5) Stock market indicator

The Taiwan Stock Exchange introduced 14 indexes to provide investors with information on both the overall market movement and different industrial sectors' performance. They fall into two main categories according to the method of computation, namely market value indexes and price average indexes. The Taiwan Weighted Price Index is the most widely quoted index of all the TSE indexes. The base year is set to 1966 and is adjusted in the event of new listing, delisting, and right issues to eliminate the influence of these non-trading activities on the index. This weighted price index covers a wide spectrum of stocks and only preferred stocks are excluded. Up to now, about 300 issues are selected as component stocks from the 382 listed issues on the Exchange.

(B.3.6) Trading system and trading hours

(B.3.6.1) Order-driven trading

The trading system of the Taiwan Stock Exchange is order-driven. After opening an account with a broker, an investor can place an order to buy or sell securities in

person or by telephone. The orders have to be made in standard units of 1000 shares with stocks par value of NT\$10 per share or multiples of standard units. Government and corporate bonds have NT\$ 10,000 face value as one trading unit. The order is processed and executed by the trading system according to price and time priority. Higher price buy order takes precedence over lower price buy order and lower price sell order takes precedence over higher price sell order. Same price orders, on the other hand, are determined by their entering time-stamps.

(B.3.6.2) Computerised trading system

In autumn 1985, the Exchange launched the Computer-Assisted Trading System of most of the Category B stocks. Later in 1988, all listed stocks in the Exchange were traded under this computerised system. It was upgraded in 1993 to a fully automated securities trading system and all securities including stocks, bonds and beneficiary certificates were traded through this system.

(B.3.6.3) Price limit rule

In order to maintain a stable stock market, daily price limits of stocks and convertible bonds are set at 7% of the closing price of the preceding business day. For other bond issues, the limits are set at 5%.

(B.3.6.4) Trading hours

The trading hours of the Exchange are from 9:00 a.m. to 12:00 noon, Monday through Friday, and 9:00 a.m. to 11:00 a.m. on Saturday.

(B.4) Cost of dealing and taxation

(B.4.1) Commission rates

Table 1.7 *Commission rates on securities transactions in the Taiwan Stock Exchange*

Types of securities	Transaction amount	Most recent Commission rates
Stocks and beneficiary certificates	Any	0.1425% (minimum NT\$20 or US\$0.76)
Corporate & government bonds	below NT\$5m (US\$0.19m)	0.1%
	from NT\$5m up to NT\$50m	0.075%
	above NT\$50m	0.05%
Convertible bonds	Any	0.125%

Source : Taiwan Stock Exchange Fact Book (1995)

(B.4.2) Securities taxation

Table 1.8 *Securities taxation in the Taiwan Stock Exchange*

Types of tax	Most recent tax rates
Securities transaction tax	0.3% levied on the sellers
Corporate bonds transaction tax	0.1%
Tax on dividends	15% for residents and 35% for non-residents
Tax on interest income	10% for residents and 20% for non-residents
Capital gains tax	Nil
Government bonds transaction tax	Nil

Source : Taiwan Stock Exchange Fact Book (1995)

(B.5) Market regulation and investors protection

(B.5.1) Market regulation

The Securities and Exchange Commission was set up in 1960 to regulate and supervise capital market operations. It has power to order a listed company to submit a detailed financial disclosure to it. Moreover, it also requires that all directors, key

employees and shareholders owning more than 5% of a company's outstanding shares must disclose their holdings. Many private companies do not like this disclosure requirement and therefore refuse to list on the Exchange.

(B.5.2) Investor Protection

There was no compensation fund for investors who incurred losses due to fraud or default by brokers or dealers before 1987. Now, each brokerage firm is required to deposit a certain amount of money in the Settlement and Clearing Fund and Business Guarantee Fund. In addition to that, the Taiwan securities industry has also set up an Investor Protection Fund with a total amount of NT\$1016 million (US\$38.72 million) to protect investors in case of broker's default.

(B.5.3) Insider dealing

Insider dealing is not treated as a criminal offence. The Securities Transaction Law only requires persons trading on inside information to disclose their profits made from such information.

(V) Conclusion

To conclude, this chapter has shown the importance of the four Asian countries in their economic developments over the past ten years as well as the institutional changes that were undertaken in their stock markets. Although the four countries differed in their economic policies, they all had a high rate of economic growth compared to the industrialised world. They had also implemented measures to improve or liberalise their stock markets within the past ten years and all of them had

experienced a sharp increase of foreign portfolio capital inflow, particularly between 1992 to 1994. There are, however, differences in many aspects of their economic and financial policies and regulations, details of which are listed in Table 1.9.

Table 1.9 *Differences in economies and stock markets of the Four Tigers (1987-96)*

	<i>Hong Kong</i>	<i>Singapore</i>	<i>South Korea</i>	<i>Taiwan</i>
Av. real GDP growth	7.0%	7.5%	7.4%	6.3%
Major economic sector	services and finance	manufacturing and finance	manufacturing and finance	manufacturing and finance
Economic policy	laissez faire	intervention	intervention	protection
Major export trade	re-export	electronic goods and re-export	semi-conductors	machinery
Current account position	deficit on each year	surplus on each year	deficit on each year	surplus on each year
Foreign exchange rates regime	pegged to US\$ since 1983	heavily weighted towards US\$	heavily weighted towards US\$ and yen	managed floating
Stock market capitalisation	US\$446 bn (end of 1996)	US\$ 84 bn (end of 1996)	US\$200 bn (end of 1996)	US\$274 bn (end of 1996)
Securities transaction tax	0.25% on contract value	0.3%-1% on contract value	0.5% on contract value	0.3% on contract value
Tax on capital gains	Nil	Nil	0 for residents 25% for non-residents	Nil
Tax on dividend	Nil	Nil	20% for residents 25% for non-residents	15% for residents 35% for non-residents

These differences in their economic and financial policies and state would be useful in explaining why price movements and volatility of the four Tiger markets might react to foreign market developments and news in different or similar ways. For instance, the varying degree of openness of their stock markets to foreign investors and the level of intervention by their governments in stabilising the markets might affect the ways the four Tiger markets are integrated with the world's leading markets. The information in this chapter thus raises several issues that need to be further investigated regarding the price and volatility behaviour of the four Asian stock markets. In particular, with the four markets becoming more liberalised and foreign portfolio investment on the increase, it is interesting to find out whether these changes have any impacts on (i) the nature of volatility of each individual markets; (ii) the level of influence that major world markets have on the price movements of the four Asian markets; and (iii) the response of volatility of the four Asian markets to foreign news. These issues will be addressed in turn in the following chapters.

Chapter Two : Foreign Investment And Price Volatility In Asian Stock Markets

(I) Introduction

Having discussed major characteristics relating to the economies of the four countries of interest, this chapter sets out to examine the nature of price volatility in the stock exchanges of these countries. As we have seen, economic growth in the Four Tigers of Asia - Hong Kong, Singapore, South Korea and Taiwan - has been consistently high in the period since the late 1980s, averaging 6%-8% per annum as discussed in Chapter One. Sound economic conditions have led to the stock exchanges in these countries being of considerable interest to many foreign institutional investors from around the world. They were attracted by the opportunities for further international portfolio diversification and the high rates of return offered. Although the economic performance in these countries has been attractive, until recently foreign participation in the stock exchanges was limited due to formal restrictions on foreign investment or concerns about the efficient operation of the markets. For example, as we have seen in the previous chapter, the stock exchanges of Taiwan and South Korea were closed to foreign investors before the early 1990s. Although Singapore in theory did not formally ban foreign investment in its stock exchange, it did place certain limitations on the foreign ownership of local shares which had the effect of reducing foreign investment to low levels. These restrictions have been eased in recent years. In the period since 1991/1992, Taiwan and South Korea have begun to open up their markets to foreign investment and more foreign participation in the Singapore Stock

Exchange has also been encouraged. Similarly, while the Hong Kong Stock Exchange has not placed major restrictions on foreign investment, since the late 1980s it has introduced changes designed to increase confidence in the market. However, encouragement of foreign investment was made against a background in which governments were cautious not to open their markets too rapidly. This caution results from a general fear that an influx of foreign investors may destabilise the market, making prices more volatile. This in turn may increase perceived riskiness and, thus, threaten the growth of the economy as a whole.

How has the volatility of Asian markets changed with the increased opportunities for participation of foreign investors? Is such a change desirable or not when compared with an entirely closed market situation? The degree to which foreign direct participation impacts on the price volatility of the Four Tigers is an important issue for two reasons. First, it may lead to a changing perception about the risk in investing in these developing markets in the light of their increased openness. Second, it would also affect governments' decisions on further liberalisation of their markets and their attitude towards foreign investors. This, in turn, will have important implications for the ability of firms in emerging markets to raise capital and, therefore, will impact on a country's ability to maintain a high level of long-term growth. However, although the issues of stock market integration and volatility spill-over between mature and emerging stock markets have been widely addressed, there have been no direct studies on the impact of the openness to foreign investment on the nature of volatility of individual Asian stock markets. Such a study is of importance in its own right, and, it is believed, should come before examinations of volatility spill-over, since it will

provide insights not only on the changing nature of volatility through time, but also the structure of volatility.

We seek to address this gap in the literature in this Chapter, by examining the nature and structure of volatility in the stock exchanges of the Four Tigers, both before and after the opening up of these markets to foreign investors. Two main questions will be addressed.

- (1) How has the volatility of Asian markets changed with an increasing participation of foreign investors?
- (2) Is such a change desirable or not when compared to an entirely closed market situation?

Undertaking such an analysis will allow determination of the impact of increased foreign investment opportunities on the nature of local stock market volatility and the extent to which the concerns of regulators in the developing markets about liberalisation are justified. It will be argued that while increased openness does raise the possibility of foreign investors having a destabilising impact by rapidly moving into and out of the market, it is also the case that increased openness for foreign investors may lead to an increase in the number and influence of informed traders in the local market. This may reduce the effect of noise trading and positive feedback trading on market volatility, which in turn may affect volatility persistence and the asymmetric response of volatility to news. Such effects, far from being detrimental to the stock exchange in question and the broader economy, may improve efficiency, increase investor confidence and bring tangible benefits to the economy.

The rest of the chapter is organised as follows. Section II gives the background to foreign participation in Asian markets. Section III briefly discusses arguments about the possible link between foreign investment and local stock market volatility. In section IV previous relevant work on Asian stock markets is reviewed and shortcomings of this work identified. Section V provides an outline of the recent major changes in each of the four stock markets in relation to foreign investment. Empirical design and data description are given in section VI, while section VII reports and discusses the empirical results. Finally, section VIII provides concluding remarks and discusses the implications of the findings.

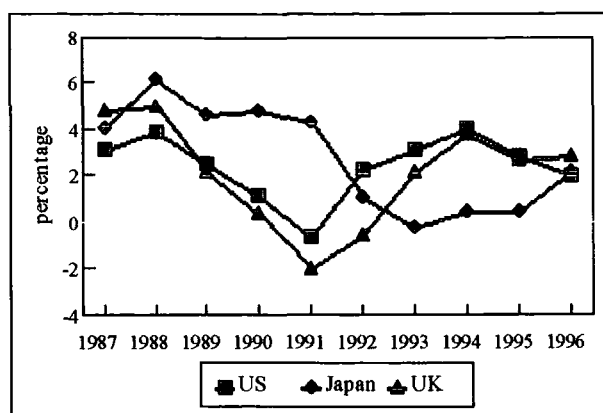
(II) Factors behind the increased foreign participation in Asian stock markets

(A) Pull factors

(A.1) Strong economic growth in Asia

Strong economic growth in Hong Kong, Singapore, South Korea and Taiwan between 1987 and 1996 has drawn attention from international investors of the industrialised world. Their average annual growth rates were around 7% over the past ten years while that of the industrialised countries was about 1% to 3% as shown in Figure 2.1 below. Such a high rate of economic growth has given potential foreign investors the confidence of obtaining higher rates of returns by investing in these markets.

Figure 2.1 *Real GDP growth rate of the US, the UK and Japan (1987-96)*



Source : Statistical Appendix of the World Economic Outlook, 1996

(A.2) Financial market deregulation in Asia

Deregulation of financial markets took place in many Asian countries during the late 1980s and early 1990s. These include South Korea, Taiwan, Thailand, Malaysia and Indonesia. They relaxed restrictions on foreign direct investment in their stock markets either by imposing an investment ceiling or by lifting the existing ceiling to a higher percentage. Capital account barriers were also eliminated, making it more attractive for foreigners to invest in these markets.

(A.3) Increased international capital mobility

During the 1970s and 1980s, many industrialised countries removed their restrictions on international capital movement. For instances, the UK abolished its foreign exchange control in 1979. Outward investment especially portfolio investment was no longer prevented. Germany and Switzerland relaxed their exchange controls during 1980, enabling non-residents' access to their stock markets. Italy lifted its restrictions upon domestic residents' ability to invest abroad in 1985. France also abolished its

25% withholding tax on dividend earnings by non-residents and raised the ceiling of investment abroad by French residents from 25% to 50% during 1985. Such removal of official barriers to international capital movements, together with reductions in transaction costs, technological change in communications and management of information had greatly increased international capital mobility. As a result, both direct investment and portfolio investment in developing economies, particularly in Asia, have expanded rapidly.

(B) Push factors

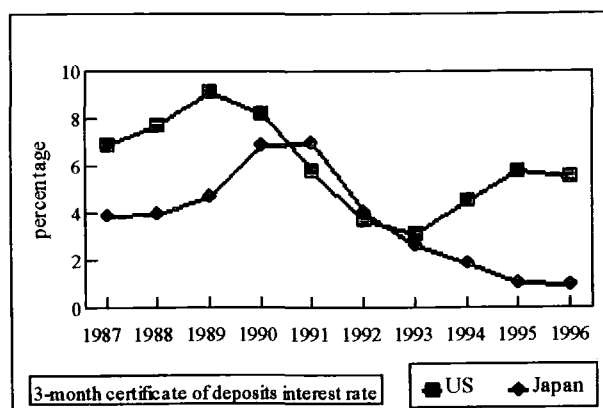
(B.1) Low interest rates and low growth in developed countries

Interest rate and exchange rate developments in US and European countries during the early 1990s have pushed western investors to seek higher return investments from emerging markets. Between 1992 and 1993, US and Japan experienced unusually low interest rates of 2% to 4% as shown in Figure 2.2. Meanwhile, the European exchange rate parity was under attack. Many countries had to either devalue their currencies within the Exchange Rate Mechanism (e.g. Spain, Portugal and Ireland) or float their currencies (e.g. UK and Italy). Official interest rates were raised by the authorities to support their currencies which inevitably led to weak growth. Investors in these industrial countries were thus attracted to high-investing yields in emerging markets such as those in Asia.

(B.2) Growth of investment funds

During the 1990s, investment funds in higher-income countries such as the US and the UK grew rapidly. For instance, American mutual funds' total net assets rose from

Figure 2.2 *Short term interest rates of the US and Japan (1987-96)*

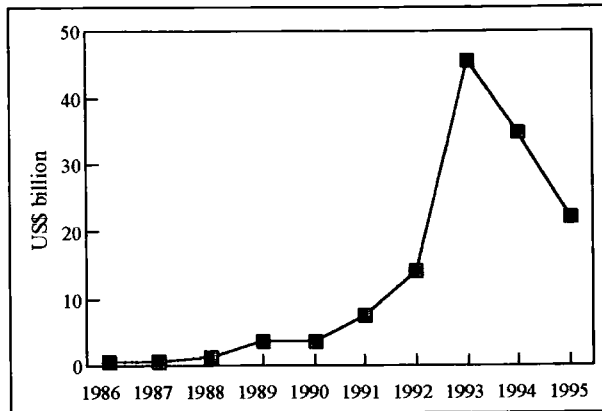


Source : Statistical Appendix of the World Economic Outlook, 1996

US\$1.4 trillion in 1992 to US\$4.2 trillion in 1996. UK's pension-fund sector now also has over a trillion US dollars in assets. These funds were operated under great competitive pressures to maximise returns and minimise risk. Diversifying into developing markets such as Asian stock markets thus became attractive. By 1996, American mutual funds allocated 49% of their assets to world equity markets while Britain's unit trusts invested 90% of their assets in equities both domestically and abroad (Source: The Economist, 25th October 1997).

As a result of these factors, foreign portfolio capital flow to emerging markets in Latin America and Asia rose dramatically between 1985 and 1995. As shown in Figure 2.3, net foreign portfolio investment grew from US\$0.1 billion in 1985 to US\$46 billion in 1993, of which two-thirds was destined to Asia. South Korea and Taiwan had also recorded a sharp rise in foreign portfolio investment since they relaxed the ban on foreign direct participation in their stock markets in 1992 and 1991 respectively. This is shown in Figures 1.39 and 1.51 in Chapter One. An increase in foreign participation in Asian markets during the 1990s thus became evident.

Figure 2.3 *Foreign portfolio investment in emerging markets*



(Source : Emerging Market Fact-book 1996)

(III) The link between foreign investment and local stock market volatility

The short-termism of foreign investment is often said to be a potential danger to the stability of local stock markets, because the presence of foreign investors in the local stock markets tends to increase stock price volatility. It is feared that foreign investors would magnify price fluctuations in the local market when they sell their shares at the time when it is weak. Alternatively, a sudden withdrawal of funds by foreign investors would cause liquidity problem in the local market which in turn might lead to higher market volatility. In an IMF Occasional paper in 1995, Khan and Reinhart argue that 'large capital inflows into a developing country are often associated with a rapid expansion of money and credit, inflationary pressures, a real exchange rate appreciation and they also tend to have a substantial impact on the stock market. If the capital inflows are purely short term, then these problems will intensify as the probability of an abrupt and sudden reversal increases' (p.15). Underlying this fear of the possible adverse effect of increasing foreign investment on a local stock market's stability is the belief that foreign investors are the major source

of stock market volatility and that without their participation, the market would be better off in the hands of local investors.

Such a perception may be unfounded, since foreign investors could also help improve information efficiency in a local developing market. For those who decide to participate in Asian stock markets may well be well-informed traders, particularly institutional investors, as cross-market investment usually involves high transaction and information costs. Prior to entry into a new market it is likely that there will have been detailed analysis of the strengths and weaknesses, and of the potential and riskiness of the market. In the absence of detailed analysis and obtaining reliable information, foreign investors may well prefer investing in a market with which they are familiar, that is their home stock market, rather than taking on unnecessary and potentially unquantifiable risk. Therefore, it is quite possible to believe that foreign investors as a group will be informed traders rather than uninformed speculators or noise traders. In contrast, local investors, who are mostly private individual investors, may not be as well informed with world market movements as those foreign institutional investors. These local investors put their money into the stock markets either because of the low interest rates offered by their local banks, as in the case of Hong Kong, or the tax advantages offered by their local governments, as there is no capital gains tax for residents in all four Tiger markets. The common source of information they get to assist their trading is from their local newspapers, financial reports or even words of mouth. Moreover, not all of them have the expertise and resources to assess the relevance and implication of a piece of local or overseas news to their market movements. Hence taking lead from their local big investors or

following the general public's opinion would be common practice among individual private investors in the local markets. It is therefore perceivable that foreign institutional investors would be relatively better informed than local private investors in general. The increased participation of well-informed investors in developing stock markets could thus be expected to improve market efficiency, increase the rate of information flow, improve the quality and reliability of information and, hence, reduce the persistence of volatility to a shock. As a result, foreign investment can alter the nature of an individual market's volatility.

Another influence that foreign investment may have on the volatility of an emerging market is that they may help reduce the influence of noise trading. In his paper, Black (1986) discusses his thinking and arguments on the meaning, functions and possible causes of noise trading in financial markets. He believes that not all investors are rational when making their buy and sell decisions. He thinks that 'noise is a major reason for the use of decision rules that seem to violate the normal axioms of expected utility. Because there is so much noise in the world, people adopt rules of thumbs' (p.535). He terms investors who do not exhibit rationality in this context as noise traders, who trade on noise as if it were information. If their trading forms a significant part of the total trading in a stock market, the price of a security is likely to be driven away from its fundamental value. This price discrepancy may well provide an opportunity for arbitrage activities so that the security price would eventually be driven back to its fundamental value. However, Shleifer and Summers (1990) argue that arbitrageurs' counteraction against noise trading is limited by various risks, such as that associated with the problem of identification, fundamental risk and noise

traders' risk. They point out that arbitrageurs themselves might act as noise traders without realising it and help drive prices further away from fundamentals, making the problem of noise trading even worse. In addition to noise traders, Shleifer and Summers (1990) identify another group of irrational traders who base their investment decisions on trend chasing. This group buy when stock prices rise and sell when stock prices fall. Very often, this behaviour is related to an element of over-reaction to news. These trend chasers are usually known as positive-feedback traders. In markets where the influence of well-informed investors is low, it is the actions of noise and feedback traders that may have the greatest influence in setting security prices, because the price discrepancies they help cause cannot easily be arbitrated away.

The impact of noise traders on stock market volatility can manifest itself in the form of the asymmetric response of volatility to news, meaning that the response of traders to a piece of good news and bad news is asymmetric. Two main arguments have been put forward as possible explanations for observed asymmetries. First, the leverage effect has been seen as the cause of this asymmetric response of volatility to news. The financial leverage hypothesis (Christie (1982)) says that as prices fall, the financial and operating leverage of firms rise and, hence, there is an increase in the required rates of return of equity holders, which causes prices to fall more. As a result, negative returns are likely to be associated with greater volatility than positive returns.

The second explanation relates news asymmetry to noise trading behaviour. In his paper, Black (1986) cites the findings of Tversky and Kahneman (1982) that 'people

will take certain gambles to avoid losses, but will refuse the same gambles when they involve prospective gains' (p.535). This could be due to the fact that investors are more sensitive to losses than to gains so that when they face losses, they would be prepared to take on more risks or gambles in an attempt to recover their losses. Alternatively, such behaviour might be related to a limited number of heuristic principles that people rely on when assessing the probability of an uncertain event (Tversky and Kahneman, 1982, p.3). For instance, 'people may be affected by the illusion of validity whereby the confidence they have in their prediction depends primarily on the degree of representativeness, that is, on the quality of the match between the selected outcome and the input, with little or no regard for the factors that limit predict accuracy' (Tversky and Kahneman, 1982, p.9). In other words, they may be too confident in their own forecasts that they inevitably introduce bias into their actions. This could be the reason why people are willing to take on gambles to avoid losses but will refuse the same gambles when they involve prospective gains. If the finding of Tversky and Kahneman (1982) is true, then the reaction to a piece of bad news is expected to be greater than that to a piece of good news. Sentana and Wadhvani (1992) also argue that 'large price declines possibly lead to more positive feedback trading as compared with large price rises. The reason is that those who trade on margin and make large losses after price declines, often have no choice but to sell their holdings in order to meet their obligations.' (pp.421-422)

If asymmetries arise from the leverage effect, then changes in foreign investment activity would have little impact on the extent of any asymmetries. However, if the second explanation of asymmetric responses is correct, then increasing activity by

well-informed foreign investors might be expected to reduce the impact of noise and feedback traders, reduce observed asymmetries and, thus, alter the nature of local stock market volatility. Thus, while opening up a market to foreign investors may, as feared, impact on volatility, if asymmetries are the result of undesirable noise trading, changes in volatility may be seen as desirable. A reduction in asymmetries thus becomes an indication of a decrease in the impact of noise trading on volatility. Changes in asymmetric responses following regulatory changes to open a market to foreign investors would thus provide evidence that foreign investors do impact on volatility in a market, but far from that impact being undesirable it is possible that foreign investors have a positive impact on the operation and behaviour of the market.

(IV) Literature review

Most empirical studies of Asian stock markets to date have focused on the issues of stock market integration and volatility spill-over between mature and emerging stock markets. No work has previously been undertaken on the changing nature of volatility of individual Asian stock markets in response to changes in the openness of markets to foreign investors. The paper by Ng et. al. (1991) is the most closely related work to the subject being examined in this chapter. It looks at the effects of relaxing restrictions on foreign investment in the Tokyo Stock Exchange in 1986 and the Securities Exchange of Thailand in 1987 on the transmission of volatility among national stock markets. A GARCH(1,1)-M model is fitted to the daily return of four markets namely Japan, Thailand, South Korea and Taiwan over a three year period between 1985 and 1987. The first two represent markets undergoing liberalisation changes while the latter two remain closed to foreign direct investment. The impact

of the most recent US news on each of the four markets is proxied by the squared difference of the observed daily US return and its conditional mean return, and is included into each market's conditional variance equation. They only find evidence of volatility transmission from the US to the two open markets Japan and Thailand while South Korea and Taiwan are not responsive at all to US news. To further investigate whether implementing liberalisation measures would intensify the spill-over effect, the full sample period is partitioned according to the time Japan and Thailand introduced their liberalisation measures. Results show that only in Japan are there signs of intensification post-liberalisation. They believe that the lack of evidence for Thailand is down to the short post-liberalisation sample period.

The important role of cross-market stock investment in inducing volatility spill-over from one market to another is also highlighted in Chowdhury (1994) and Rogers (1994) and Cheung and Mak (1992). Chowdhury (1994) looks at the transmission mechanism of stock price movements from the US and Japan to Hong Kong, Singapore, South Korea and Taiwan over a four year period from 1986 to 1990. Daily rates of return on the six stock market indices are fitted into a six-variable vector autoregressive (VAR) model. The dynamic responses of each of the markets to a shock in a particular market are then traced out using the impulse responses of the estimated VAR system. He finds that out of the four newly industrialised markets, only Hong Kong and Singapore, which do not have restrictions on foreign investment, are responsive to shocks from the US and Japan. South Korea and Taiwan, which stay closed during the sample period, are not responsive to any foreign shocks, thus

confirming his argument that cross-country direct investment is the key to international volatility transmission.

Rogers (1994) uses the same VAR technique to address the issue of volatility transmission from well developed to newly developed stock markets in Asia and Latin America surrounding the 1987 world market crash period. His results show that price spill-over from the US occurs only in markets without stiff foreign entry barrier such as Thailand and Chile. In Taiwan and South Korea, such price spill-over is non-existent because they are the most restrictive of all markets under investigation.

Cheung and Mak (1992) use the Granger-causality tests to investigate the price relationships between two developed markets and eight Asian-Pacific markets. Most Asian-Pacific markets show signs of being Granger-caused by the US except Taiwan and South Korea. They remain unaffected by weekly return changes in the US market over the period of 1977 to 1988. This finding is again attributed to their different degree of market openness.

Not all studies agree that foreign investment opportunity is a requirement for volatility spill-over. The flow of public world information and/or market contagion could be responsible for that too. For example, Eun and Shim (1989) and Becker, Finnerty and Tucker (1995) argue that cross-market volatility transmission is a result of common reaction to public world information such as US news. King and Wadhvani (1990) and Lin, Engle and Ito (1994) on the other hand, believe that volatility spillover is driven by market contagion.

Eun and Shim (1989) are the first to use variance decomposition derived from the VAR method to investigate the issue of market inter-dependence. Examining the period of December 1979 to December 1985, they find evidence of high correlation of stock returns between the Asian-Pacific markets (including Hong Kong, Singapore, Taiwan and South Korea) and the United States, regardless of their varying degrees of market openness. They argue that this may reflect the importance of US news in affecting the world markets because of its dominant position in the world economy.

Becker, Finnerty and Tucker (1995) examine the short-term correlation structure between the US overnight returns and current intra-day UK stock returns to find out whether international markets are linked in a way which supports the public information hypothesis or the over-reaction hypothesis. They find that the UK market does respond to US news over the sample period of mid 1986 to end of 1990, particularly inflation and merchandise trade figures. Market volatility in the UK also appears to be higher on US announcement days than non-announcement days. They therefore conclude that the results are supportive of the public information hypothesis as an explanation of international equity market linkages.

King and Wadhvani (1990) disagreed with the view that public information is the key mechanism for volatility transmission. They recognise that investors in individual markets might make their investment decisions by extracting information on global factors from price changes in other markets as if it were public information. Such contagious market psychology might cause international markets to move up or down

in unison even when the move is not justified by economic fundamentals of the individual market. They argue that this is exactly the case for the uniform decline of world markets during the 1987 world market crash.

Lin, Engle and Ito (1994) echo King and Wadhvani's (1990) argument in finding evidence from the signal extraction model that Japanese traders are not able to extract the global information optimally from the observed price changes in the US market. Instead, information from the US that should only have a local impact is also reflected in the pricing of stocks in Japan. This is suggestive that market contagion psychology is at work. Thus they conclude that their empirical results are consistent with the contagion effect hypothesis of King and Wadhvani (1990).

All the aforementioned papers have their own merits. They have either helped in broadening the understanding of market integration between developed stock markets and emerging Asian markets or in devising new methods to investigate the issue of the international volatility transmission mechanism. What is missing though is that they have not directly addressed the issue of how volatility in individual Asian developing markets changes after the opportunity for foreign investment in local stocks has increased. This might be due to the fact that the samples used in these papers mainly cover the two to three year period surrounding the 1987 crash. The most recent samples in these papers are only up to the year 1990. Yet for most markets in Asia, liberalisation of one form or another took place after 1991. Now the availability of post liberalisation data make it possible to address the issue of the changing nature of volatility in an individual Asian market directly. As each stock market is unique with

its own economic and political background, the study of the changing nature of volatility in an individual market forms an important basis for understanding the impact of market openness on volatility. Furthermore, it will provide insights about volatility which may be important in subsequent analysis of volatility transmission between these markets. If increased foreign investment opportunities do impact on volatility, then while the existence of trade relations, or the effect of market contagion may be partly responsible for volatility spill-over, it would suggest that there is also a need to take account of the regulatory framework of the market with respect to openness to foreign investors. It will also be indicative of a need to partition time periods for the analysis of volatility transmission with respect to different periods of market openness.

Further limitation of previous studies is that they have not taken account of the asymmetric response of volatility to news. Previous work has assumed that positive and negative news of a given magnitude have the same effect on stock market volatility. However, as Black (1986) and Engle and Ng (1993) point out, this might not necessarily be the case. Negative news is very likely to have a greater impact on volatility than positive news. Thus by examining the change in asymmetric effects as the opportunity for foreign participation changes, we might be able to infer whether the impact of noise trading has been reduced as a result of the institutional change. This will also provide insights into the causes of asymmetries. If there is no change following the opening up of a market this would suggest that leverage arguments provide the most appropriate explanation of asymmetries. On the other hand, a

change in asymmetries would suggest that noise trading arguments are more persuasive.

In summary, the contributions of this chapter to an understanding of the issue of volatility are twofold. First, it provides the basis for an understanding of the possible link between the changing nature of an individual market's volatility and the changing opportunities for foreign investors. As most Asian stock markets relaxed their restrictions on foreign investors after 1991, the effects of foreign investment on an individual market's volatility before and after the change can be directly compared. The study also sheds light on whether foreign investment leads to the local market becoming more volatile, which has important implications for regulators. Second, the effect of noise trading on volatility in an individual market can also be traced by examining how asymmetric responses have changed after restrictions on foreign investors are relaxed. In general, a reduction in the asymmetric effects would indicate a fall in the influence of noise trading in the market.

(V) Key changes in the four Asian stock markets

The four markets studied in this chapter differ not only in their level of financial market openness, but also in the way their economies operate (see Chapter One) and the political changes and uncertainties which they face. For example, the uncertainty over the handing over of Hong Kong back to China in 1997 and the threat of military invasion from mainland China and North Korea to Taiwan and South Korea respectively. These factors may all influence the nature of volatility in their stock markets. However, while these factors may be important, the focus of our attention

here is on the importance of foreign investment opportunities and market openness on volatility. In order to examine this issue, key changes in markets which have led to a rise in foreign investment opportunities must be identified, as must the time at which the changes were implemented. This will allow the partitioning of data into times before and after increased market openness. Analysis of these sub-periods will enable identification of the impact of liberalisation on market volatility. A summary of the key changes in each market is given below, together with the date at which the data will be partitioned for analysis for each market. A comparison of the size of foreign equity investment in the Four Tigers in the post-liberalisation periods is also provided.

(A) South Korea

According to the classification of Rhee et. al. (1991), the stock exchange of South Korea (KSE) was a restricted market as of December 1987. At that time it had very severe foreign exchange and stock ownership controls, making it almost impossible for foreign investors to invest directly in Korean stocks. These controls have been gradually lifted, beginning in January 1992 when foreign investors were allowed to hold up to 10% of a Korean company's shares in aggregate. This ceiling was marginally raised to 12% in December 1994, to 15% in June 1995 and 18% in April 1996. Since the first relaxation is likely to have been of most importance and since subsequent further relaxations have been taken in relatively small stages, the post-liberalisation period is taken to be from January 1992.

(B) Taiwan

Like South Korea, Taiwan had a tradition of being a strictly controlled market, since it did not allow any foreign direct investment in the Taiwan Stock Exchange (TSE). While it may be considered slightly more liberalised than the KSE in that since 1987 domestic investors could invest up to US \$5 million per year abroad, it was not until January 1991 that the TSE was opened to foreign investment. At that time a ceiling for foreign ownership of 10% of any company's stock was set, although only foreign institutional investors were allowed to participate. Foreign individuals were still prohibited from direct investment until February 1996. Following the relaxation in 1991, the ceiling was raised to 12% in February 1995, 15% in September 1995 and 20% in February 1996. Over the same period, measures which encourage foreign investment were also introduced. For instance, the rate of securities transaction costs was halved to 0.3% in 1993. In January 1996, limits on the repatriation of profits earned by foreign investors on the TSE were also abolished. While all of these changes are likely to have been of influence, it is again the first of these which appears to be of most importance and, hence, the post-liberalisation sample period is taken as commencing in January 1991.

(C) Singapore

Fixing a precise date which is appropriate for examining the impact of changing opportunities for foreign investment in the Stock Exchange of Singapore (SES) on volatility is not as straight forward as it is for the previous two markets. On the surface, there are no exchange controls nor restrictions on foreign investment in local firms except in specific areas of investment like banking and strategic companies.

However, in practice, foreign investors do face certain limitations. For example, foreign institutional holdings of an individual company's share is limited to a maximum of 49%. Similarly, the bylaws of specific Singaporean companies can and often do restrict foreign holdings in many listed firms. Many of the largest and most popular issues, such as Singapore Airlines, also have limits on foreign ownership. Furthermore, foreign brokerage operations in the SES were also restricted prior to 1992. Their participation in local brokerages was limited to 49% of ownership. All of these restrictions indicate that foreign investment in the SES may have been constrained and limited.

Between 1992 and 1993, a number of institutional changes took place which had the effect of reducing some of the above constraints and encouraging foreign participation in the market. For example, in 1992, seven foreign brokerage companies were admitted to the exchange as international members to deal freely in SES securities on behalf of non-resident firms and individuals. By 1993, the 49% limit on foreign ownership of local brokerages was raised to 70%. In October of the same year, the government offered a 7.3% stake in Singapore Telecom, the communications monopoly, to public ownership. Many more state-owned utilities and companies were also planned to be part-privatised and some of their shares would be offered to the public. Given that these measures, taken together, would give more opportunities for foreign investors to participate in the market and, in turn, could be expected to increase the level of foreign investment, the post-liberalisation period will be designated to start from October 1993.

(D) Hong Kong

The Hong Kong Stock Exchange (HKSE) has always been open to foreign investors with no restrictions since it was established in April 1986 by unifying four existing stock exchanges. There is no obvious change in the market which marks a sudden increase in opportunities for foreign investment. However, while there were no formal restrictions on foreign participation, there may have been practical considerations which led foreign investors to be less willing to participate. In particular, it is possible that foreign investors lacked confidence in the operation and regulatory framework of the market. In late 1989 the Securities and Futures Commission was established in the HKSE with the aim of cleaning up and modernising the market. With the introduction of this new regulatory apparatus designed to prevent fraud, it is likely that foreign investors would have increased confidence in the market. Thus 1989 is chosen to mark the start of the post-liberalisation sample period.

During their post-liberalisation periods, the size of foreign equity investment in the Four Tigers differed not according to their degree of openness, but rather to the actual investment opportunities that existed in individual markets. Thus South Korea, one of the least open markets among the Four Tigers, had attracted more foreign equity investment than the relatively more open market in Singapore. It amounted to a total of US\$22.8 billion for South Korea between January 1992 and July 1996, compared to a total of US\$3.7 billion for Singapore between October 1993 and July 1996, and a total of US\$11.8 billion for Taiwan between January 1991 and July 1996 (Source: Economist Intelligence Unit). As for Hong Kong, due to data constraint,

only the equity investment from the US in part of its post-liberalisation period is available. Between 1990 and 1993, total US equity investment in Hong Kong stood at US\$ 11.9 billion (Source: Khan and Reinhart, 1995). However, a survey of foreign share-holdings in individual companies in each of the Four Tiger markets indicates that Hong Kong had the largest proportion of its listed companies with foreign holdings of their shares of about 50% in 1996. This is compared to 3% for Singapore, 17% for Taiwan and 33.5% for South Korea in the same year (Source: Asian Company Handbook).

(VI) Empirical design and data description

(A) Empirical design

Engle (1982) has shown that ARCH type models are suitable for examining financial variables which typically are not normally distributed, but instead are characterised by fat-tails, with constant means and variances that change over time. Engle's (1982) ARCH model was the first formal model capable of capturing these stylised facts. In 1986, Bollerslev proposed an extension of the conditional variance function which he termed generalised ARCH (GARCH). The specification of conditional variance in a GARCH(p, q) model is given in (1) below.

$$h_t = \alpha_0 + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^q \beta_i h_{t-i} \quad (1)$$

where h_t is the conditional variance of the residual;

and ε_{t-i}^2 is the squared residuals of the conditional mean equation.

In practice, numerous studies have demonstrated that a GARCH(1,1) specification is most appropriate. This specification has the advantage that the coefficients are easily interpreted, with the estimate of α_1 showing the impact of current news on the conditional variance process and the estimate of β_1 the persistence of volatility to a shock or, alternatively, the impact of 'old' news on volatility.

However, the use of this simple GARCH model is inadequate and inappropriate for the purpose of our study, since it does not allow for the asymmetric response of volatility to news. In many markets there is evidence of asymmetries (see, for example, Engle and Ng (1993) and Kim and Kon (1994)). Furthermore, whether there exist asymmetries and the extent to which any asymmetries change as markets are opened up are central issues in this chapter. The estimation of asymmetries forms a crucial basis from which to draw inferences about noise trading and whether its effect on volatility has been reduced by an increase in the opportunities for foreign investment. Therefore the simple GARCH model is an inadequate model for our analysis. Glosten, Jagannathan and Runkle (1989) (GJR) extend the simple GARCH(1,1) model to allow for asymmetric effects by including an indicative dummy as shown in equation (2)¹.

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \alpha_2 S_{t-1}^- \varepsilon_{t-1}^2 \quad (2)$$

The indicative dummy S_{t-1}^- takes on the value of 1 if $\varepsilon_{t-1} < 0$ and 0 otherwise. The impact of a piece of negative news in this equation is given by the sum of α_1 and α_2 . The impact of a piece of positive news is estimated by α_1 alone, because the indicative

¹ This specification of asymmetric GARCH effects is preferred to the E-GARCH specification following the findings of Engle and Ng (1993) and Kim and Kon (1994).

dummy S_{t-1}^- is 0 in this case. The persistence of volatility to any kind of shock is estimated by β_1 . Engle and Ng (1993) find that the GJR model captures the asymmetries of the Japanese stock index most accurately among other alternative models.

To take account of the impact of the stock market crash on volatility, equation (2) is augmented with a dummy variable for the five weeks surrounding the October 1987 crash period. It takes on the value of 1 if the observations fall in this period and 0 otherwise². Thus the conditional variance equation estimated for periods including the stock market crash is:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \alpha_2 S_{t-1}^- \varepsilon_{t-1}^2 + \gamma DC \quad (3)$$

where $DC = 1$ if $1987:10:19 \leq t \leq 1987:11:21$.

This model is estimated only for the pre-change period for Hong Kong. All other sample periods start after the crash.

(B) Data description

In order to examine the volatility of prices we begin by constructing a returns series for each market to be investigated. The returns series are constructed using an appropriate market index for each market to allow a market wide measure of volatility to be determined. In view of the importance of the indexes in both measuring and reflecting the level of activity in the market, their underlying structure and weighting are important considerations in appraising their accuracy and representativeness.

² The model was also estimated without the crash dummy and the broad pattern of results were unchanged.

Therefore, the indexes used in this chapter are all value-weighted. The constituents of these indexes are generally made up of large capitalisation stocks that are actively traded in the markets. The use of value-weighted indexes is preferred to the use of All Shares Indexes because the former are more representative in reflecting the real level of trading activities in the markets, minimising the impacts of infrequent trading activities of smaller capitalisation stocks on the indexes. Hence in this chapter the indexes used are the Hang Seng Index (Hong Kong), Korea Composite Price Index, Singapore Straits Times Industrial Index and Taiwan Weighted-Price Index. They are calculated using the market-value weighted formula defined by :

$$\text{Current Index} = (\text{Current AMV} / \text{Base AMV}) \times \text{Base Index}$$

where AMV stands for the aggregate market value. The base index and base date vary from one exchange to another. Daily returns expressed in percentages for each market are computed as logarithmic price relatives:

$$R_t = \ln(P_t / P_{t-1}) \times 100 \quad (4)$$

A number of studies on individual Asian markets have found the existence of market anomalies such as day-of-the-week effects and a January effect (see for example Lee (1992) and Huang (1995)). In order to concentrate only on the unpredictable part of the return series when estimating the conditional variance, adjustments are made to the data along the lines of Engle and Ng (1993). The procedure involves two steps which removes any predictability from the return series. First, actual returns are regressed on a constant and four day-of-the-week dummies and the residuals from this regression are saved. Second, this residual series is then regressed on a constant and

its own six lags to remove possible auto-correlation. The residuals from this second regression then become our unpredictable return series. Making adjustments to the series in this way is important to ensure correct observation of any asymmetric effects.

To ensure that the impact of other major changes in the markets under investigation are minimised, we choose the beginning of our pre-liberalisation period to coincide with the onset of a computerised trading system in each market. Thus the returns series for the HKSE, SSE, KSE and TSE start from April 1986, March 1989, March 1988 and January 1988 respectively. For all markets the sample period ends at July 1996. The samples are split into pre-change and post-change periods according to the time when foreign investment opportunities in each individual market increased, as explained in section V. Thus, the sample sizes for the pre-change period are 849, 1197, 1001, and 782 for the HKSE, SSE, KSE and TSE respectively and the corresponding figures for the post-change period are 1848, 739, 1196 and 1457.

(VII) Empirical results

Summary statistics of preliminary data analyses for the four daily return series are reported in Table 2.1.1 and 2.1.2. In table 2.1.1, the value of the kurtosis statistic is extremely large for Hong Kong over its full pre-change sample period, suggesting that the underlying data is heavily tailed and sharply peaked about the mean when compared with the normal distribution. When some extreme observations, such as the period surrounding the world stock market crash and the immediate aftermath of Beijing's Tien-an-man Square Massacre, are dropped from the full pre-change sample period as shown in columns three and four of the table, the values of the kurtosis

statistics fall substantially. This suggests that the presence of outliers is the major cause of the extreme kurtosis found in the full pre-change sample period. Nevertheless, the kurtosis in all four markets over both sample periods is still high, indicating that their daily return series have a fat-tail distribution. This fat-tail nature of the return distribution supports the use of the autoregressive conditional heteroskedasticity (ARCH) model for the variance processes of the returns.

Asymmetric GARCH models along the lines of Glosten, Jagannathan and Runkel (1989) shown as equation (2) or equation (3) are estimated for each of the four markets as appropriate. Tables 2.2 to 2.5 show the results of estimations for the pre- and post-change periods for Hong Kong, Singapore, South Korea and Taiwan respectively.

Table 2.1.1 *Preliminary data analyses over the pre-change period*

<i>Country</i>	<i>HK(1)</i>	<i>HK(2)</i>	<i>HK(3)</i>	<i>Singapore</i>	<i>S. Korea</i>	<i>Taiwan</i>
Daily return :						
Mean	0.000	0.06	0.087	-0.000	-0.009	-0.000
Std. Dev.	2.182	1.60	1.36	1.005	1.414	2.898
Skewness	-8.30	-4.27	-0.25	-1.023	0.277	-0.064
Kurtosis	144.2	66.46	9.74	15.23	3.194	1.031

Sample periods :

HK(1) : 1986:4:1 - 1989:6:30

HK(2) : 1986:4:1 - 1989:6:30 with the 5 week-period surrounding the world stock market crash (i.e. 1987:10:19 - 1987:11:21) dropped from the full sample.

HK(3) : same as HK(2) but with an additional outlier dropped from the full sample as well. This outlier is found on the 5th of June 1989, a day immediately following the Tien-an-men Square massacre in Beijing.

Singapore : 1989:3:1 - 1993:9:30

S. Korea : 1988:3:3 - 1991:12:31

Taiwan : 1988:1:1 - 1990:12:31

Table 2.1.2 Preliminary data analyses over the post-change period

Country (Sample period)	Hong Kong (89:7:3 - 96:7:31)	Singapore (93:10:1 - 96:7:31)	Korea (92:1:1 - 96:7:31)	Taiwan (91:1:1 - 96:7:31)
Daily Return:				
Mean	-0.026	0.000	0.000	-0.000
Std. Dev.	1.340	0.943	1.266	1.762
Skewness	-0.473	-0.162	0.313	-0.021
Kurtosis	4.782	3.283	2.604	2.975

Table 2.2 GJR-GARCH results for the Hong Kong Stock Exchange

	α_0	α_1	α_2	β_1	γ	χ^{2*}
Pre-change (1986:4:8 - 1989:6:30)	0.1177 (0.0105)	0.0408 (0.0075)	0.2812 (0.0012)	0.8022 (0.0050)	17.5499 (2.0918)	
Post-change (1989:7:3 - 1996:7:31)	0.1511 (0.0043)	0.0727 (0.0041)	0.0900 (0.0080)	0.8108 (0.0029)	-	214.378 (0.0000)

An asterisk * denotes test statistic for test of equality of asymmetry coefficients over the two sample periods with probability value shown in parenthesis. Standard errors of the estimated coefficients are given in parentheses.

Table 2.3 GJR-GARCH results for the Stock Exchange of Singapore

	α_0	α_1	α_2	β_1	χ^{2*}
Pre-change (1989:3:1 - 1993:9:30)	0.3571 (0.0044)	0.1116 (0.0183)	0.4055 (0.0348)	0.3250 (0.0076)	
Post-change (1993:10:1 - 1996:7:31)	0.1914 (0.0107)	0.3033 (0.0311)	0.1497 (0.0622)	0.3775 (0.0191)	18.308 (0.0000)

*Footnotes as table 2.2

Table 2.4 *GJR-GARCH results for the Korea Stock Exchange*

	α_0	α_1	α_2	β_1	χ^{2*}
Pre-change (1988:3:3 - 1991:12:31)	0.2831 (0.0138)	0.1281 (0.0121)	0.1434 (0.0277)	0.6646 (0.0086)	
Post-change (1992:1:1 - 1996:7:31)	0.0848 (0.0064)	0.0762 (0.0052)	0.0430 (0.0114)	0.8500 (0.0048)	13.167 (0.0003)

*Footnotes as table 2.2

Table 2.5 *GJR-GARCH results for the Taiwan Stock Exchange*

	α_0	α_1	α_2	β_1	χ^{2*}
Pre-change (1988:1:1 - 1990:12:31)	0.1870 (0.0376)	0.0492 (0.0085)	0.1454 (0.0176)	0.8572 (0.0072)	
Post-change (1991:1:1 - 1996:7:31)	0.1078 (0.0054)	0.0482 (0.0029)	0.0338 (0.0054)	0.8975 (0.0022)	40.175 (0.0000)

*Footnotes as table 2.2

In each of the markets there is clear evidence of an asymmetric response of volatility to news both before and after the opening up of the market to foreign investors. In the pre-change periods, negative news impacts on the volatility of the four markets, which are measured by the summation of α_1 and α_2 , are 8 times, 5 times, 2 times and 7 times higher than positive news impacts of an equal magnitude for Hong Kong, Singapore, South Korea and Taiwan respectively. This might suggest that during the pre-change periods, negative news could have more prolonged and significant influence on the development of the markets than positive news. Examples of negative news during these periods include the world stock market crash in 1987 and the political uncertainty following the massacre of protesting students in Beijing, which greatly affected Hong Kong in particular, as well as the outbreak of the Gulf War in 1990. Such big negative news were likely to have prolonged effects on market

movements as well as investors' confidence, as they were uncertain about how these crises might affect the political, economic and financial stability of both the local and world markets. In times of uncertainty, it would be difficult to distinguish noise from information. As was mentioned in Section III, most local investors are private individual investors who do not have the expertise to analyse the implications of world and local news to their local markets. Thus noise and feedback traders might become more active in the markets during this time, chasing the trend of local and / or overseas markets, and following the lead of big investors in their local markets in making their investment decisions. The high persistence of volatility to shocks during the pre-change periods in three out of four markets might also support the view that the news they encountered had far-reaching impacts, probably not only on the stock markets alone but on their economies as well. The impacts of news on the economies would later have feedback effects on the stock markets, resulting in a higher persistence of volatility to news. Therefore, the finding of an asymmetric response of volatility to news over the pre-change period along with a significant beta for each of the four markets could be reasonable.

The results for the post-liberalisation period show that the estimated asymmetry coefficients have gone down by approximately two-thirds in all four markets from the pre-liberalisation period, suggesting that the opening up of the markets to foreign investors has substantially reduced the asymmetric response of volatility to news. If the assumption that foreign institutional investors are mostly informed traders and that local private individual investors generally tend to be noise or feedback traders is to be accepted, then such a reduction in news asymmetries following liberalisation could



be interpreted as an indication of a reduction in the impact of noise trading activities in the local markets. The increase in informed traders in the local markets could also be the reason why news persistence have become higher than in the pre-change periods. For noise and feedback traders might mis-interpret or over-react to a piece of news and hence their trading activities would drive prices away from their fundamental values. When the markets have an increasing number of informed traders, Black (1986) suggests that their research and actions might help offsetting the noise that noise traders put into stock prices, until the prices of stocks are moved back to their fundamental values. It is such counter-actions taken by informed traders against noise traders' reaction to a piece of news that make it possible to reduce the impacts of noise trading activities in the markets whilst causing the news to become more persistent in affecting volatility of the markets.

Alternatively, the reduction in news asymmetries over the post-liberalisation periods might be due to the fact that the negative news during this period had less prolonged damaging effects on the markets or on investors' confidence than before. In fact, after the four markets' liberalisation, there had been no major warfare or financial crises threatening their political stability and economic developments. Instead, positive news such as a higher rate of economic growth above the world average and a rapid expansion of their export and financial markets was prevalent. As a result, there might be a lesser extent of asymmetric response of volatility to negative news in the post-liberalisation period than before.

As for the increase in news persistence in the four markets following liberalisation, if it is not due to the attempts of informed traders to counteract noise traders' activities and thus delaying the impounding of information into prices, it might imply that the four markets were less efficient than they were before liberalisation. This then would be contrary to the finding of Antoniou et. al. (1997), in which regulatory changes in an emerging market, namely the Istanbul Stock Exchange, are found to help improve information quality and lead to prices impounding information more rapidly. It would also differ from the argument of Bekaert and Harvey (1997) that capital market liberalisation in emerging markets does not drive up volatility. The difference of our findings from other studies might indicate that the true impact of market liberalisation on the four Asian markets has not been fully captured by a before-and-after snapshot in this study. After all, liberalisation is a gradual process and perhaps different stages of the regulatory changes should have been taken into account during the empirical analysis.

(VIII) Conclusion

In this chapter, we seek to measure directly the impact of increasing foreign investment opportunities in local stocks on the nature of volatility of four Asian stock markets, namely Hong Kong, Singapore, South Korea and Taiwan. Previous research on volatility in these markets has focused on the link between foreign stock investment and volatility transmission. However, without first establishing the evidence that local market volatility can be changed by increased foreign investment opportunities, and gaining an understanding of the nature and structure of volatility in the individual markets, assessment of volatility spill-over appears premature. The

opening up of the Taiwan and Korea Stock Exchanges and the institutional changes in Hong Kong and Singapore in the late 1980s and early 1990s which have led to an increase in foreign investment opportunities have provided an opportunity to assess the impact of increased openness for foreign investors. In addition, this chapter provides the first direct examination of the asymmetric responses of volatility to news in these Asian stock markets, both before and after they became more liberalised or attractive to foreign investors.

The results show that the effect of increasing foreign investment opportunities in local stock markets might come through a reduction in asymmetries in the four markets. Asymmetric effects have fallen substantially in all markets following their liberalisation. If the assumption that foreign investors are generally more informed than local investors who lack the expertise and resources to assess relevant market information is to be accepted, then the reduction in news asymmetries might support the view that asymmetries are caused by noise trading, rather than by leverage effects. As the opportunities for foreign investment increased, more informed traders became active in the market, and thus the impact of noise trading on volatility was reduced. Their counter-actions against noise traders' response to a piece of news until prices of stocks return to their fundamental values might also explain why persistence of volatility to news in the post-liberalisation period would have gone up. Alternatively, the absence of negative news that had similar prolonged damaging effects on the four markets as before might be related to the reduction in news asymmetries during this period. Moreover, if the increase in news persistence over the post-liberalisation period was not related to informed trading and noise trading, it might suggest that the

true impacts of market liberalisation in the four Asian markets have not been fully captured by the before-and-after snapshot. Thus there could be a need to take into account the different stages of regulatory changes when assessing the impacts of liberalisation on market volatility in future studies.

Having examined the changing nature of volatility in each of the four Asian markets, we will go on to look at their market inter-relationships with other world leading markets in the next chapter. The finding of a possible increase in the influence of informed traders also suggests that price co-movement and volatility spill-overs may exist, but have not, as yet, been examined formally. Such links between markets have important implications for foreign institutional investors to assess their global investment strategies, as well as for the Asian governments to determine on their market liberalisation measures. Hence we will turn to the issues of market inter-relationships between the four Asian markets and other leading world markets in the next two chapters.

Chapter Three : Foreign Investment And Integration Between Asian And World Stock Markets

(I) Introduction

In Chapter Two, it was established that the nature and structure of stock market volatility in Hong Kong, Singapore, South Korea and Taiwan had undergone changes following their liberalisation to allow or attract more foreign direct participation. Asymmetric responses to local news were found to have reduced following their liberalisation. This has been argued as an indication of a reduction in the impact of noise trading activities. The increase in foreign participation in the markets has resulted in more informed trading. Thus while noise traders and positive feedback traders typically may over-react to negative news, such over-reaction appears to have reduced since financial liberalisation. Volatility in the individual Asian markets post-liberalisation could now be seen as a manifestation of the dominance of information flow rather than noise trading effects.

Given that the four Asian markets have undergone changes in their volatility structure since lifting their restrictions on foreign investment, it is logical to continue by examining whether the way they interact with other world markets has changed as well. Such an examination has important policy implications for both foreign institutional investors as well as the Asian governments. First, if the developing markets become more integrated with the world markets following liberalisation, then there would be little benefits of risk diversification for buying into developing

markets. Foreign investors might be deterred from committing themselves to invest in these markets long term. Instead, they would reshuffle their investment capital more frequently across national markets in search for the best and safest investment returns which a market can offer. Second, if opening up the markets results in local stock price movement being more influenced by other markets, then the government might become sceptical about further liberalisation. They might even consider tightening up their markets once again. On the positive side though, increasing market integration not only enables developing markets in Asia to tap the growing pool of global capital to raise investment, but also enhances the spill-over of information and knowledge to their markets. This is often achieved through direct participation of institutional investors in these markets who are equipped with advanced communication technology for use in transmitting information across markets. The establishment of foreign brokerages could also help improve financial operations in developing markets in that their expertise can be shared by local firms. Thus if developing markets are found to be more integrated with the world markets, governments would have to face a decision of whether to sacrifice 'independence' of their stock markets in exchange for foreign investment capital.

Apart from having policy implications, investigating the changing pattern of linkages between developing and developed markets could also give more insight into the significance of cross-market portfolio investment in strengthening international market integration. As was established in Chapter Two, increased participation of foreign investors in Asian markets brought with it an increase in informed trading to the markets. Market news from both local and foreign sources would be transmitted

across borders almost immediately while its implication for the local markets is assessed and generates a response. If the news is seen to be relevant to the pricing of stocks in the local markets or crucial in affecting the investment strategies of global institutional investors, then price movements in one market would certainly spill over to another market. Such spill-overs would become more frequent and the links between world markets become closer as more institutional investors are participating in the local markets. Thus the increasing opportunities for participation by foreign investors in Asian markets following liberalisation should help strengthen their links with other world stock markets.

To date, evidence on the impacts of foreign investment on market integration is mixed with regard to the causal relationships of national stock price movements. Some suggest that the US is the dominant leader of price movements among the Asian-Pacific markets (e.g. Eun and Shim (1989) and Cheung and Mak (1992)), while others argue that Japan and the UK play a significant role too (e.g. Chowdhury (1994), Liu et. al. (1996), Masih and Masih (1997) and Rogers (1994)). Moreover, those markets with the strictest entry barriers, like Taiwan and South Korea, are commonly believed to be the least affected by changes in other national markets (e.g. Chowdhury (1994) and Rogers (1994) and Cheung and Mak (1992)). This is disputed in Liu et. al. (1996) who report that Hong Kong, the least restricted market of all developing markets, shows no significant linkage with other markets. Masih and Masih (1997) also give evidence that stock prices in South Korea are constantly led by Singapore, Taiwan by South Korea and Singapore by Hong Kong and Taiwan. These inconsistent results on the same issue of market linkage between developing

and developed markets may be due to the different choice of sample period, data frequency and estimation method.

In most papers, an arbitrary sample period of four (e.g. Rogers (1994)) to thirty years (e.g. Chan et. al. (1997)) is chosen to investigate the pattern of market linkages. In one or two papers only, Bracato (1994) and Liu et. al. (1996), the full sample period is split in half to investigate if there is a changing pattern of market inter-relationship after the 1987 crash. If we were to obtain an economic understanding as to how and why national markets are linked the way they are, the sample period used in the empirical analysis ought to be specifically chosen. The period surrounding the four Asian markets' introduction of liberalisation measures serves this purpose well. A comparison of the pre- and post liberalisation period results could enable us to infer whether foreign investment in developing markets can help strengthen international market integration.

The data frequency used in previous studies also varies widely from daily data to weekly and monthly data. The use of monthly data does not appear to be an appropriate choice in the study of stock market integration. The reason is that if markets are efficient, information is expected to be incorporated into prices rapidly. It is very rare that information from one market a month ago can still impact on other market's prices. Though the choice of daily data is more suitable, the problem of over-lapping trading hours between regional markets could make interpretation of the results very difficult. Whether one market is reacting to information originating from another market that has over-lapping trading hours or merely to its response to other

common world news would be difficult to discern. One way to mitigate this problem is to use weekly closing data because only the prices shown on the last trading day of the week would actually suffer from this problem, the rest of the week would not.

The use of different estimation methods is another possibility that leads to the inconsistent findings of market linkage pattern. Three methodologies are used in previous studies, namely (i) the variance decomposition analysis (e.g. Eun and Shim (1989), Bracato (1994), Chowdhury (1994) and Rogers (1994)), Liu et. al. (1996)), (ii) the Granger causality test (e.g. Cheung and Mak (1992) and (iii) the cointegration test (e.g. Allen and MacDonald (1995), Corhay et. al. (1993), Masih and Masih (1997)). The first method gives a descriptive picture of how much of a market's error variances are explained by its own shock and how much by external shocks. The second method investigates whether past prices in a market are able to explain price changes in another market. Both of these methods focus on the short-run nature of market inter-relationships. The third method, cointegration analysis, gives a more comprehensive picture of how markets are linked in the long- and short-run. Since government policy on further liberalisation or institutional investors' decisions on global investment strategies will not rely on the markets' short-term behaviour alone, it is worth investigating world markets' long run relationship as well.

Given that most previous studies have not directly examined the impact of foreign investment on market integration between Asian developing and world developed markets, it is necessary now to turn to empirical evidence to ascertain if foreign investment has a role to play in strengthening world market integration. We will

investigate the issue of market integration between Hong Kong, Singapore, South Korea, Taiwan, the US, the UK and Japan using the multivariate cointegration method with weekly closing stock price series. The full sample period of mid 1986 to mid 1996 that surrounds the four Asian markets' liberalisation is specifically chosen to reflect the possible impact of foreign investment on market integration. The finding of a changing pattern of volatility in the four markets individually in Chapter Two implies that there is a need to partition the sample period into two according to the time when market liberalisation was introduced in the four markets. A comparison of the pre- and post-change cointegration results give an insight into the changing pattern of market inter-relationships over time as the four markets become more open or attractive to foreign investors. We find a significant cointegrating relationship between two Asian markets and one developed market following their liberalisation but none before that. This is attributed to the improved efficiency in the local stock markets in transmitting information into prices through more contacts with foreign financial institutions and information technology. It is also argued that the major industrial market which has the closest link with the developing markets is the one with a relatively larger investment in their equities. Similarly, the Asian developing markets which exhibit the closest link with the developed markets are the ones without much government intervention into the stock markets. Thus only the UK, Hong Kong and Taiwan are found to be cointegrated following their market liberalisation.

The remaining chapter will be organised as follows. Section II describes the link between foreign investment and international market integration. Section III

summarises the literature to date on the issue of market integration. Section IV describes the data set and gives an account of the empirical design. Section V reports the estimation results and a concluding remark is given in Section VI.

(II) The link between foreign investment and market integration

An increase in cross-market investment opportunity following liberalisation could strengthen market integration between developed and developing markets in two ways : through an improved efficiency in information flow and institutional investors' portfolio shifts. As cross-country investment involves higher risk (such as political risk and exchange rate risk), a thorough research of the market and the target companies is essential for foreign investors. This information has to be transmitted across markets efficiently and accurately so that foreign investors can act upon them swiftly. However, this information gathering and transmitting exercise incurs high costs so that large institutional investors like unit trust and mutual fund companies can afford to invest in foreign markets. An increase in foreign investment opportunities in the four Asian markets after liberalisation creates the need for foreign investors to possess advanced information technology. As a result, information flow between markets becomes more efficient and this allows national stock prices to respond simultaneously to common world news.

The flow of portfolio capital across borders will also become more frequent as institutional investors seek to maximise their expected returns. They will adjust their international portfolio position according to internal factors of the developing markets as well as developments in other world markets. If it emerges that investing in their

home markets is becoming more favourable, they will pull out their capital from the developing markets and reinvest in the developed markets. Due to the large size of total assets of institutional investors, even relatively small portfolio shifts towards or away from the developing markets would impact on the movement of stock prices there. Such portfolio shifts might result in a negative relationship between developing and developed markets' price movements as institutional investors abandon one in favour of another. Thus an increasing opportunity in cross-market stock investments accompanying liberalisation in the developing markets could impact on international market relationships. Thus we will argue that comovement of national stock prices will occur only in the post-liberalisation period.

(III) Literature review

Previous research on the issue of integration between emerging and developed markets can be divided according to the method of study used, namely variance decomposition analysis, Granger causality test and cointegration method.

Eun and Shim (1989) are the first to study the international transmission of stock market movements by estimating a VAR. They examine 9 markets: 6 developed markets in Europe and America and three in Asia. Using daily rates of return to stock markets over the period of 1980 to 1985, they try to find out if the US is the source of price movements in the rest of the world and how rapidly do other markets respond to its innovations. The results are supportive of a uni-directional causality from the US and the transmission of a US shock to other markets is found to be rapid within a

matter of days. This they argue is consistent with a notion of informationally efficient stock markets.

Brocato (1994) uses the variance decomposition analysis to examine a slightly different aspect of market integration. He aims to test whether world stock markets have become more integrated over the 1980s as the financial ties between major world equity exchanges grow. His data set considers six internationally active stock exchanges (the US, the UK, Canada, Japan, Germany and Hong Kong) trading over the sample period of 1980 to 1987, which is split in half to make the sample size in both periods equal. The estimation results using a weekly rate of return average for each index suggest that there are significant linkage alterations over the decade of the 1980s. The dominant role of the US market in influencing price movements in others has eroded. Instead, other markets appear to have absorbed much of the linkage strength lost by the US. For instance, West Germany increases its linkage to Canada, as does Hong Kong to West Germany and Britain, Japan and West Germany to Hong Kong. Despite these findings of a changing market linkage pattern, Brocato has not explained how this phenomenon is related to growing world financial integration during the sample period. Therefore, it remains unknown as to why increasing world financial integration would undermine the leadership role of the US, but make other markets become more influential .

Chowdhury (1994) is among the first to investigate the relationship between the Newly Industrialised Economies (NIEs) and other major markets. In this paper, he argues that markets with severe restrictions on cross-country investing are not

responsive to innovations in foreign markets. Thus Hong Kong and Singapore, the least restricted markets of the NIEs included in the study, should be more influenced by changes in major markets, such as the US and Japan, than Taiwan and South Korea, the most restricted markets during the sample period of 1986 to 1990. Daily returns of the seven markets are fitted into a VAR. Results from the variance decomposition and the impulse response functions indicate that a significant link exists only between markets with no restrictions on foreign investment, i.e. Hong Kong, Singapore, Japan and the US. On the other hand, South Korea and Taiwan, which have had very tight barriers to foreign entry, are not responsive to foreign innovations. This paper is among the very few that reports standard errors alongside the variance decomposition coefficient estimates, making the results more reliable in this respect.

Rogers (1994) similarly investigates the general relationship between entry barriers and the transmission of stock prices, particularly surrounding the crash period of October 1987. He argues that the 1987 crash has increased volatility of national stock markets. This increased volatility of individual market returns in turn provides an opportunity for international arbitrage. The low transaction costs relative to the expected return from arbitrage make this arbitrage worthwhile. As a result, price spill-overs from one country to another have increased. In countries with stiffer entry barriers, however, transaction costs are too high to make any arbitrage opportunity profitable after the crash. It thus prevents prices from being spilled over to them from other markets. On examining the daily rates of return to ten markets: the US, the UK, Japan, Germany, Taiwan, Thailand, South Korea, Argentina, Mexico and Chile, over

the period of 1986 to 1989, he finds evidence of volatility rises for all markets immediately after the crash and price spillovers from the US and Japan do not take place in Taiwan and South Korea which have the most severe entry barriers.

Liu, Pan and Fung (1996) examine the transmission of the volatility of daily price changes (proxied by daily squared returns) among the US and six Asian-Pacific stock markets (Japan, Hong Kong, Singapore, Taiwan, Thailand and South Korea) over a period of 1984-1991. Granger causality tests are conducted within each individual equation of the VAR system over two sub-periods --- pre- and post-crash. They find that the US stock market is not the most influential market among the seven markets examined. Japan and Singapore have strong impacts on the Asian-Pacific markets too. Japan is also reported to impact significantly on the US market's return and return volatility after the crash. Hong Kong, shows no significant linkage in volatility with other markets despite it being the least restricted Asian-Pacific market.

Corhay et. al. (1995) study stock prices of the five largest and least restricted Pacific-Basin markets, namely those of Australia, Japan, Hong Kong, New Zealand and Singapore using cointegration. Monthly data on the stock price indices for the five markets over a period of twenty years from 1972 to 1992 are used in the cointegration analysis. They find evidence of a single cointegrating vector between the markets. Tests of restrictions on the significance of each of the cointegrating parameters suggest that Singapore and New Zealand only play a minor role in the long run because they do not enter significantly into the cointegrating vector, whilst tests of restrictions on the long run adjustment matrix show that Australia and New

Zealand are exogenous to the cointegrating system. They do not adjust to the price differences from the other three Asian markets. This is interpreted as an indication of regionalism among the integrated Pacific-Basin financial area.

Allen and MacDonald (1995) also estimate a number of bivariate relationships between sixteen countries using the Engle-Granger cointegration method over a period of 1970 to 1992. The results are used to help select appropriate variables entering the Johansen multivariate model because they are concerned that the outcome of the Johansen procedure would be sensitive to the choice of lag length if the number of variables is excessive. Among the sixteen markets examined, the pair-wise cointegration results show that Canada, the UK and Hong Kong are found to cointegrate with the Australian market individually. There is no evidence of the US or Japan having cointegration with the UK and Australia. The results obtained using the Johansen procedure confirm the existence of a cointegrating relationship between Australia, the UK and Canada. The presence of cointegration is again interpreted as evidence against the hypothesis of weak form efficiency.

Chan, Gup and Pan (1997) conduct a brief investigation into the link between monthly stock prices of eighteen markets over a period of 1961 to 1992 which is split into three sub-periods, the 1960s, the 1970s to the mid-1980s and after 1988. They divide the markets into seven regional groups and test for cointegration within each region. No details on the cointegration test results are given and no restriction tests on the cointegrating vectors are made. It is reported that markets in some regions are

found to co-move and the number of cointegrating stock prices appear to have increased before the October 1987 crash.

Masih and Masih (1997) employ a mixture of techniques to investigate the linkage between the Four Asian Tigers (Hong Kong, Korea, Singapore and Taiwan) with Japan, the US, the UK and Germany. They first use the multivariate cointegration technique to search for possible relationships between the four Asian markets and one of the other developed markets in four separate five-dimensional models. Zero restrictions on each parameter of the cointegrating vectors in the four models are also tested. Then, they carry out the variance decomposition analysis and estimate the impulse response functions for each market within the four different models to 'quantify their temporal causality results.' (Masih and Masih, p.68). Their results show that there is a single cointegrating vector in each of the four models using monthly stock price indices for the eight markets from 1982 to 1994. Temporal causality tests based on four vector error correction models (VECM) reveal that Hong Kong and all the developed markets are weakly exogenous. They do not respond to deviations from the equilibrium relations. Singapore and Taiwan, on the other hand, have to bear the brunt of short-run adjustments to long run equilibrium. Most interesting of all, their VECM results show that Taiwan is consistently found to be led by South Korea, South Korea by Singapore and Singapore by Hong Kong and Taiwan in the short term. This linkage pattern, however, is not exactly consistent with their variance decomposition results.

Finally Cheung and Mak (1992) conduct a series of causality tests to see if the eight chosen Asian-Pacific markets are influenced by the US and Japan, a proxy for global factors and regional factors respectively. They try to find out whether market returns in these Asian-Pacific markets are individually affected by past return movements in the US and Japan over six two-year periods that spanned from 1978 to 1988. They find evidence of causality from the US market to most of the Asian-Pacific markets with the exception of South Korea, Taiwan and Thailand. This, they argue, is attributed to their limited degree of openness. Japan, on the other hand, is found to have a less significant impact on the Asian-Pacific markets. They also argue that the results are indicative of market inefficiency in these markets because the significant lag structure found in the regression models invalidates the hypotheses of instantaneous information dissemination.

The major shortcoming of the studies above is their choice of sample periods. The arbitrary choice of sample periods in most studies makes it hard to explain why some markets are linked to or Granger caused by other markets whilst others are not. In most cases, it is asserted that the linkage pattern is related to the degree of market openness. With the onset of market liberalisation in Asian markets in recent years, particularly in Taiwan and South Korea, the possible effects of such institutional changes can now be tested directly. Moreover, the use of monthly data in some of the papers is inappropriate because it aggregates a lot of information about the day to day movement of individual market's stock prices. The finding of no integration between several markets may not actually reflect the real world situation.

(IV) Empirical design : data, sample and methodology

(A) Data

The data set consists of end-of-week closing stock price indices of seven stock markets including Hong Kong (HK), Singapore (S) , Korea (K), Taiwan (T), Japan (J), the United States (US) and the United Kingdom (UK). The indices used for each of them are respectively the Hang Seng Index, Singapore Straits Times Industrial Index, Korean Composite Price Index, Taiwan Weighted Price Index, Nikkei 225 Average Stock Index, Dow Jones Industrial Index and the FTSE 100 Index. These indices are the most representative indicators of each market's performance because they are either made up of stocks which constitute the largest amount of market capitalisation or the most active stocks traded in the market. They are transformed into logarithmic form prior to estimation. The number of observations for all markets in the pre-change period (April 1986 to June 1989) and the post-change period (October 1993 to July 1996) are respectively 169 and 147.

To be consistent with the practice in the previous chapter, daily data should have been used in this chapter. However, the emphasis of this chapter is on the long-run co-movement of stock prices in the seven markets and how they adjust themselves to the price discrepancies that might arise in the short run to re-establish the long-run equilibrium relationship. The use of lower frequency data like weekly data might be more appropriate than the use of daily data as the latter would require a higher order of vector autoregression to yield serially uncorrelated residuals when estimating cointegration. It is noted in Charemza and Deadman (1992) that the use of long lags in the VAR would diminish the power of the Johansen cointegration test. Thus end-

of-week prices instead of daily prices are used in this chapter , although they still do not overcome the problem of non-synchronicity of time zones among the four Asian markets and two of the three major world markets, namely the US and the UK.

(B) Sample period

The finding of changing volatility behaviour in each individual market in Chapter Two is indicative of the possibility that the pattern of market linkage between the Four Tigers and the three major world markets, the US, the UK and Japan would have also undergone some changes too. Thus two sub-sample periods will be used to estimate a seven-dimensional model and the results compared. The data are 'extracted' from the longest full sample period used in Chapter Two which spanned from April 1986 to July 1996. The reason is that market liberalisation took place at different times in the four markets. In order to make possible the formulation of a VAR system for use in the cointegration test, a common sample period or the same number of observations for the markets has to be used. Therefore, the pre-liberalisation period can only be up to the time just before the first market began to liberalise, while the post-liberalisation period can only begin after the last market has introduced its liberalisation measures. The time when some markets have tried to open up or improve themselves while others are still having strict restrictions on foreign participation will be left out from the sample period. As a result, the pre-and post-liberalisation period will span from April 1986 to June 1989 and from October 1993 to July 1996 respectively.

(C) Methodology

(C.1) Testing for the order of integration

As a prerequisite for testing for cointegration we must verify that all series involved are stationary and share common integrational properties, i.e., they are all integrated of the same order. The danger of using non-stationary time series in regression analysis is that spurious regression would be yielded whereby unrelated variables can be shown to produce apparently meaningful relationships. If a non-stationary series must be differenced d times to make it stationary, Engle and Granger (1987) define it as integrated of order d denoted as :

$$x_t \sim I(d)$$

There are several different types of procedures available in testing for the degree of integration of univariate time series. One of them is that proposed by Dickey and Fuller (1979). Suppose we wish to test the hypothesis that a non-seasonal variable x_t is integrated of order one, that is x_t is generated by equation (1). The Dickey-Fuller test is a test of the hypothesis that in equation (2), $\rho = 1$,

$$X_t = \mu + X_{t-1} + \varepsilon_t \quad (1)$$

$$x_t = \rho x_{t-1} + \varepsilon_t \quad (2)$$

The unit root test is based on the estimation of an equivalent regression equation to (2), namely:

$$\Delta x_t = \delta x_{t-1} + \varepsilon_t \quad (3)$$

where

$$\delta = \rho - 1$$

If $\delta \neq 0$, it implies that $\rho \neq 1$ and the process cannot therefore be modelled as a random walk. The null hypothesis $\delta = 0$ implies that the data are I(1). The t-ratio of

δ (i.e. t_δ) from equation (3) does not have a standard t distribution. Instead it is shown to be distributed as a Dickey-Fuller distribution (Fuller (1976)).

A weakness of the original Dickey-Fuller test is that it does not take account of possible auto-correlation in the error process ε_t . If ε_t is auto-correlated, then the OLS estimates of equation (3) will not be efficient and t -ratios will not follow the tabulated DF distribution. A simple solution, advocated by Dickey and Fuller (1981) is to use lagged left-hand side variables as additional explanatory variables to approximate the auto-correlation. This test is known as the Augmented Dickey-Fuller test (ADF) and the testing procedure is the same as before. The ADF equivalent of (3) is shown as equation (4):

$$\Delta x_t = \mu + \alpha t + \delta x_{t-1} + \sum_{i=1}^k \beta_i \Delta x_{t-i} + \varepsilon_t \quad (4)$$

where k is the minimum number of lags required to remove auto-correlation. The practical rule for establishing the value of k (the lag length of Δx_{t-i}) is that it should be relatively small in order to save degrees of freedom, but large enough to remove auto-correlation in ε_t . The strategy is to start running the regression from a lower order k and then use the *LM* test (see Charemza and Deadman (1992) p.196) to test if the null of no serial correlation in the error term can be accepted. If not, then we sequentially test for a higher order k until the null of no serial correlation can be accepted.

(C.2) Testing for cointegration

Once the order of integration of each series is established, a VAR system can be formulated to test for cointegration. A simplified account of cointegration inference in a VAR model is given below. Starting from an unrestricted VAR model:

$$Y_t = \sum_{i=1}^k A_{(i)} Y_{t-i} + \varepsilon_t \quad (5)$$

where Y_t contains all n variables of the model and ε_t is a vector of random errors; the order of VAR lag lengths is determined by minimising Akaike's Information Criterion (AIC).

The VAR model (5) can be represented in the form given in (6):

$$\Delta Y_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-k} + \varepsilon_t \quad (6)$$

where $\Gamma_i = -I + A_1 + \dots + A_k$ (I is an identity matrix)

$$\Pi = -(I - A_1 - \dots - A_k)$$

Since there are n variables which constitute the vector Y_t , the dimension of Π is $n \times n$ and its rank can be at most equal to n . It follows from the Granger Representation Theorem (Engle and Granger (1987) that: (i) If the rank of matrix Π is equal to n , that is equal to the total number of variables explained in the VAR model, the vector process Y_t is stationary; (ii) If the rank of matrix Π is equal to $0 < r < n$, there exists a representation of Π such that:

$$\Pi = \alpha\beta' \quad (7)$$

where α and β are both $n \times r$ matrices.

Matrix β is called the cointegrating matrix and has the property of βY_t (the disequilibrium error) $\sim I(0)$, while $Y_t \sim I(1)$. This in turn implies that the variables Y_t

are cointegrated, with the cointegrating vectors $\beta_1, \beta_2, \dots, \beta_r$ being the columns of the cointegrating matrix β . The coefficients α measure the adjustment to past equilibrium errors. Note that in the case where Π is of reduced rank, the term ΠY_{t-k} represents an error correction mechanism. Equation (7) is therefore referred to as a Vector Error Correction Model (VECM).

To determine the number of cointegrating vectors from equation (6), two test statistics are used : the maximum eigenvalue statistics and the trace statistics. In the trace test, the null hypothesis that there are at most r cointegrating vectors is tested against a general alternative hypothesis (i.e. H_0 is not true), while in the maximum eigenvalue test, the null hypothesis of at most r cointegrating vectors is tested against the alternative of $r + 1$ cointegrating vectors where r is an integer. In both tests, we start off by assuming $r = 0$. If this is rejected, then we sequentially go on to assume $r = 1, r = 2, \dots, r = n$ until we cannot reject H_0 and determine the number of cointegrating vectors. The decision rule is that if the test statistic is smaller than the critical value, accept H_0 and reject otherwise.

(C.3) Hypothesis testing

The hypothesis of a closer link between developed and developing markets following liberalisation can be tested through imposing zero restrictions on both α and β in (10). Tests of zero restrictions on β allow us to identify which variables enter the cointegrating relationship significantly. If $\beta_i = 0$ cannot be rejected, that means the corresponding market does not enter the cointegrating relationship significantly. Those markets whose corresponding β_i are statistically different from zero represent

the key elements of an underlying relationship that the cointegrating vector is actually picking up.

The tests on α show whether the burden of adjusting to any long run dis-equilibrium is borne by all markets or just a few. According to Johansen (1995 p.77), the hypothesis of zero coefficients in α for a certain subset of equations means that the subset of variables is weakly exogenous. If the restriction holds, then the long run solution to X , for instance, is not affected by the level of Y and in particular departures from the equilibrium defined in the cointegrating vector will not determine X in the long run (see Hall and Milne 1994 p. 600). They define this as long run causality and note that it is a necessary condition for Granger Causality. These tests on individual cointegrating parameters are distributed as chi-squared variates with one degree of freedom.

(V) Empirical results

(A) Tests for unit roots

Table 3.1 *Unit root tests for the order of integration*

<i>Market</i>	<i>Pre-change Period</i> <i>(April 86 - June 93)</i>		<i>Post-change Period</i> <i>(October 93 - July 96)</i>	
	<i>Level</i>	<i>1st Difference</i>	<i>Level</i>	<i>1st Difference</i>
Hong Kong	-2.5193 (2)	-9.2007 (0)*	-2.0777 (2)	-10.893 (0)*
Singapore	-2.5488 (2)	-9.9459 (0)*	-2.8611 (2)	-10.772 (0)*
Korea	-1.3138 (2)	-12.782 (0)*	-2.8125 (2)	-10.772 (0)*
Taiwan	-0.6357 (2)	-9.4095 (0)*	-2.7635 (2)	-11.121 (0)*
Japan	-1.4313 (2)	-15.162 (0)*	-1.6613 (2)	-13.173 (0)*
United States	-1.7455 (2)	-11.858 (0)*	-0.1459 (2)	-12.883 (0)*
United Kingdom	-2.0106 (2)	-9.1016 (0)*	-0.8637 (2)	-13.604 (0)*

N.B. Figures in parentheses are the number of lags used in the ADF equation.

Table 3.1 shows the ADF test statistics from the unit root regressions under the null hypotheses that the variables are not stationary against the alternatives that they are stationary in levels or after taking first differences. The numbers in parentheses represent the number of lags included in each unit root regression. The critical value for all regressions with a time trend is -3.44. An asterisk denotes that the null of non-stationarity in the corresponding market can be rejected. Results in Table 3.1 show that the null hypotheses of non-stationarity when variables are in levels cannot be rejected. However, after taking first differences, all variables become stationary because the null hypotheses of non-stationarity can be rejected in these cases.

(B) Cointegration test

Table 3.2.1 *Cointegration test for the pre-liberalisation period*

<i>rank</i>	<i>trace statistics</i>	<i>small sample statistics</i>	<i>95% critical value</i>	<i>maximum eigenvalue statistics</i>	<i>small sample statistics</i>	<i>95% critical value</i>
r = 0	46.71*	42.82	45.3	125*	114.5	124.2
r = 1	27.47	25.18	39.4	78.24	71.72	94.2
r = 2	20.85	19.11	33.5	50.77	46.54	68.5
r = 3	14.55	13.34	27.1	29.92	27.43	47.2
r = 4	9.805	8.988	21.0	15.37	14.09	29.7
r = 5	3.821	3.502	14.1	5.563	5.099	15.4
r = 6	1.742	1.597	3.8	1.742	1.597	3.8

(N.B. VAR₍₁₎ is used in the cointegration test)

Table 3.2.2 *Cointegration test for the post-liberalisation period*

<i>rank</i>	<i>trace statistics</i>	<i>small-sample statistics</i>	<i>95% critical value</i>	<i>maximum eigenvalue statistics</i>	<i>small-sample statistics</i>	<i>95% critical value</i>
$r = 0$	54.96*	52.31*	49.4	163.8*	155.9*	146.8
$r = 1$	35.05	33.36	44.0	108.9	103.6	114.9
$r = 2$	25.52	24.29	37.5	73.83	70.27	87.3
$r = 3$	18.96	18.04	31.5	48.31	45.98	63.0
$r = 4$	13.87	13.2	25.5	29.35	27.93	42.4
$r = 5$	10.61	10.1	19.0	15.48	14.73	25.3
$r = 6$	4.869	4.634	12.2	4.869	4.634	12.2

(N.B. VAR₍₁₎ is used in the cointegration test)

In Tables 3.2.1 and 3.2.2, the null hypothesis of the trace test that there are at most r cointegrating vectors is tested against a general alternative hypothesis (i.e. H_0 is not true), while in the maximum eigenvalue test, the null hypothesis of at most r cointegrating vectors is tested against the alternative of $r + 1$ cointegrating vectors. The test statistics using a small-sample correction as suggested by Reinsel and Ahn (1992) are also reported in Tables 3.2.1 and 3.2.2. It is noted in Richards (1995 p. 634) that the asymptotic critical values provided by Johansen and Juselius (1990) may be misleading in small samples. The empirical size (the rejection frequency when the null hypothesis of no cointegration is true) of the Johansen tests is increased (i.e. worse) in cases of small samples and a high number of explanatory variables. An asterisk indicates that the corresponding null hypothesis can be rejected at the 5% significance level. In Table 3.2.1, the small sample statistics for both the trace and the maximal eigenvalue tests are smaller than the 95% critical values, the null of no cointegration cannot be rejected. This apparently contradicts the results given by the

unadjusted sample test statistics, shown in columns two and five of the tables. However, concerns over misleading results when using small sample size in the Johansen test lead us to favour the small sample test statistics. Accordingly, there is no cointegrating relationship between the seven markets in the pre-liberalisation period. In Table 3.2.2, both the asymptotic values and the small sample statistics are greater than the 95% critical value for $r = 0$, thus indicating that there exists a single cointegrating vector during the post-liberalisation period.

(C) Test of restrictions on the cointegrating parameters

To find out which markets enter significantly into the cointegrating relationship, zero restriction tests on the cointegrating vector (β) are performed using the likelihood ratio test. If $\beta_i = 0$ can be rejected, that means the corresponding markets enter significantly into the cointegrating relationship. Otherwise, they are insignificant within the relationship. The test statistic is distributed as χ^2 - variates with 1 degree of freedom. The null of zero loading for the corresponding market will be accepted if the test statistic is smaller than the critical value, otherwise, it will be rejected. Results on the restriction tests are shown in Table 3.3.

In Table 3.3, the p-values associated with the χ^2 statistics are given in parentheses. An asterisk indicates that the corresponding null hypothesis can be rejected at the 5% significance level. It is found that in the post-liberalisation period, the cointegrating vector is actually picking up cointegration between the UK, Hong Kong and Taiwan. We proceed with a model to include only these three markets which enter significantly into the cointegrating vector.

Table 3.3 *Test of zero restrictions on β in the post-change cointegrating vector*

<i>Markets</i>	<i>H₀: $\beta_i = 0$</i>
Hong Kong	19.377 (0.0000)*
Singapore	0.9248 (0.3362)
Korea	0.0155 (0.9009)
Taiwan	5.3757 (0.0204)*
Japan	0.8845 (0.7662)
United States	1.0267 (0.3110)
United Kingdom	9.7639 (0.0018)*

Table 3.4 *Cointegration test on the parsimonious model*

<i>rank</i>	<i>trace statistics</i>	<i>small-sample statistics</i>	<i>95% critical value</i>	<i>maximum eigenvalue statistics</i>	<i>small-sample statistics</i>	<i>95% critical value</i>
r = 0	45.28*	44.87*	25.5	64.17*	62.85*	42.4
r = 1	12.19	11.94	19.0	18.35	17.97	25.3
r = 2	6.162	6.035	12.2	6.162	6.035	12.2

(N.B. VAR₍₁₎ is used in the cointegration test)

The test statistics in Table 3.4 confirm that a significant cointegrating relationship exists between the UK, Hong Kong and Taiwan during the post-change period. The estimates of the long-run parameters $\hat{\beta}'$ normalised on the UK are given below:

$$\hat{\beta}' = (1.00, 0.278, -0.159)$$

with the corresponding estimates of α :

$$\hat{\alpha}' = (-0.013, 0.009, 0.011)$$

Test results on the zero restrictions on α are given in Table 3.5.

Table 3.5 : *Test of zero restrictions on α in the parsimonious model*

<i>Markets</i>	<i>$H_0 : \alpha_i = 0$</i>
UK	12.906 (0.0003)*
Hong Kong	13.385 (0.0003)*
Taiwan	15.149 (0.0001)*

All test statistics in table 3.5 are distributed as $\chi^2(1)$. Associated p -values of the test statistics are given in parentheses and an asterisk indicates that the corresponding null hypothesis can be rejected at the 5% significance level. The results show that all markets involved in the relationship are endogenous to the system in the post-change period. They all Granger-cause each other in the long run although the speeds of adjustment to the price discrepancies from the other markets within the cointegrating system are slow, as illustrated by the estimated adjustment matrix α of less than 0.02 in real terms for all three markets. Nevertheless, our results suggest that the causal relationship between the UK, Hong Kong and Taiwan is multidirectional instead of unidirectional.

(D) Discussion of results

(D.1) No long-run relationships when cross-market investment opportunity is limited

Though the US, the UK and Japan are major trading partners to the four Asian markets, there is no cointegration between their stock prices during the pre-liberalisation period. It seems that the presence of a significant trade relation between the seven countries in the goods market alone is not sufficient to foster a similar relationship in their capital markets. The lack of direct foreign investment

opportunities in the Asian markets could be the main reason for the non-existence of a long-run relationship between their stock prices. During this period, both the stock markets in South Korea and Taiwan were closed to direct foreign investments. Singapore did not have such a restriction on foreign investments but the opportunities offered to them were limited. At least no foreign brokerages were allowed to be set up during this period and many large companies were state-owned. The Hong Kong Stock Exchange was newly established in 1986 by merging four existing exchanges together and foreign investors could be expected to have reservations about the efficient functioning of this new establishment. The lack of foreign direct investment opportunities in these four markets is therefore obvious. As such, cross-market information flows would be less efficient and developing markets would remain predominantly affected by their own economic and political developments. Thus it is not surprising that developing and developed markets do not have a long run price relationship when foreign direct investment in the former is limited or even non-existent.

(D.2) Foreign investment could strengthen market integration for some Asian markets

With an increased opportunity for foreign investments in Asian developing markets after liberalisation, there is cointegration between the major and developing markets. In particular, a significant cointegrating relationship is found between the weekly stock prices of the UK, Hong Kong and Taiwan from October 1993 to July 1996. The integration of Taiwan into other regional and world markets only after allowing foreign direct participation in its stock market provides some support that foreign investment does help promote a closer link between international markets. Figure

1.51 in Chapter One shows that foreign portfolio investment in the Taiwan Stock Exchange between 1993 and 1996 was at its record high of around US\$2 billion to US\$3 billion per annum. With such an influx of foreign capital, it is reasonable to expect that price movements in other stock markets could spill over to Taiwan, particularly when the movement prompts an adjustment to the international investors' world-wide position. Thus foreign investment is likely to impact on international market integration.

As for Hong Kong, it is closely related to the UK both politically and economically. It was a British colony until 1997 and most of its local public construction and development projects were undertaken by British firms between 1993 and 1996, for example the construction of a new international airport and a cross harbour bridge, as well as the extension of the underground railway network. Twenty-eight large capitalised Hong Kong-based stocks were cross-listed in the London stock exchange in December 1997. Similarly, a few UK-based companies, for example British Telecom, were cross-listed in Hong Kong. This kind of direct involvement in each other's stock market is a potentially important mechanism for the transmission of price movements. It is therefore not surprising to find a cointegrating relationship between the UK and Hong Kong.

(D.3) Government intervention could prevent market integration

While Taiwan has experienced a closer link with other national stock markets after its liberalisation, South Korea does not seem to have any significant relationship with other markets despite opening its market to foreign investment as well. One obvious

reason is the state interventionist policies adopted by the Korean government to influence its stock market. Though the Korean stock exchange was open to foreign investors for the first time in 1992, the government is reluctant to raise their investment ceiling. It fears that too large an inflow of foreign funds would push up the nominal exchange rate and, via inflation, push the real exchange rate up even further. Thus it frequently intervenes to keep the market from what it believes to be over-heating. For instance, it was alleged to have put pressure on the nation's three investment trust companies to sell off shares in order to depress stock market prices during 1994 when the market was thought to be overheated. In the run up to parliamentary elections in April 1996, however, the government told the official stock market stabilisation fund to purchase stocks so as to push up prices. Thus the performance of the Korean stock market is subject to state intervention and the possible impact of foreign investment on its relationship with other markets would be distorted.

A similar situation happens in Singapore where the government influences its stock market by directly holding stakes in individual companies throughout the spectrum, from high-tech defence contractors to low-tech service industries. Public utilities and land and housing development are all controlled by the government despite their part-privatisation in 1993. This complex web of government involvement in industry enables the government to encourage the development of certain industries without competitors knowing exactly what is going on. Privately owned firms may be disadvantaged by these government-linked firms. As a result of such intervention practices, opportunities for foreign participation in both the South Korea and

Singapore stock exchanges are still limited. Market information is imperfect and stock price movements may be inconsistent with their economic fundamentals. All these can prevent their prices from interacting with those in other foreign markets during the post-liberalisation period.

(D.4) Why does the UK integrate more with the Asian markets than the US and Japan?

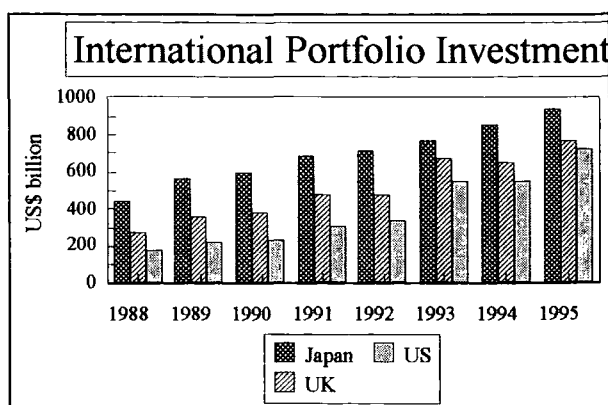
Stock prices in the US and Japan do not appear to have a close link with those in the liberalised Asian markets. This may be attributed to their lesser investment in the Asian markets' equities compared to UK investors. Figures 3.1 to 3.3 show that despite having the largest international portfolio investment between 1988 and 1995, Japan did not have any foreign equity holdings at all in the world markets. Instead, all its international portfolio investment was devoted to debt securities. As for the US, although it invested more in international equity securities than the UK between 1993 and 1995, more than 75% of its activity in foreign equities was concentrated in Japan, the UK and Canada. Only a fraction of its capital was actually invested in emerging markets. For instance, in 1993 net purchases of equities in the four Asian developing markets by US investors was less than US\$9 billion in aggregate as shown in Table 3.6. US investors' interest in developing markets was largely focused on debt and equity issues in Latin America. This is in contrast to the UK investors who are reported to be more interested in buying assets in Asia (Khan and Reinhart, 1995, p.12).

The reason for low investment in the stock markets of Asia by US and Japanese investors relative to the UK investors could be related to their changing economic

conditions since 1994. During the recession of major industrial countries between 1989 and 1993, US investment in emerging markets' equities increased significantly. Examples of this can be found in Table 3.6 where Hong Kong and Mexico were the two main beneficiaries. However, with economic recovery firmly established again in the US in 1994, as a result of its policy of low interest rates to stimulate demand, domestic stock markets rose strongly. The strength of the recovery and the rising expectations of corporate earnings began to divert some funds from the emerging markets. The fall in US participation in the developing markets thus could have prevented a close link being formed between the US and the four Asian markets' price movements during the post-liberalisation period.

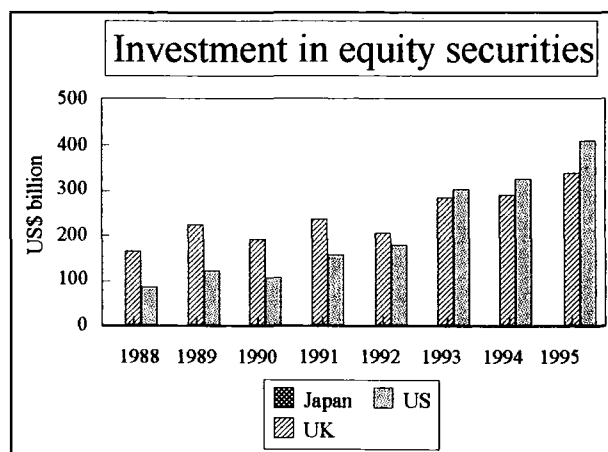
As for Japan, a strong yen discouraged Japanese investors from investing in dollar-denominated foreign assets between 1994 and early 1996, even at apparently attractive interest rate spreads (EIU Country Profile: Japan 1997 p.35). An increased government demand stimulus to expand domestic production facilities could also have made Japan's cross-border transactions in bonds and equities fall from 120% of its GDP in 1990 to 82% in 1996. In fact, the recession in Japan and the uncertainty of recovery during this period were the major causes of its sharp fall in stock prices despite a boom in overseas equity markets in mid-1996. Hence Japan is not expected to be closely linked with the four Asian markets' price movements during the post-liberalisation period.

Figure 3.1 *International portfolio investment by Japan, the UK and US*



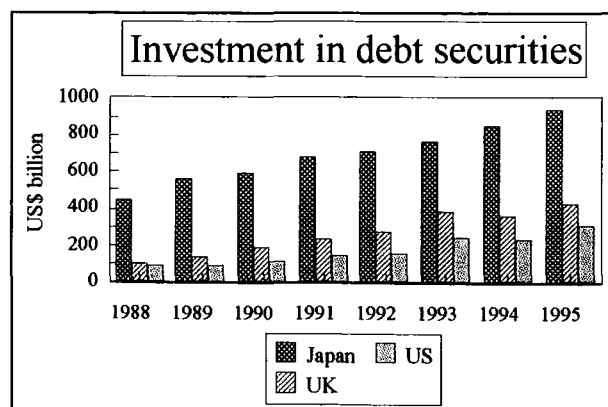
Source : Balance of payment statistics yearbook, IMF 1996

Figure 3.2 *International investment in equity securities by Japan, the UK and US*



Source : Balance of payment statistics yearbook, IMF 1996

Figure 3.3 *International investment in debt securities by Japan, the UK and US*



Source : Balance of payment statistics yearbook, IMF 1996

Table 3.6 *Net purchases of foreign equities by US investors (in US\$ billions)*

Markets	1988	1989	1990	1991	1992	1993
Hong Kong	0.3	-0.3	0.6	1.1	3.6	6.3
Singapore	-	0.4	0.5	-0.2	0.5	1.2
S. Korea	-	-	-	-	0.5	1.3
Taiwan	-	-	-	-	-	0.1
Chile	-	0.1	0.1	-0.1	0.1	0.3
Mexico	-	-	1.1	2.1	2.8	5.2

(Source : Khan and Reinhart, 1995)

(VI) Conclusion

The inter-relationships between the four Asian stock markets (Hong Kong, Singapore, South Korea and Taiwan) and three major world markets (Japan, the US and the UK) are investigated over two sub-sample periods. The need to split the samples into two periods stems from the fact that significant measures to liberalise the markets in the four Asian markets is found to have a crucial impact on their changing volatility pattern individually in the previous chapter. Thus the full sample period of April 1986 to July 1996 cannot be treated as a single period. It is believed that such institutional changes should also have an impact on their relationships with other world markets. The results obtained from our cointegration tests confirm this argument. When the opportunities for foreign direct investments in the Asian developing stock markets were not available or limited before market liberalisation, there was no significant link between the movements of prices in the seven markets. After liberalisation, a significant cointegrating relationship between the UK, Hong Kong and Taiwan exists. The reason we offer to explain this changing pattern of relationship is that the opportunities for cross-market stock investment play a part in linking world markets

together. When most of the four Asian markets were still closed or less attractive to foreign investments during the pre-liberalisation period, domestic factors were the main determinants of local stock price movements. External developments were much less important. With an increase in foreign investors, particularly institutional investors, following liberalisation, foreign developments become more important in moving local prices. This is the result of an improved information flow, aided by institutional investors' use of advanced information technology, to ensure that common world factors are reflected in price changes in individual national markets. In addition, foreign developments might also require institutional investors to make portfolio shifts away or towards the developing markets which in turn might cause price movements in world markets to be negatively related.

A brief examination into the economic background of the US and Japan as well as government policies of Singapore and South Korea in dealing with their stock markets reveals that world market integration could be prevented in two ways even after liberalisation of the developing markets. First is the low level of actual investment on the part of foreign investors from developed markets and second is the intervention policy on the part of local governments. That could be why only a significant cointegrating relationship is found between the stock prices of the UK, Hong Kong and Taiwan following liberalisation in the latter two developing markets.

As far as policy implications are concerned, institutional investors seeking to diversify their investment risk could still find it beneficial to buy into a number of developing markets. No two developing markets could be treated as the same as each of them

would have their own strengths and weaknesses, although they might share some common market characteristics. As for local governments' fear of their markets being led by foreign developments, evidence from this chapter indicates that there should be little cause for alarm. The reason is that even when developing markets are found to cointegrate with other world markets, the forces that drive price changes in all markets involved are multidirectional rather than unidirectional. Thus, local developing markets are not bound to be under the influence of developed markets alone, they could influence price movements in developed markets too. Yet in both cases, the magnitude of influence is minimal as suggested by the estimated α of the final parsimoniously cointegrating vector between the UK, Hong Kong and Taiwan. Therefore, governments of local developing stock markets should not be frightened away by their markets being more integrated with other world markets.

While the cointegration results indicate a weak influence of foreign markets on the price movements of the four Asian markets in the long run, no inferences can be drawn on the responses of volatility in the four markets to foreign news in the short run. As local governments often worry that opening up their markets to foreign investors would make them becoming more volatile, an investigation into the impacts of foreign news on the volatility of individual Asian markets is necessary. Moreover, the finding of a changing nature of volatility in individual Asian markets following their liberalisation in Chapter Two suggests that volatility spill-overs may exist, but has not as yet been formally examined. This is what we will turn to next.

Chapter Four : Foreign Investment, Trade Relations And Volatility

Transmission To Asian Stock Markets

(I) Introduction

It was established in the previous two chapters that while the nature and structure of volatility in the individual stock markets of the Four Tigers have substantially changed over time, their long run price relationships with the world's leading markets have little change. Long run price relationships between the four newly developed and the major developed markets were non-existent before the lifting of the ban on foreign investments. After they were relaxed, there was just one cointegrating relationship between the UK, Hong Kong and Taiwan, showing signs of a common trend in their price movements. Singapore, South Korea, the US and Japan were not found to enter significantly into the cointegrating relationship. This, we argue, is supportive of the view that foreign investment could help strengthen world market integration through an improved cross-market information flow brought about by institutional investors. The need to adjust their international portfolio position as world market conditions change could also influence the way national markets relate to one another. We also argue that low levels of actual participation in the Asian developing markets from the developed markets such as the US and Japan could prevent the formation of a close link between them. Similarly, active government intervention in influencing local stock prices, as is the case in South Korea and Singapore, could have the same effect on world market integration. Hence, these four markets are not found to enter the long-run cointegrating relationship significantly during the post-liberalisation period.

However, as cointegration essentially deals with the existence of a stable long-run equilibrium between markets, it says little about the short-term linkages and interactions between those markets without a long run cointegrating relationship. In addition, the presence or absence of a long run price relationship between world markets gives no information on the relative significance of local and world news in affecting developing markets' volatility. Such short term dynamic interactions between developing and developed markets are highly likely for they have close trading relations and/or increasing foreign portfolio investments over the past decade. News that increases a major market's volatility could also impact on the volatility of other developing markets within a short space of time. The purpose of this chapter is to provide additional insights into the mechanism of cross-market volatility spill-over and the differing roles local and foreign news play in affecting market inter-relationships, particularly in the short-term.

The issue of volatility transmission has been widely addressed in the finance literature during the past decade. With regard to the markets examined, Japan, the US and the UK are the most frequently researched markets. Volatility transmission amongst these countries' markets is well documented, as is volatility transmission from them to other smaller markets (e.g. Eun and Shim 1989, Hamao et. al. 1990, Lin et. al. 1993). Recent interest has also emerged in investigating the volatility link between regional markets, such as European markets (e.g. Booth et. al. 1997, Koutmos 1996). Findings to date are mixed and no single general pattern of volatility transmission structure can be identified, such as the dominant role of the US market, as a source of volatility spill-over. This may be due to a number of differences in these studies,

which include the use of different indices for the same markets, data frequency and methodology as well as sample periods used. Whilst most papers only report evidence of the various ways different markets could be linked together through volatility transmission, only a few offer insights into the nature and mechanism of volatility transmission. King and Wadhvani (1990) suggest that a contagion effect is the main reason for volatility spill-over between markets, where pricing mistakes in one market can be transmitted to another market without changes in its economic fundamentals. Ng et. al. (1991) on the other hand, argue that cross market direct portfolio investment is a key channel to facilitate volatility spill-over. The possibility of a changing pattern of volatility spill-over through time is documented in von Furstenberg and Jeon (1989). Last but not least, volatility interaction between markets could be asymmetric as shown in Booth et. al. (1997), Koutmos (1996) and Bae and Karolyi (1994). This means that negative news in a given market produces higher volatility spill-over to other markets than does positive news of an equal magnitude, in a way which is similar to the issues investigated in Chapter Two.

Motivated by the arguments and findings from these aforementioned papers, this chapter seeks to add further insights into various aspects of volatility transmission from developed to developing markets. The same set of markets examined in Chapter Three will be used, namely Hong Kong, Singapore, South Korea, Taiwan, Japan, the US and the UK. Three main issues will be addressed.

(1) The transmission mechanism of volatility from the major markets to the developing Asian markets.

- (2) The changing importance of foreign news in affecting volatility of the local developing markets.
- (3) The asymmetric effects of local and foreign news on local developing markets' volatility and their implications.

We will argue that the forces behind cross-market volatility transmission are inter-related. The importance of substantial trade relations as the key mechanism for volatility transmission could be inferred from the differing asymmetric effects of foreign news on local markets' volatility, which is highly dependent on the nature of the markets' economic ties. While the presence of trade relations is sufficient to cause volatility spill-over across markets, the opportunities for cross-market direct investment in the developing markets could affect the actual size of spill-over. As such, markets which are most restrictive to foreign investors would be less affected by foreign news even though the foreign market might be their main trading partners. Alternatively, the actual size of volatility spill-over could be affected by the level of investment in the developing markets. If the foreign market has little exposure to the four markets' equities despite being their main trading partner, volatility of these markets would not be significantly affected by its news either. We will also argue that contrary to the fear that increasing foreign investment in the local markets would make the markets more vulnerable to foreign shocks, foreign news impacts would actually fall as there is an increase in better informed trading following liberalisation. Investors would be more able to discern the relevance of foreign news impacts on the local markets' economic fundamentals before making any move, thus reducing the

risk of over-reacting to foreign news. Such effects, far from being damaging, could improve market efficiency and investor confidence in the local developing markets.

The remainder of the chapter is organised as follows. Section II sets out the theoretical issues regarding cross-market volatility interactions. Section III reviews some existing literature and Section IV describes the data set, sample period and methodology used. Discussion of empirical results are given in Section V and Section VI concludes the study.

(II) The key mechanism for cross-market volatility transmission

The need to identify the key channel of volatility spill-over across markets is important because it has implications for assessing investment risks and the benefits of diversifying into developing markets. Two main channels for volatility transmission have been identified in previous research, namely the contagion effect and the presence of cross market direct portfolio investment.

(A) Contagion effect

According to the World Bank Policy Research Report (IMF, 1998), two types of contagion can be distinguished, pure contagion and fundamentals contagion.

(A.1) Pure contagion

Pure contagion takes place when shocks in one country affect investments in other countries, even if the economic fundamentals of the latter have not changed. It is this kind of pure contagion that King and Wadhvani (1990) proposed when they found a

uniform fall in stock markets during October 1987 even though they all had differing economic circumstances before the crash. In their paper, they argued that:

‘contagion between markets occurs as a result of attempts by rational agents to infer information from price changes in other markets. This provides a channel through which a ‘mistake’ in one market can be transmitted to other markets.’ (King and Wadhvani 1990, p.5)

If this sort of contagion effect is responsible for cross-market volatility transmission, we should expect to find a uniform and simultaneous rise and fall of national markets, regardless of their individual economic circumstances or their degree of openness to foreign direct participation. Exposure to developing markets could thus help little in diversifying risks for international institutional investors. Moreover, such a pure contagion effect can manifest itself in the form of foreign news asymmetry, whereby negative foreign news causes higher volatility in the local developing markets than does positive foreign news. The reason is that local investors could be over-reacting to negative foreign news when it bears little significance to their own economic fundamentals. Movements of the markets are thus driven by a ‘herd effect’ or contagion market psychology. If the pure contagion effect is responsible for volatility transmission to the four developing markets, we should expect to find a uniform asymmetric response of their volatility to negative foreign news. In other words, negative foreign news from each of the three major markets, the US, the UK and Japan should all induce higher volatility in the four Asian developing markets than

does their positive news. If not, then the importance of pure contagion in causing cross-market volatility transmission should be in doubt.

(A.2) Fundamentals contagion

Fundamentals contagion occurs when a shock in one country affects investments in other countries because the countries share similar fundamentals or are exposed to common external shocks. Or it is possible that the shocks in one country are transmitted through trade or financial channels and thereby affect the economic fundamentals of other countries. This in turn means that volatility in the developed stock market could be transmitted to the developing markets via this route with or without cross-market stock investment. Figures 4.1 to 4.4 show that the four Asian developing markets all have significant trading relationships with Japan and the US, accounting for an average of one-third to one-half of their total export and import trade in aggregate between 1993 and 1996. Thus there is a possibility that news from Japan and the US might impact on the four markets' volatility under the fundamentals contagion hypothesis. Evidence of volatility spill-over from the US, Japan and the UK to the four Asian developing markets, particularly to South Korea and Taiwan before they were opened to foreign investors would support this fundamentals contagion argument.

If fundamentals contagion is the key channel, it means that diversifying into developing markets is still beneficial because economic fundamentals of the developing and industrial markets are not identical. Shocks arising from the changing economic fundamentals of the developing markets' trading partners may or may not

have similar impacts on the volatility of their markets. Moreover, the same piece of foreign news could have differing impacts on each individual developing market. It all depends on the nature of economic ties they have with the industrial countries. Consider the following two cases.

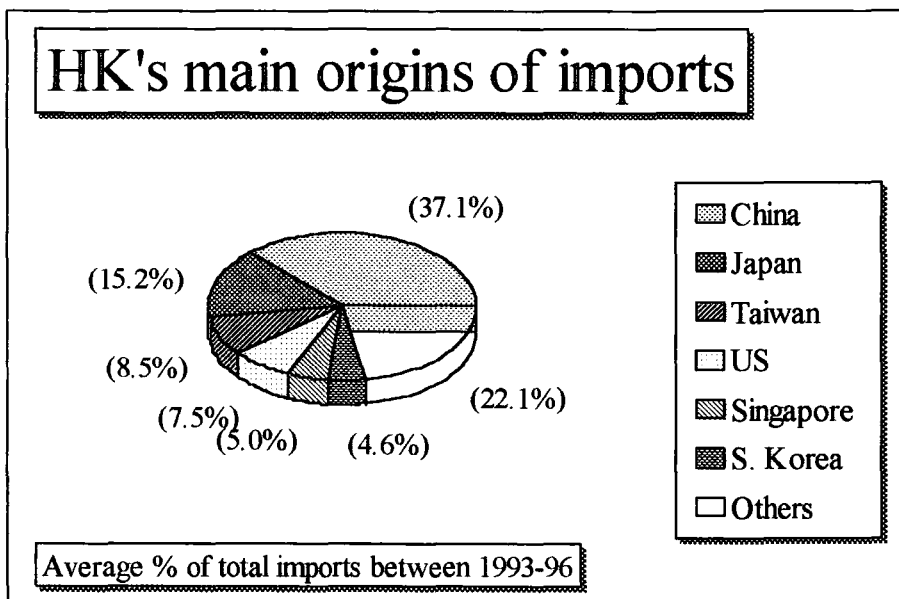
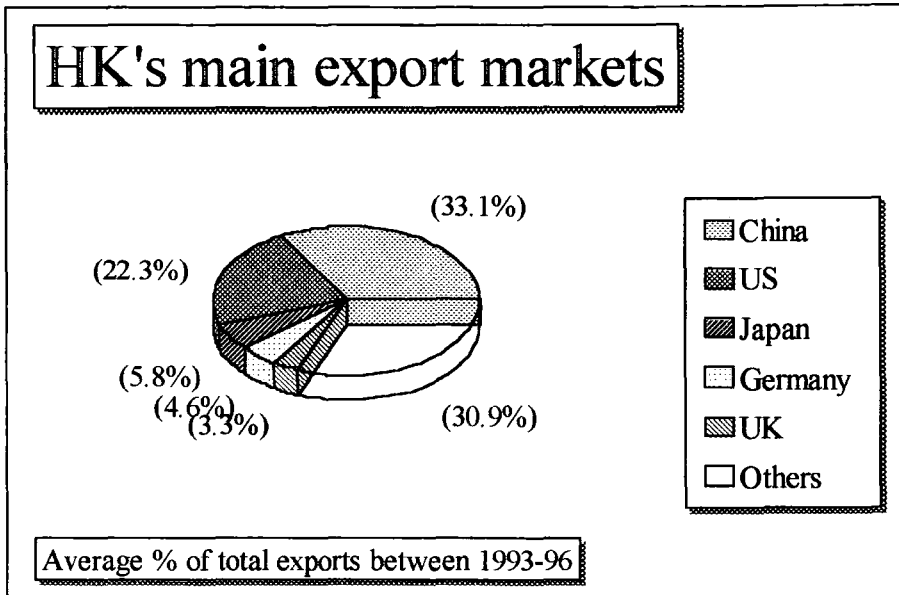
Case 1

If the developed country is the main export market of the developing country, a contraction in economic growth of the former would result in a fall in demand. This would have knock-on effects on corporate earnings of the export companies traded in the latter. In this case, the foreign shock should have a similar effect on the price volatility of both markets.

Case 2

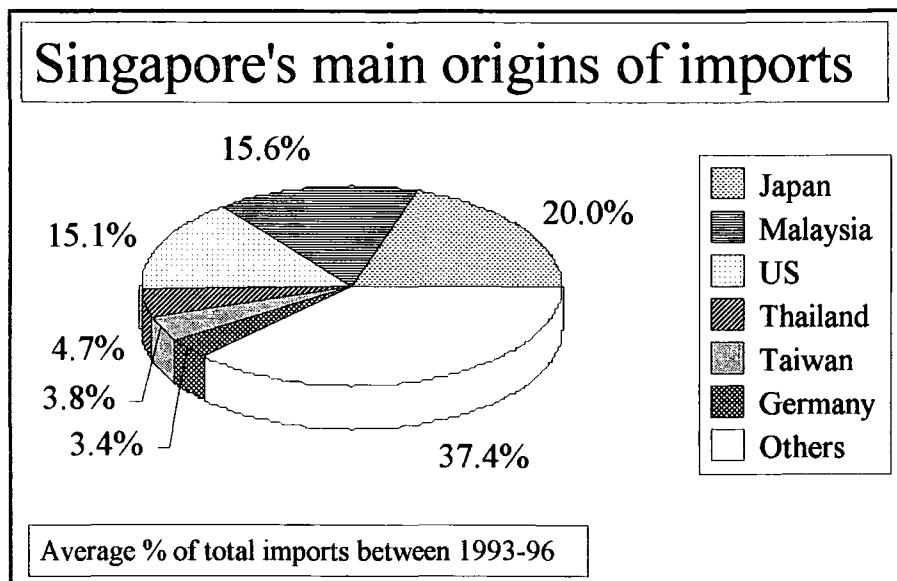
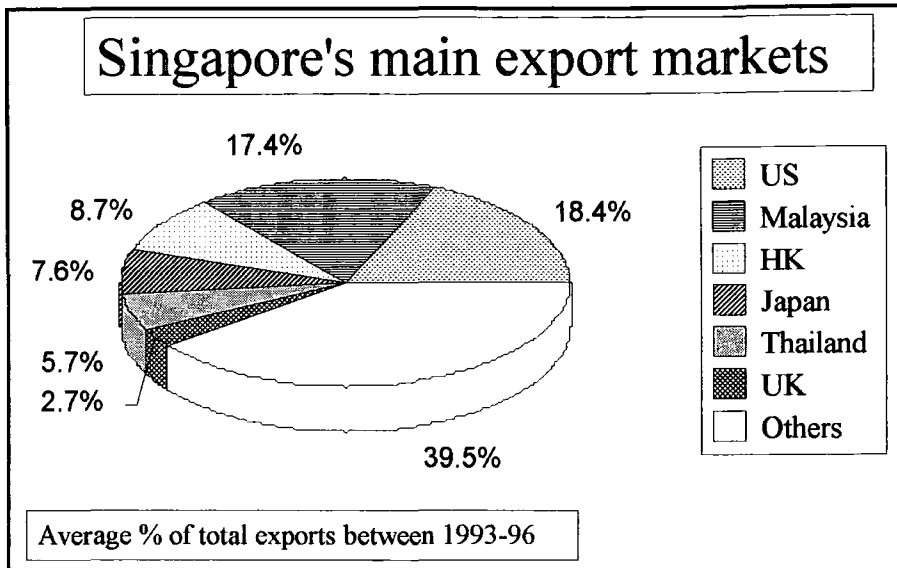
If the developed country is the main source of raw materials import of the developing country, the story would be totally different. The same sort of economic contraction experienced in the developed market would not cause similar effects on the volatility of the latter. Instead, depreciation of currency to boost exports on the part of the developed country, for example, would cut importation costs for companies in the developing country relying on such imports. Hence their profitability would rise and this in turn would help boost the stock market. In this case, therefore, a foreign shock which has a negative impact on the source market's volatility could have a positive impact on the developing market instead.

Figure 4.1 *Hong Kong's main trading partners between 1993 and 1996*



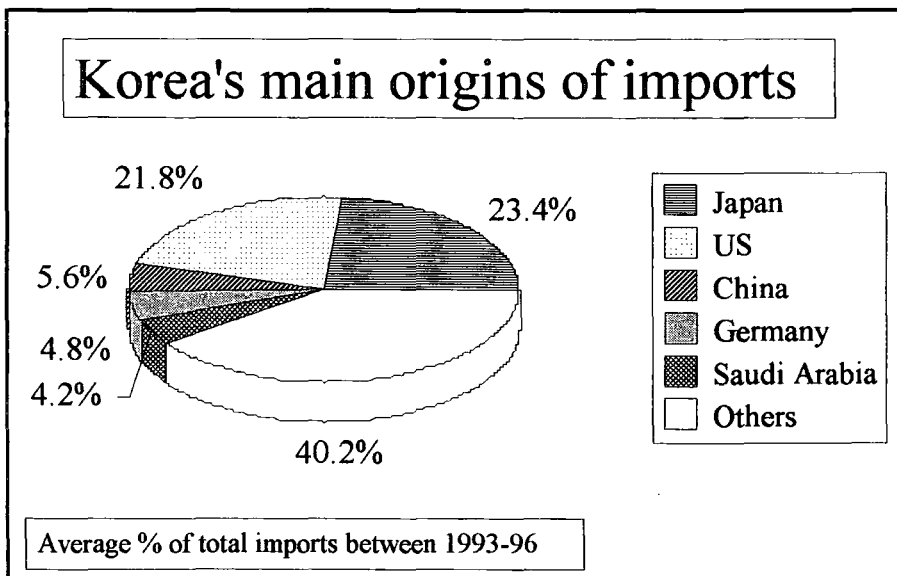
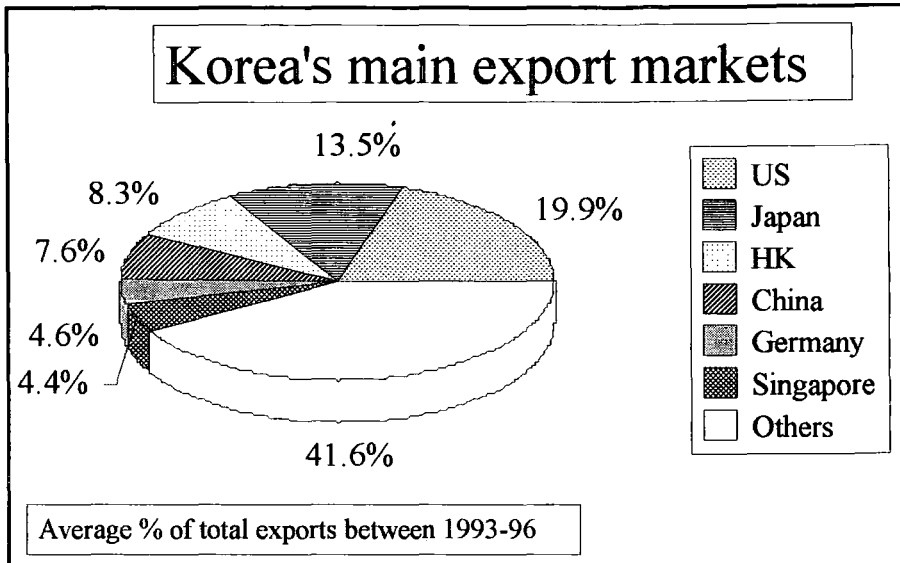
Source : EIU Country Profile : Hong Kong (1995-1998)

Figure 4.2 *Singapore's main trading partners between 1993 and 1996*



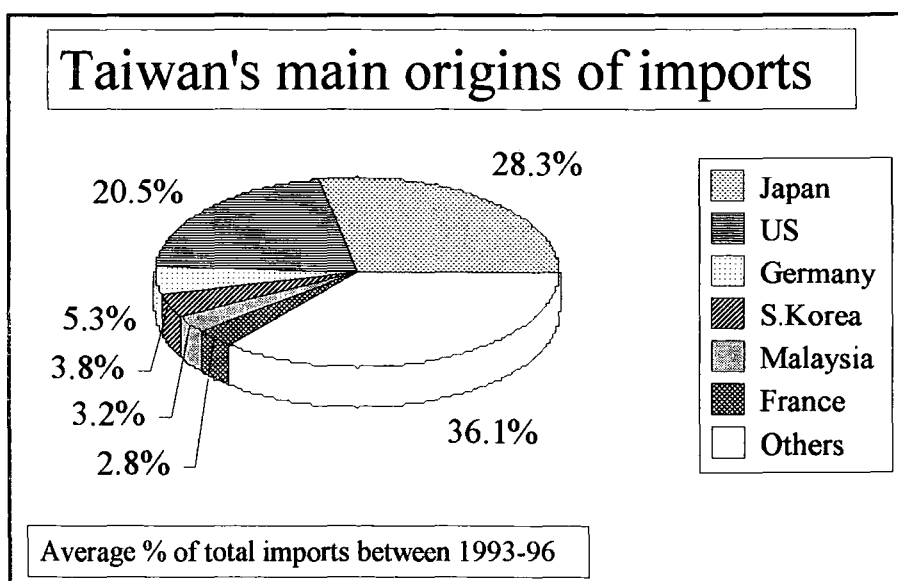
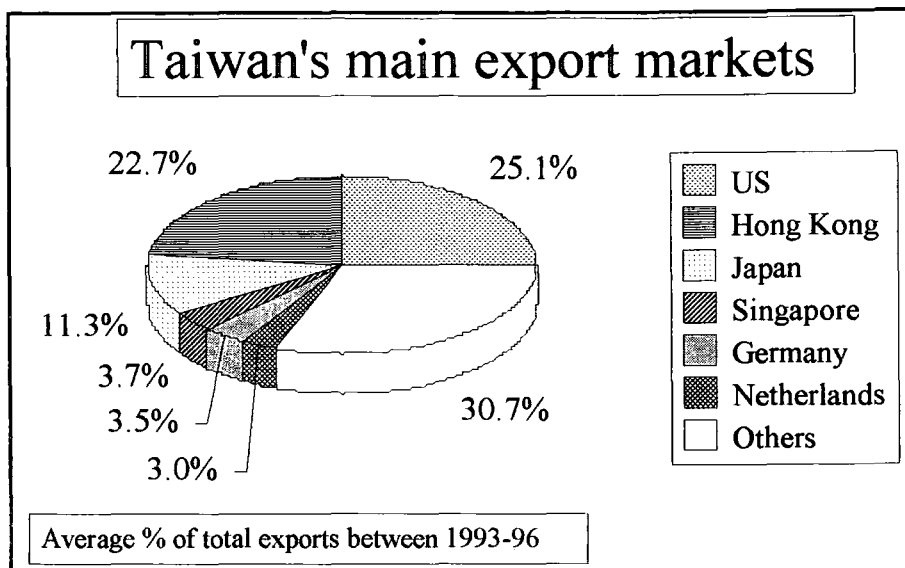
Source : EIU Country Profile : Singapore (1995-1998)

Figure 4.3 *South Korea's main trading partners between 1993 and 1996*



Source : EIU Country Profile : South Korea (1995-1998)

Figure 4.4 *Taiwan's main trading partners between 1993 and 1996*



Source : EIU Country Profile : Taiwan (1995-1998)

The fact that negative foreign news could have totally different impacts on the volatility of different developing markets under the fundamentals contagion argument may suggest different implications for foreign news asymmetry. Instead of having negative foreign news causing higher local market volatility, positive foreign news might do the same too if the positive news has a negative effect on the local markets' economic fundamentals or vice versa. In that case, the interpretation of foreign news asymmetry should be related to the fundamentals contagion effect rather than the pure contagion effect described above. Thus, the extent to which there is an asymmetric response of volatility to news, and the nature of this response is an empirical issue.

(A.3) Foreign direct portfolio investment

Foreign direct portfolio investment is the second possible channel for volatility transmission suggested by Ng et. al. (1991). They argue that the presence of merchandise trade relations between markets is not sufficient to induce volatility spill-over between national stock markets, even though their economic fundamentals are linked through the trade relation. This argument is supported by their finding that there is no volatility spill-over to South Korea and Taiwan from the US prior to their liberalisation, although the US is their major trading partner. Instead, they find that cross-country stock investment is the key channel to facilitate the transmission of volatility. As has been argued in previous chapters, the presence of foreign investors in developing markets could help improve information flow from developed markets through their advanced information technology and thus increase the level of informed trading. French and Roll (1986), Ross (1989) and Lamoureux and Lastrapes (1990),

among others, all agree that market volatility is related to the flow of information to the market. The improved rate of information flow across markets and the increase in informed trading based on the arrival of information following market liberalisation in the developing markets could thus induce volatility to be spilled over to them. In this case, investment risks in developing markets should be reduced rather than increased as more trading is based on information rather than on noise. The finding of volatility spill-over from the US, Japan and the UK to the four Asian developing markets only after they have liberalised would thus be supportive of the view that foreign direct portfolio investment is the key mechanism for volatility transmission.

To sum up, discussion in this section has three implications to the testing and interpreting of volatility interactions in this chapter:

- (1) If volatility spill-over only takes place following market liberalisation, particularly in South Korea and Taiwan, then cross-market stock investment opportunities in a given local market are a vital key for volatility transmission
- (2) If volatility spill-over is also found in the period before liberalisation, regardless of whether there are cross-market stock investment opportunities, it suggests that either pure contagion or fundamentals contagion is at work in causing volatility transmission.
- (3) If there is a lack of uniform asymmetric response of volatility in the four Asian developing markets to all negative foreign news and if such negative news does not always cause higher volatility in the developing markets, it would be indicative of the importance of fundamentals contagion as the mechanism for volatility transmission.

(III) Literature review

The issues of market integration and volatility transmission between national stock markets have been widely addressed. Eun and Shim (1989) provide the pioneering work on the international transmission of stock market movements in which six developed markets in Europe and America and three in Asia are examined using a VAR model. Daily rates of return of stock markets over the period of 1980 to 1985 are fitted to the model. Variance decomposition coefficients and impulse response functions derived from the model show that the US is the major source of price movements to the rest of the world. Since the publication of their work, a number of studies using the same VAR methodology have been published, but results regarding the way stock markets are linked together are mixed. For examples, Brocato (1994), who uses weekly data over the sample period of 1980 to 1987, which is equally split into half, finds that the dominant role of the US in influencing price movements in the UK, Canada, Japan, Germany and Hong Kong has eroded over time. Chowdhury (1994) reports that US innovations impact on the daily returns volatility of the least restricted newly developed markets only, such as Hong Kong and Singapore. Those with the strictest entry barriers, like South Korea and Taiwan, remain unaffected between 1986 and 1990, a period before these two markets were open to foreign investors. Similarly, Rogers (1994) investigates the general relationship between entry barriers and the transmission of stock prices surrounding the crash period of October 1987. He also finds that prices in South Korea and Taiwan, which have the stiffest entry barriers, do not respond to innovations from the US and Japan over the period of 1986 to 1989.

Despite the usefulness of impulse response functions derived from a VAR model in depicting the dynamic response of a local market to foreign innovations, there are limitations of examining market volatility interaction along this line. First, the variance decomposition coefficients derived from the VAR can only give a qualitative or descriptive picture of market linkage patterns. No statistically significant causal inferences regarding the linkage pattern can be made from the findings. Second, the mechanism that links markets together cannot be established from the estimated variance decomposition coefficients. One can only assert that it is due to the level of market openness (e.g. Rogers 1994; Chowdhury 1994 and Brocato 1994) or market contagion (e.g. von Furstenberg and Jeon 1989). Third, since the foreign shocks used in the VAR are simulated, we cannot tell whether such shocks are country-specific or world-wide. Hence the variance decomposition coefficients cannot be used to distinguish whether the news affecting a local market's price or volatility movements is country-specific or global in nature.

The use of GARCH type models in studying volatility spillover between markets has overcome some of these problems. The first paper in which price and volatility spillovers are analysed within a GARCH type model is that by Hamao et. al. (1990). They divide daily close-to-close returns data into daily open-to-close and daily close-to-open returns data for Japan, the UK and the US over a three year period between April 1985 and March 1988. They then fit them into a moving average GARCH-in-the-mean model, MA(1)-GARCH-M model, shown as the conditional mean and conditional variance equations in (1a) and (1b) respectively. Since the ARCH models assume that the conditional error is serially uncorrelated, they therefore add the

conditional variance term and one lagged error term into the conditional mean equation to remove serial correlation from the stock returns' first moment. By estimating this model, they want to analyse whether the spill-over effects of a foreign innovation reflect country-specific changes or global economic changes. The former is manifested through an impact of foreign open-to-close returns changes on domestic close-to-open returns changes, whilst the latter is shown by the impact of foreign close-to-open returns changes on domestic open-to-close returns changes. Alternatively, if the coefficient corresponding to the proxy of foreign surprises appended into the conditional variance equation is found to be statistically significant, then there is volatility spill-over from the foreign to the domestic market. If the spill-over effect reflects the influence of a common economic effect on the volatility of all three stock market indices, introducing a second foreign market is unlikely to add much incremental explanatory power.

$$R_{i,t} = \beta_{i0} + \beta_{i1}h_{i,t} + \delta_i \varepsilon_{i,t-1} + \varepsilon_{i,t} \quad (1a)$$

$$h_{i,t} = \alpha_{i0} + \alpha_{i1}\varepsilon_{i,t-1}^2 + \gamma_i h_{i,t-1} + \sum_{j=1}^n \delta_{ij} X_{j,t-1} \quad (1b)$$

where $R_{i,t}$ is the returns for market i ,

$h_{i,t}$ is the conditional variance of $R_{i,t}$,

$X_{j,t-1}$ is the a proxy for innovations of foreign market j . The proxy is the lagged squared residuals of a standard GARCH-M model fitted with the returns series of market j .

Building on this GARCH framework, Lin et. al. (1993) estimate market interdependencies between Tokyo and New York and they find evidence of a bi-directional spill-over between the two markets using intra-daily data. Like King and Wadhvani (1990), who use the correlation method to examine volatility behaviour of

world markets surrounding the 1987 Crash period, Lin et. al. (1990) conclude that world markets are linked through the contagion effect. The term contagion effect means that local investors make their investment decisions by extracting information on global factors from price changes in other markets. As a result, an internationally contagious psychology which is not justified by the economic fundamentals of an individual market could spread across world markets causing uniform market decline during the crash period.

Ng et. al. (1991) also follow the framework used in Hamao et. al. (1990) to study volatility spill-over from the US to four Asian markets, namely Japan, Thailand, Taiwan and Korea. However, their argument about the mechanism for volatility transmission is entirely different from that of King and Wadhvani (1990) and Lin et. al. (1993). They apply daily closing returns data to model (1a) and (1b) and include a dummy variable in the model to mark the implementation of institutional changes in Japan and Thailand to encourage foreign investors. They argue that if cross-country stock investment is the key channel for volatility spill-over, only Japan and Thailand, which have opened themselves up, should be affected. No spill-over effects should exist in the two most restricted markets, Korea and Taiwan. Moreover, the new measures to attract more foreign investors should intensify the spill-over effects to Japan and Taiwan. These are exactly what they have found in their study and they therefore conclude that international volatility transmission is not caused by a contagion effect, but by the presence of cross-market stock investments.

These papers which use standard GARCH type models to examine volatility spill-over have shown an improvement over those using the VAR method. For instance, the impact of local news and global news, as well as foreign market's country specific news and world-wide market news can be separated with the use of intra-daily data. The causal relationships between national markets volatility changes can also be established from the empirical findings. However, these studies have ignored the possibility of asymmetric volatility interactions between markets in which foreign negative news might have a greater impact on local market volatility than positive foreign news of an equal magnitude. The exponential GARCH model (EGARCH) and GJR-GARCH type models (named after the work of Glosten, Jagannathan and Runkle 1989) is able to address this issue directly. Studies by Booth et. al. (1997), Koutmos (1996), Koutmos and Booth (1995) and Theodossiou and Lee (1995) employ either the bivariate or multivariate EGARCH method while Bae and Karolyi (1994) adopt the GJR-GARCH method. Booth et. al. (1997) use daily closing returns data to examine the asymmetric volatility interaction between four regional Scandinavian markets. They find evidence that negative innovations in the foreign market have a higher impact on the volatility of the local market than positive innovations. In other words, the volatility transmission mechanism is asymmetric. Similar findings are also reported in Theodossiou and Lee (1995) who study European and US markets; in Koutmos (1996) who examines four European markets; and in Koutmos and Booth (1995) and Bae and Karolyi (1994) in which the three world leading markets namely Japan, UK and US are investigated.

Our findings in Chapter Two of the thesis show that volatility in the each of the Four Tigers is responding asymmetrically to their own past innovations. This is suggestive of the possibility that volatility spill-overs to these markets could also be asymmetric. Yet whether negative innovations in a foreign market produce a higher volatility spill-over in the local market than do positive innovations depends on the nature of economic ties between the developing and developed markets. Therefore, in investigating the issue of volatility spill-over to the Four Tigers in this Chapter, we will use a similar asymmetric GARCH type model along the lines of GJR (1989) instead of the commonly used GARCH-M models. The reasons are two-fold. First, the emphasis of this chapter is the inter-relationship between markets, not the inter-temporal relation between risk and expected returns. The issue of whether there is a trade-off between risk (as measured by the volatility of the stock market) and expected returns is of secondary importance. Second, the aim of specifying the conditional mean equation as a MA(1)-GARCH-M process shown in equation (1a) is to extract serial correlation from the stock returns' first moment, for ARCH models assume that the conditional error is serially uncorrelated. Since the returns series used in this Chapter have been pre-filtered in the same way as shown in Chapter Two, we can drop the MA process in our conditional mean equation and simply apply the GJR type GARCH model in this Chapter. The key advantage of using this model is that the loglikelihood estimate of the model is often found to be superior to the EGARCH model (Engle and Ng, 1993; Antoniou, Holmes and Priestley, 1998). In addition, Engle and Ng (1993) found that the GJR model is the best at parsimoniously capturing the asymmetric effect of news on market volatility.

Our study is the first attempt in the finance literature to investigate the possible foreign news asymmetric effects on the volatility of the Asian Four Tigers. Moreover, the availability of daily data after the liberalisation of markets in Taiwan and South Korea has opened a new opportunity for us to assess the conflicting theories about the key channels for cross-market volatility transmission, by comparing the findings for pre- and post-liberalisation periods. Given the big differences in the size of the markets under investigation, news originating from the major markets is expected to impact more on the newly developed markets' volatility than vice versa. Thus this chapter will only concentrate on the examination of volatility transmission from the three leading world markets to the four newly developed markets.

(IV) Data and methodology

(A) Data

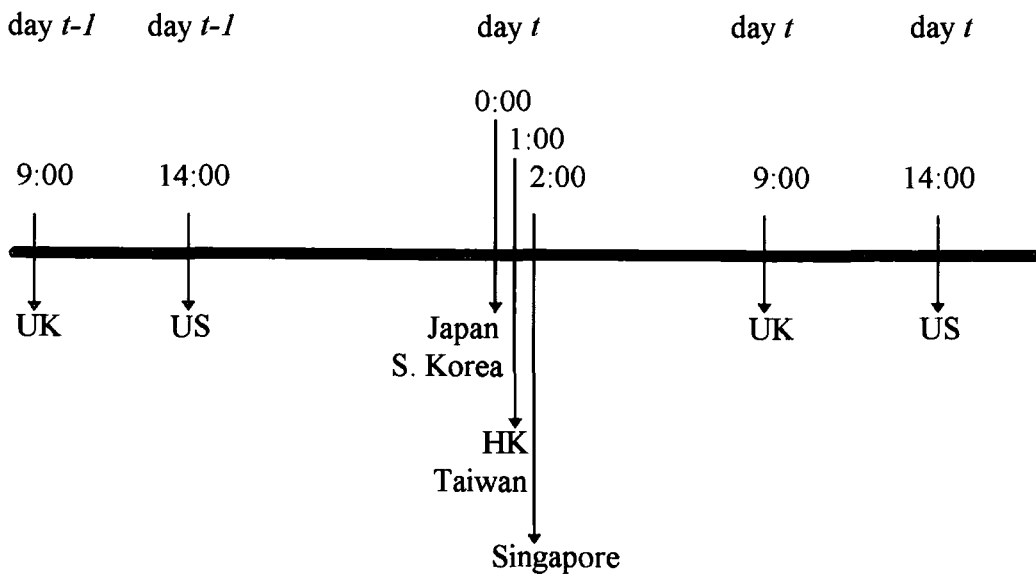
The same data and sample period for the four local markets are used as in Chapter Two. For Japan, the US and the UK, Nikkei 225 Average Stock Index, Dow Jones Industrial Index and the FTSE 100 Index are used respectively. These indices are the most representative indicator of each market's performance because they are either made up of stocks which constitute the largest amount of market capitalisation or the most active stocks traded in the market. In order to examine the possible changing nature of volatility spill-over from the world markets, the full sample period for each of the four Asian developing markets is partitioned as in Chapter Two.

To study the bivariate volatility interaction between a foreign and a local market, returns series for Japan, the UK and the US have to be partitioned in the same way as each local market does. Since there are four local markets under investigation,

returns series for these three major markets are partitioned in four different ways. One advantage of investigating volatility spill-over to the four local markets over different periods is that our results are not time-period specific or event-related. In other words, we are not looking at the significance of a particular piece of US news, for example, on the four local markets simultaneously. Instead, an overall impact of US news on these markets during their pre- and post-liberalisation periods can be inferred from the results.

One thing we should be aware of however, when interpreting the differing impacts between Japan, UK and US news on the four local markets is the issue of overlapping trading hours. Figure 4.5 shows the sequential opening time of all seven markets studied in terms of UK Greenwich Mean Time.

Figure 4.5 *A time line showing the sequential opening time of seven stock markets in Greenwich Mean Time*



Between Japan and the four markets, there are substantial overlapping trading hours. News relating to the Japanese market during trading hours would thus have an immediate impact on the four regional markets. Therefore, conditional volatility of Hong Kong at time t is expected to be more affected by news from Japan within the same calendar day. The UK and the US markets, on the other hand, open sequentially after all the four Asian markets are closed. Thus New York returns at time t may affect returns in Hong Kong at time $t+1$ (and not time t). The same is true for UK news. As lagged foreign innovations are included in our model of estimation, it is comparatively easy for us to distinguish between foreign news impacts from the US and the UK and local news impacts, but is not so clear with Japanese news impact. Hence, Japanese news impact could vary with UK and US news impact on the four markets in our results.

Due to the presence of non-overlapping trading hours between the four Asian developing markets, the UK and the US, it is not known whether any correlation of stock returns found between them should be classified as contemporaneous correlation or lagged spill-over. Theoretically, this problem could be solved if we divide daily close to close returns for these markets into open to close (i.e. daytime) returns and previous close to open (i.e. overnight) returns. The correlation between foreign daytime returns and domestic overnight returns is an indication of contemporaneous spill-over from foreign to local markets. The correlation between foreign daytime returns and subsequent domestic daytime returns would indicate the presence of lagged spill-over from the foreign market. The unavailability of intraday data in all four developing markets has prevented us from identifying these two

possible types of spill-over. Therefore, all findings of volatility spill-over from Japan, the UK and the US to the Four Tigers would be regarded as the impact of their most recent surprises on the four local markets.

(B) Empirical design

A number of methodologies have been employed in the study of volatility transmission and market integration. These include vector autoregressive regression; Granger causality tests; standard univariate GARCH models, univariate and multivariate exponential GARCH models as well as an asymmetric GARCH type model called GJR-GARCH model named after Glosten, Jagannathan and Runkle (1989). The first three methods named above do not deal with the possibility of an asymmetric response of local volatility to foreign news and therefore are not appropriate for use in our study. Although the EGARCH type models can help detect the existence of news asymmetry, they tend to over-estimate the conditional variance of a market in cases of more extreme shocks (Engle and Ng, 1993, p.1776) By contrast, the GJR asymmetric GARCH type model is regarded by them as the best model to capture asymmetry. Thus the GJR model will be adopted and modified to include asymmetric foreign news terms into the conditional variance equation shown in (2b) to examine the asymmetric volatility interaction between the seven markets.

Let :

- $R_{i,t}$ be the returns for market i at time t , where, $i = 1,2,3,4$ (1 = Hong Kong, 2 = Singapore, 3 = South Korea and 4 = Taiwan);
- $X_{j,t-1}$ be the most recent squared residuals as proxies of foreign news for market i , where $j = 1,2,3$ (1=Japan, 2=UK and 3=US)
- Ω_{t-1} be the information set available at time $t-1$;
- $\mu_{i,t}$ be the conditional mean of $R_{i,t}$ such that $u_{i,t} \equiv E(R_{i,t} | \Omega_{t-1})$;

$h_{i,t}$ be the conditional variance of $R_{i,t}$ such that $h_{i,t} \equiv \text{Var}(R_{i,t} | \Omega_{t-1})$;
 $\varepsilon_{i,t}$ be the stochastic error conditional on the information set Ω_{t-1} ;
 $S_{i,t-1}$ be an indicative dummy that takes the value of 1 if $\varepsilon_{i,t-1}$ or $X_{j,t-1}$ is negative and 0 otherwise,

$$R_{i,t} = \mu_{i,t} + \varepsilon_{i,t} \quad \text{where } i = 1 \text{ to } 4 \quad (2a)$$

$$h_{i,t} = \alpha_{i,0} + \beta_i h_{i,t-1} + \alpha_{i,1} \varepsilon_{i,t-1}^2 + \alpha_{i,2} S_{i,t-1}^- \varepsilon_{i,t-1}^2 + \theta_{ij,1} X_{j,t-1} + \theta_{ij,2} S_{j,t-1}^- X_{j,t-1} \quad (2b)$$

where $j = 1$ to 3 and $i \neq j$

The returns data used in the conditional mean equation are pre-filtered in the same way as in Chapter Two. The main aim is to utilise only the unpredictable part of the returns series when estimating the conditional variances of each market. Thus all possible day-of-the-week effects as well as autocorrelation effects have been removed in the two-step procedure. The implication of such data adjustments to equation (2a) is that $\mu_{i,t}$ is expected to be close to zero, because all predictable parts of the raw data series should have been accounted for by the two pre-filtering procedures.

β_i is the coefficient on the lagged variance term. It is picking up the impact of price changes relating to days prior to the previous day. In other words, it reflects the impact of past local news which arrived before yesterday. In theory, the value of β_i should fall as the rate of information flow within the market increases with an increase in foreign participation. In practice, however, the availability of information on publicly traded companies in the developing markets is limited and the quality of information is not comparable to those available for developed markets' securities. Thus it might take foreign investors a longer time to assess the implication of local

news on their investment strategies and to monitor any new developments. As a consequence, the impact of past local news could remain persistently high even when there are more informed traders in the market.

The two lagged squared error terms, $\varepsilon_{i,t-1}^2$ and $S_{i,t-1}\varepsilon_{i,t-1}^2$ shown in (2b), represent changes in returns on the previous day due to local factors. The coefficients associated with them, $\alpha_{i,1}$ and $\alpha_{i,2}$, relate to the impact of yesterday's local news that cause market returns changes on current volatility. The value of $\alpha_{i,1}$ indicates the impact of a piece of positive local news, while the sum of $\alpha_{i,1}$ and $\alpha_{i,2}$ estimates the impact of a piece of negative local news on current returns volatility. A high value of $\alpha_{i,1}$ or the sum of $\alpha_{i,1}$ and $\alpha_{i,2}$ implies that recent news has a greater impact on current returns volatility. A higher (lower) value of $\alpha_{i,1}$ or the sum of $\alpha_{i,1}$ and $\alpha_{i,2}$ found during the post-liberalisation period is indicative of local recent information being impounded more (less) quickly into prices.

The second last term of equation (2b), $X_{j,t-1}$, is the most recent squared innovations or news from either Japan, the UK or the US. It is a proxy for the most recent foreign news in these major markets obtained from equation (2a). The term $S_{j,t-1}X_{j,t-1}$ is designed to capture the possible additional impact of negative foreign news in affecting local market's current volatility. The coefficients corresponding to these two terms indicate the effects of positive and negative foreign news in affecting local market volatility. Positive foreign news impact is given by $\theta_{j,1}$, while the summation of $\theta_{j,1}$ and $\theta_{j,2}$ indicates the impact of negative foreign news on local market volatility. If none of them are found to be statistically significant, then market j 's volatility does not spill over to market i . When $\theta_{j,1} + \theta_{j,2}$ is significantly positive and at the same time

$\theta_{ij,1} + \theta_{ij,2} > \theta_{ij,1}$, it implies that there is negative foreign news asymmetry. Negative foreign news has a greater impact on local volatility than positive foreign news of an equal magnitude. On the other hand, if $\theta_{ij,1} + \theta_{ij,2} < \theta_{ij,1}$, then there is positive foreign news asymmetry.

(V) Empirical results

(A) Preliminary data analyses

Summary statistics for all seven markets' unpredictable returns series are reported in Tables 4.1 to 4.4. They show that the unpredictable mean returns are similar across markets, no matter what sample periods for the four Asian markets are used. They are either zero or very close to zero, suggesting that no one single market outperformed or lagged behind other markets. This is an indication that all unexpected returns in each market are caused by market surprises rather than predictable factors like day-of-the-week effects which have been pre-filtered. The standard deviation of each market's daily unpredictable returns distribution for all markets in the four tables all decrease over the post-change period, with only two exceptions – Japan over Hong Kong and Taiwan's post-change period. As far as the four Asian developing markets are concerned, the observed decrease in standard deviation means that they have lower total risk than before liberalisation. When compared with the other three major markets, however, each of these four markets still has relatively higher total risk than the latter markets during their respective pre- and post-change sample periods. Given the size and maturity of the two sets of local and major markets, such a finding is reasonable.

Table 4.1 *Summary statistics for Hong Kong and three overseas markets' unpredictable returns series*

		Mean	Standard deviation	Skewness	Kurtosis	LB(24)	LB ² (24)
HK	1	-0.001	2.182	-8.730	144.2	44.04*	6.563
	2	-0.026	1.340	-0.473	4.782	24.24	365.8*
Japan	1	-0.001	1.127	-3.087	55.03	24.99	64.47*
	2	-0.066	1.416	0.447	5.570	40.05	326.1*
UK	1	-0.002	1.152	-2.330	28.75	30.38	546.7*
	2	-0.003	0.788	0.167	2.460	27.39	193.6*
US	1	-0.001	1.484	-6.246	105.6	18.96	14.13
	2	-0.001	0.764	-0.550	6.531	24.90	82.10*

*N.B. Rows marked with 1 and 2 represent pre- and post-change sample period respectively used for each of the four Asian markets.

Pre- and post- change period for the four local markets are:

1986:4:1 to 1989:6:30 and 1989:7:1 to 1996:7:31 for Hong Kong

1989:3:1 to 1993:9:30 and 1993:10:1 to 1996:7:31 for Singapore

1988:3:1 to 1991:12:31 and 1992:1:1 to 1996:7:31 for Korea

1988:1:1 to 1990:12:31 and 1991:1:1 to 1996:7:31 for Taiwan

Skewness = coefficient of skewness

Kurtosis = coefficient of kurtosis

LB(24) and LB²(24) are Ljung-Box statistics for 24th order serial correlation for daily and squared daily unpredictable returns respectively. An asterisk denotes that the null of no dependencies can be rejected at either 1% or 5% significance level.

Table 4.2 : *Summary statistics for Singapore and three overseas markets' unpredictable returns series*

		Mean	Standard deviation	Skewness	Kurtosis	LB(24)	LB ² (24)
Singapore	1	-0.000	1.005	-1.023	15.23	14.89	130.8*
	2	0.000	0.943	-0.162	3.283	27.49	192.4*
Japan	1	0.000	1.484	0.503	6.064	35.19	232.8*
	2	0.000	1.220	0.197	3.915	18.80	87.09*
UK	1	0.000	0.839	0.261	2.709	34.25	102.2*
	2	0.000	0.694	-0.213	0.237	21.58	75.08*
US	1	-0.000	0.830	-0.507	6.611	20.33	41.32
	2	0.000	0.640	-0.483	2.016	17.08	32.18

Footnotes as table 4.1.

Table 4.3 : *Summary statistics for South Korea and three overseas markets' unpredictable returns series*

		Mean	Standard deviation	Skewness	Kurtosis	LB(24)	LB ² (24)
S. Korea	1	-0.009	1.414	0.277	3.194	23.28	285.6*
	2	0.000	1.266	0.313	2.604	19.69	341.3*
Japan	1	-0.095	1.264	0.376	11.17	52.76	268.23*
	2	-0.000	1.349	0.420	3.284	21.76	216.87*
UK	1	0.002	0.818	-0.135	0.885	22.42	85.40*
	2	0.000	0.748	0.313	3.673	20.41	146.8*
US	1	-0.095	1.264	-0.475	5.245	12.57	19.86
	2	0.000	0.629	-0.376	1.707	19.69	37.69

*Footnotes as table 4.1.

Table 4.4 : *Summary statistics for Taiwan and three overseas markets' unpredictable returns series*

		Mean	Standard deviation	Skewness	Kurtosis	LB(24)	LB ² (24)
Taiwan	1	-0.000	2.898	-0.064	1.031	25.43	746.5*
	2	-0.000	1.762	-0.021	2.975	37.73	414.6*
Japan	1	-0.000	1.231	0.602	15.40	65.43*	240.3*
	2	-0.000	1.341	0.355	3.121	20.27	226.3*
UK	1	-0.000	0.822	-0.236	1.096	20.59	77.68*
	2	0.000	0.760	0.319	3.041	18.87	130.27*
US	1	0.000	0.967	-0.697	5.341	12.33	19.35
	2	0.000	0.682	-0.051	3.179	15.32	40.76*

Footnotes as table 4.1.

The kurtosis and skewness coefficients for most returns series are significantly different from zero, indicating that these distributions are non-normal with fat tails and mostly left skewed. Moreover, there is strong evidence of non-linear dependencies in most unpredictable returns series. Linear and non-linear dependencies of the unpredictable returns series are measured by Ljung-Box statistics⁴ for up to 24 lags denoted by LB(24) and LB²(24) respectively. With only a few exceptions, LB(24) statistics shown in all tables suggest that a majority of markets' unpredictable returns series are linearly independent. On the contrary, independence of the squared return series is rejected at the 5% level for all markets. Thus the non-linear dependencies are much more prevalent than the linear dependencies. In sum, the fat-tail distribution and non-linear dependencies of the returns series are supportive of the use of an autoregressive conditional heteroskedasticity (ARCH) model for the variance processes of the returns data.

(B) Bi-variate GJR-GARCH models estimation results

The model and the estimation results for the impact of news from Japan, the UK and the US to market volatility of the four Asian markets are given in Tables 4.5 to 4.8. In each of the four tables, local (foreign) news impacts are measured by coefficients α_{i1} and α_{i2} ($\theta_{ij,1}$ and $\theta_{ij,2}$). Provided that the local (foreign) news asymmetry coefficient α_{i2} ($\theta_{ij,2}$), is statistically significant, the summation of α_{i1} and α_{i2} ($\theta_{ij,1}$ and $\theta_{ij,2}$) measures the impact of negative local (foreign) news on local market volatility.

⁴ The formula for the Ljung-Box statistic is $LB(k) = T(T+2) \sum_{j=1}^k r_j^2 / (T-j)$, where r_j is the j th lag autocorrelation, k is the number of autocorrelations, and T is the sample size. The statistics follow χ^2 distribution with k degrees of freedom.

These sums are provided in each of the four tables for quick reference. Positive local news impact is measured by α_{il} ($\theta_{j,2}$) alone. The terms ‘local’ and ‘foreign’ news here cannot be strictly interpreted as news purely originating from local and foreign markets because daily close-to-close returns data used in this study may reflect both the influence of foreign news when the local market has closed and local news during its trading hours. The unavailability of open-to-close and close-to-open data for the four Asian markets means that we have to assume $\varepsilon_{i,t-1}$ and $X_{j,t-1}$ are good proxies for local and foreign news.

(C) Analyses and discussion of the estimation results

(C.1) Foreign news impacts ($\theta_{j,1}$ and $\theta_{j,1} + \theta_{j,2}$)

Four interesting points can be observed from tables 4.5 to 4.8 regarding foreign news impacts on the four individual Asian markets. First, news from Japan, the UK and the US does spill over to the four developing markets even before their liberalisation. Second, not all developing markets experience an intensification of foreign news impacts on their market volatility after liberalisation. Third, negative foreign news does not cause a uniform decline in all four stock markets. Instead, each individual developing market has a different asymmetric response to foreign news, good and bad alike. Fourth, foreign news impacts on the four Asian markets on the whole diminish following their liberalisation. The first three observations have important implications for the key mechanism of volatility transmission to the four developing markets.

Table 4.5 : *Volatility spill-over to Hong Kong from Japan, UK and US*
(1986:4:1 to 1989:6:30 and 1989:7:1 to 1996:7:31)

<i>Countries / Parameters</i>	<i>Pre-change period</i>			<i>Post-change period</i>		
	<i>Japan</i>	<i>UK</i>	<i>US</i>	<i>Japan</i>	<i>UK</i>	<i>US</i>
α_{10}	0.0803*	0.0319*	0.0294*	0.1205*	0.0231*	0.1193*
α_{11}	0.0845*	0.0423*	0.0682*	0.0622*	0.0624*	0.0986*
α_{12}	0.1340*	0.1796*	0.1653*	0.0911*	0.0872*	0.0639*
$\alpha_{11} + \alpha_{12}$	0.2185	0.2219	0.2335	0.1533	0.1496	0.1625
$\theta_{1j,1}$	-0.0195	0.2063*	0.1588*	-0.0070*	-0.0356*	-0.0588*
$\theta_{1j,2}$	0.0565*	-0.1698*	-0.1198*	0.0179*	0.0725*	0.2751*
$\theta_{1j,1} + \theta_{1j,2}$	0.0565	0.0365	0.0390	0.1090	0.0369	0.2163
β_1	0.8088*	0.8096*	0.7841*	0.8236*	0.8249*	0.7749*

(1) $\mu_{i,t}$ are found to be statistically insignificant in every case and therefore are not reported.

(2) An asterisk indicates that the corresponding estimated coefficients are statistically significant at 5% significance level, except for the fourth and seventh rows which give the summation of the positive and negative news estimates based on their individual statistical significance.

Table 4.6 : *Volatility spill-over to Singapore from Japan, UK and US*
(1989:3:1 to 1993:9:30 and 1993:10:1 to 1996:7:31)

<i>Countries / Parameters</i>	<i>Pre-change period</i>			<i>Post-change period</i>		
	<i>Japan</i>	<i>UK</i>	<i>US</i>	<i>Japan</i>	<i>UK</i>	<i>US</i>
α_{20}	0.3386*	0.0623*	0.1545*	0.1562*	0.1488*	0.1627*
α_{21}	0.1040*	0.1237*	0.1344*	0.0873*	0.0970*	0.1301*
α_{22}	0.2833*	0.2003*	0.2293*	0.1974*	0.1781*	0.1753*
$\alpha_{21} + \alpha_{22}$	0.3873	0.3240	0.3637	0.2847	0.2751	0.3054
$\theta_{2j,1}$	-0.0040	-0.0092*	0.1614	0.0082	0.0417	0.1323*
$\theta_{2j,2}$	0.0701*	0.2650*	0.0760*	-0.0040	0.0394	0.0530
$\theta_{2j,1} + \theta_{2j,2}$	0.0701	0.2558	0.2374	0	0	0.1323
β_2	0.3601*	0.4010*	0.4182*	0.6202*	0.6023*	0.5091*

Footnotes as table 4.5.

Table 4.7 : *Volatility spill-over to South Korea from Japan, UK and US*
(1988:3:1 to 1991:12:31 and 1992:1:1 to 1996:7:31)

<i>Countries / Parameters</i>	<u><i>Pre-change period</i></u>			<u><i>Post-change period</i></u>		
	<i>Japan</i>	<i>UK</i>	<i>US</i>	<i>Japan</i>	<i>UK</i>	<i>US</i>
α_{30}	0.2044*	0.3617*	0.2064*	0.0890*	0.0817*	0.1018*
α_{31}	0.0967*	0.1479*	0.0975*	0.0585*	0.0690*	0.0717*
α_{32}	0.1558*	0.1670*	0.1553*	0.0672*	0.0532*	0.0522*
$\alpha_{31} + \alpha_{32}$	0.2525	0.3149	0.2528	0.1257	0.1222	0.1239
$\theta_{3j,1}$	0.1494*	-0.0595*	0.1458*	0.0264*	0.0067	-0.0875*
$\theta_{3j,2}$	-0.1378*	0.1924*	-0.1337*	-0.0262*	0.0049	0.1146*
$\theta_{3j,1} + \theta_{3j,2}$	0.0116	0.1329	0.0121	0.0002	0	0.0271
β_3	0.6823*	0.5792*	0.6809*	0.8363*	0.8506*	0.8452*

Footnotes as table 4.5.

Table 4.8 : *Volatility spill-over to Taiwan from Japan, UK and US*
(1988:1:1 to 1990:12:31 and 1991:1:1 to 1996:7:31)

<i>Countries / Parameters</i>	<u><i>Pre-change period</i></u>			<u><i>Post-change period</i></u>		
	<i>Japan</i>	<i>UK</i>	<i>US</i>	<i>Japan</i>	<i>UK</i>	<i>US</i>
α_{40}	0.1948*	0.1419*	0.2012*	0.0953*	0.0971*	0.1058*
α_{41}	0.0008	0.0296*	0.0287*	0.0515*	0.0515*	0.0491*
α_{42}	0.1916*	0.1622*	0.1765*	0.0326*	0.0292*	0.0329*
$\alpha_{41} + \alpha_{42}$	0.1916	0.1918	0.2052	0.0841	0.0807	0.0820
$\theta_{4j,1}$	0.2647*	-0.0287	-0.0232	0.0264*	0.0634*	0.0782*
$\theta_{4j,2}$	-0.1438	0.2491*	0.0706	-0.0245*	-0.0402*	-0.1071*
$\theta_{4j,1} + \theta_{4j,2}$	0.2647	0.2491	0	0.0019	0.0232	-0.0289
β_4	0.8491*	0.8606*	0.8542*	0.8903	0.8914	0.8941

Footnotes as table 4.5.

In section II, we have argued that volatility can be transmitted from one market to another through (i) the presence of cross-market stock investment; (ii) a pure contagion effect or (iii) a fundamentals contagion effect. The absence of volatility spill-over to South Korea and Taiwan in particular before their liberalisation as well as an intensification of foreign news impacts on Hong Kong and Singapore after their liberalisation would be supportive of the first channel as the key mechanism. However, results from tables 4.7 and 4.8 show that volatility in South Korea is influenced by news from all three major markets before liberalisation whilst Taiwan is influenced by news from Japan and the UK. Meanwhile, results from tables 4.5 and 4.6 show that only Hong Kong has experienced a substantial increase in foreign news impacts such as negative news impacts from Japan and the US during the post-liberalisation period. Volatility spill-overs to Singapore on the other hand have reduced rather than intensified following its liberalisation. In addition, a higher level of equity investment in the developing markets from the major market does not necessarily lead to a greater influence on the volatility of the four developing markets. Take the UK news impact as an example. Although the UK has relatively larger exposure in the four developing markets' equities following their liberalisation as has been mentioned in Chapter Three, the magnitude of its news impact on the four markets has fallen by 25% to 100% during this period. Taken together, these results give a clear indication that the presence of cross-market stock investment is not necessarily the key mechanism for cross-market volatility spill-over. This is opposite to what was reported in Ng et. al. (1991) when they found no evidence of volatility spill-over from the US to Taiwan and South Korea before they were opened up. It could be due to the choice of different indices, sample periods, estimation methods as

well as the foreign markets included in the studies. Yet the ability to address directly the issue of the link between cross-market direct investment and volatility transmission with the availability of post-liberalisation data for both Taiwan and South Korea in this chapter makes our results very interesting.

If cross-market direct investment is not the vital key for volatility transmission, it could either be the pure contagion effect or fundamentals contagion effect. To distinguish the two, we examine the asymmetric foreign news impacts on each individual market. If the negative news of any one of the three major markets simultaneously causes higher volatility in the four Asian markets than positive news of an equal magnitude, this would be supportive of the pure contagion argument. If, on the other hand, different developing markets have different asymmetric responses to different foreign news depending on the nature of their economic ties, then it would be supportive of the fundamentals contagion argument. A comparison between the positive and negative foreign news impacts, i.e. $\theta_{ij,1}$ and $\theta_{ij,1} + \theta_{ij,2}$ respectively, on each developing market for each sample period shows that only in some cases are there significant negative foreign news asymmetries. For example, (i) the negative foreign news impacts from Japan, the UK and the US on Singapore over the pre-liberalisation period, (ii) the negative foreign news impacts from the UK on South Korea over the pre-liberalisation period, (iii) the negative foreign news impacts from Japan and the UK on Taiwan over the pre-liberalisation period and (iv) the negative foreign news impacts from Japan and the US on Hong Kong over the post-liberalisation period are all higher than positive news from the same foreign markets. In all other cases, the negative foreign news impacts on developing markets are simply

non-existent or lower than the positive foreign news impacts in absolute terms. Therefore, the lack of a uniform response of volatility in the four developing markets to negative foreign news eliminates the possibility of the pure contagion effect being the key mechanism for cross-market volatility transmission. Instead, volatility is more likely to spill over through the fundamentals effect where changes in one market's economic fundamentals would cause a knock-on effect on the other stock market where there are close economic ties between them.

Despite the importance of merchandise trade relations in inducing cross-market volatility transmission, the role played by foreign participation in the local developing markets should not be entirely dismissed. Although local developing markets do not necessarily need foreign direct participation for volatility to spill over to them, its presence could make a difference to the actual size of spill-over from the foreign markets. Take the US news impact on the four Asian markets as an example. Its influence on the volatility of South Korea and Taiwan is minimal, often less than 0.1 per unit of US news. This is reasonable given that South Korea and Taiwan are the two least open markets to foreign investors in both periods. This is in contrast to Hong Kong and Singapore, the two least restricted markets, where US news impacts on their volatility could be as high as 0.22 to 0.24. It is interesting to note that all four local markets have the US as one of their major export destinations which account for about 18% to 25% of their total exports between 1993 and 1996, yet the size of influence from the US stock market could be so different across these markets. This indicates that while the presence of merchandise trade relations is the key

mechanism for volatility spill-over, the actual size of spill-over is affected by the degree of openness of the local markets.

In addition, the actual size of spill-over could also be affected by the level of investment in the local markets on the part of major markets. Take the news impact from Japan as an example. Despite being one of the largest import and export markets for all four Asian markets between 1993 and 1996 as shown in Figures 4.1 to 4.4, news from Japan barely affects the volatility of these stock markets. Per unit of Japanese news typically increases or reduces volatility of the four Asian markets by just 0.0002 to 0.11. This could possibly be due to the substantial overlapping trading hours between Japan and the four regional markets. Hence news coming from Japan could have an immediate effect on their price volatility and lagged Japanese news does not make much difference at all in affecting their volatility. Alternatively, the lack of equity exposure of Japanese investors in these markets could be responsible for the low impact of Japanese news. The reason is that market movements in Japan would not necessarily require a portfolio adjustment from foreign investors in the local markets of other nationalities. That is why the actual size of volatility spill-over to the local markets could also be affected by the major market's level of participation in the local markets.

As far as the change in the overall foreign news impacts on the four Asian markets is concerned, there is a significant decline of more than 50% over the four markets' post-liberalisation periods. This could be due to the fact that there are better informed investors in the markets post-liberalisation. They would be more able to

discern the relevance of a piece of foreign news to the local market's fundamentals. More emphasis would also be placed on local market-specific news as it is more relevant in assessing their investment risks relating to that particular local market. Thus the decline in the overall foreign news impacts post-liberalisation could be a result of an increase in informed trading in the local markets. This would be consistent with the findings in Chapter Two.

(C.2) Local news impacts ($\alpha_{ij,1}$ and $\alpha_{ij,1} + \alpha_{ij,2}$)

Local positive news $\alpha_{ij,1}$ and negative news $\alpha_{ij,1} + \alpha_{ij,2}$ are all found to be significant for all four Asian markets in both periods with the exception of $\alpha_{A1,1}$ in the bivariate model between Taiwan and Japan over the pre-liberalisation period. A distinguishable change in the overall local news impacts is that negative news impacts have declined in all four Asian markets following their liberalisation. This resembles the findings of significant reductions in local news asymmetries for all four Asian markets reported in Chapter Two. It thus reinforces our argument that the increase in informed trading following liberalisation has helped reduce the impact of noise trading that is believed to be the major cause of local news asymmetries.

(C.3) Local news persistence ($\beta_{i,j}$)

Persistence of local news has increased in all cases following liberalisation, even when the possible impact of foreign news has been taken into consideration. As was suggested in Chapter Two, this could be a result of the counteraction by informed traders against the response of noise traders to a piece of news so as to drive prices of stocks to their fundamental values, thus prolonging the impact of a piece of news on

market volatility. Alternatively, it might be the case that the true impact of liberalisation on market volatility has not been fully captured by the before-and-after snapshot as different stages of developments in the regulatory changes should have been taken into account during the analysis.

(VI) Conclusion

To conclude, the forces behind cross-market volatility transmission are found to be inter-related. While the presence of a merchandise trade relation is found to be the key mechanism for volatility spill-over to the four Asian markets, the actual size of spill-over could be determined by the availability of foreign investment opportunities and the actual level of foreign participation. Our results show that volatility spill-over does not necessarily need to involve direct participation in local developing stock markets. The lack of a uniform asymmetric response of volatility in the four Asian markets to all negative foreign news has also precluded the possibility of a pure contagion effect being the most significant volatility transmission mechanism. Instead, the presence of substantial merchandise trade relations is sufficient to induce the transmission of foreign shocks through fundamentals contagion to markets like South Korea and Taiwan even before they were liberalised. The different nature of economic ties between the developing and major markets could explain why volatility of the four markets have different asymmetric responses to foreign news. Without the existence of a substantial trade relation, a higher level of equity investment in the Asian markets from the major markets does not necessarily lead to a greater influence on the volatility of the four developing markets either. This is illustrated in the case of

the UK which has relatively larger exposure to the four developing markets' equities, but only accounted for less than 2% of their total import and export trade.

Although cross-market direct investment is not the key mechanism for volatility transmission, its presence has two important implications on local market volatility. First, it would affect the actual size of volatility spill-over from foreign markets. This is supported by the finding of differing impacts from the US news on the volatility of the four markets despite the fact that the US is their major export market. The news has greater impact on the volatility of Hong Kong and Singapore, the two markets with the least restrictions, than on South Korea and Taiwan, markets that have tighter restrictions. That is why we argue that the forces behind cross-market volatility transmission are manifold although the presence of substantial trading relations appears to be the basic factor.

Second, the presence of cross-market investment could indirectly help reduce foreign news impacts on local markets and make local news impacts more persistent as there is an increase in informed trading following liberalisation. Foreign investors, particularly institutional investors, would pay more attention to local news because the main source of investment risk is likely to come from within the local markets themselves rather than from overseas markets. Thus they would play down the significance of foreign news which is irrelevant to the local markets' economic fundamentals. As regards the local market specific news, it might take them longer to assess its implications on their investment strategy because developing markets are expected to be less transparent. That is why cross-market direct investment could

indirectly help reduce foreign news impacts on local markets and make local news impacts more persistent.

Results from Chapters Three and Four indicate that the inter-relationships between the four Asian markets and the three leading world markets, the US, the UK and Japan, were not strong over the past decade. Price movements and volatility of prices in the four Asian markets have not been increasingly driven or affected by innovations from the leading world markets after their liberalisation. However, similarity in the economic growth of most Asian countries in the past ten years may suggest that the Four Tigers could be more closely related to other regional stock markets than with the world's major markets. One possible reason is that their high rates of economic growth were all attractive to foreign investors, and hence they would have to compete for their investment capital. As a result, a negative relationship between the markets might exist. An upward movement of one market might cause a slowdown to another market when foreign investors moved their capital from one country to another. Alternatively, the regional markets in Asia could be moved by regional shocks in the same directions as they all shared similar economic fundamentals and experienced similar economic cycles over the past decade. The benefits of exposing to a number of emerging markets in Asia by foreign investors to diversify risks would thus diminish. Whether the Four Tigers were more integrated with their regional counterparts than with the three leading world markets over the past ten years is a subject that will be investigated empirically in the next chapter.

Chapter Five : The Asian Financial Crisis And The Inter-relationships Of Regional Stock Markets

(I) Introduction

The last three chapters of this thesis have examined the changing nature of volatility in each of the four Asian markets namely Hong Kong, Singapore, South Korea and Taiwan as well as the world market effects from the US, the UK and Japan on their prices and volatility. While the nature and structure of volatility of each individual market have undergone changes following their liberalisation, their price and volatility inter-relationships with the three major world markets have not changed dramatically. An increase in foreign investment opportunities in the four Asian markets has not created a closer long-run price relationship between the seven national markets. This has been attributed to the changing economic developments in some major markets as well as their low level of actual participation in the Asian markets. The active government intervention on the stock markets in some developing markets even after liberalisation shared some responsibility too. The volatility spill-over effects from the major to the Asian markets have not intensified either with the increase in foreign investment opportunities. This has been argued to be a result of an increase in informed trading as foreign investment increases. Hence irrelevant foreign news on the pricing of local stocks is left aside. Instead, more emphasis is placed on local news as it becomes more relevant in assessing the risks of investing in these developing markets.

Despite the non-existence of substantial integration of the four developing Asian markets into the world markets, there might be a closer link among the Asian regional markets. Previous studies have shown evidence of such inter-relationships on stock price co-movements as well as volatility spillover. These include Corhay et. al. (1995), Masih and Masih (1997), Chowdhury (1994) and Eun and Shim (1989), to name a few. In Corhay et. al. (1995), they find evidence that within the Pacific-Basin region, Asian markets are more integrated among themselves than with Pacific markets such as Australia and New Zealand, probably because of the geographical separation. In Masih and Masih (1997), their cointegration results show that the Hong Kong market predominantly led the markets of Singapore, South Korea and Taiwan between 1982 and 1994, yet no explanations have been offered for such a linkage pattern. In fact, the similarity in their economic and foreign investment growth within the last ten years as well as their trade relations might explain why they are linked in the ways they are. Thus in this chapter, the regional linkage patterns of the Four Tigers with other regional Asian markets will be investigated and the reasons behind their linkage patterns explored. With the emergence of the Asian financial crisis in Thailand, Malaysia and Indonesia since July 1997, affecting both the regional and world markets and economies alike, it would be interesting to examine whether the crisis has strengthened the inter-relationships among these Asian emerging markets. Thus, the issue of regional market linkages among the Asian markets surrounding the recent Asian financial crisis period would be the subject of investigation in this chapter.

No doubt, given the extensive knock-on effects the crisis in Asia might bring to the world economies, it has been a topic already widely written and commented about ever since it came to light. Yet not much empirical work has been done to help quantify how individual Asian markets have been affected by the crisis. Therefore, we seek to fill this gap in the literature in this chapter by examining the regional effects of the Asian financial crisis on the stock markets of Hong Kong, Singapore, South Korea and Taiwan. The aim is to obtain a general picture of how Asian regional markets are inter-related to allow a comparison with the world market linkage pattern found in the last two chapters. Such information is important for international investors to evaluate the risks of exposing themselves to several Asian stock markets at the same time and the signposts to look for to make better investment decisions in potential markets in the future. We will argue that before the Asian financial crisis, there is little interaction between the Four Tigers and three regional markets namely Thailand, Malaysia and Indonesia. Regional innovations have limited effects on the four markets except Singapore where the innovations have substantial impacts on its returns variations. However, during the crisis, their interactions become much stronger and impacts of the regional shocks are more persistent. Responses to the shocks are slow and lack direction where they may fall one day and rise again the following day. All these have been attributed to the market contagion effects that were, it is argued, at work during the crisis, which helped spread the crisis throughout the region.

The rest of the chapter will proceed as follows. Section II gives an account of the Asian crisis. Section III discusses the links between regional effects and the Asian

stock markets movements. Section IV describes the methodology and data used. Empirical results will be reported and discussion provided in Section V. Section VI concludes the chapter.

(II) The Asian financial crisis

The Asian financial crisis has been extensively reported in newspapers such as the Financial Times and business periodicals such as the Far Eastern Economic Review, The Economist and The Banker, to name a few. Below is an account of the origin and development of the crisis from a number of articles and reports based on these newspapers, periodicals and journals.

(A) The crisis in Thailand, Malaysia and Indonesia

(A.1) Background to the crisis

July, 2, 1997 marked the beginning of the so called Asian crisis when Thailand abandoned its peg with the US dollar and let its currency (the baht) float in the market. Thereafter, Indonesia and Malaysia followed Thailand in floating their currencies under tremendous pressure of capital outflow. It is widely believed that the crisis in these three countries was an outcome of a series of cumulative factors that dated back to the late 1980s when they enjoyed unbroken high economic growth. These factors include explosion of liquidity, reliance on short-term external borrowing, mismanagement of macro-economic policy, local banking problems and export slow down.

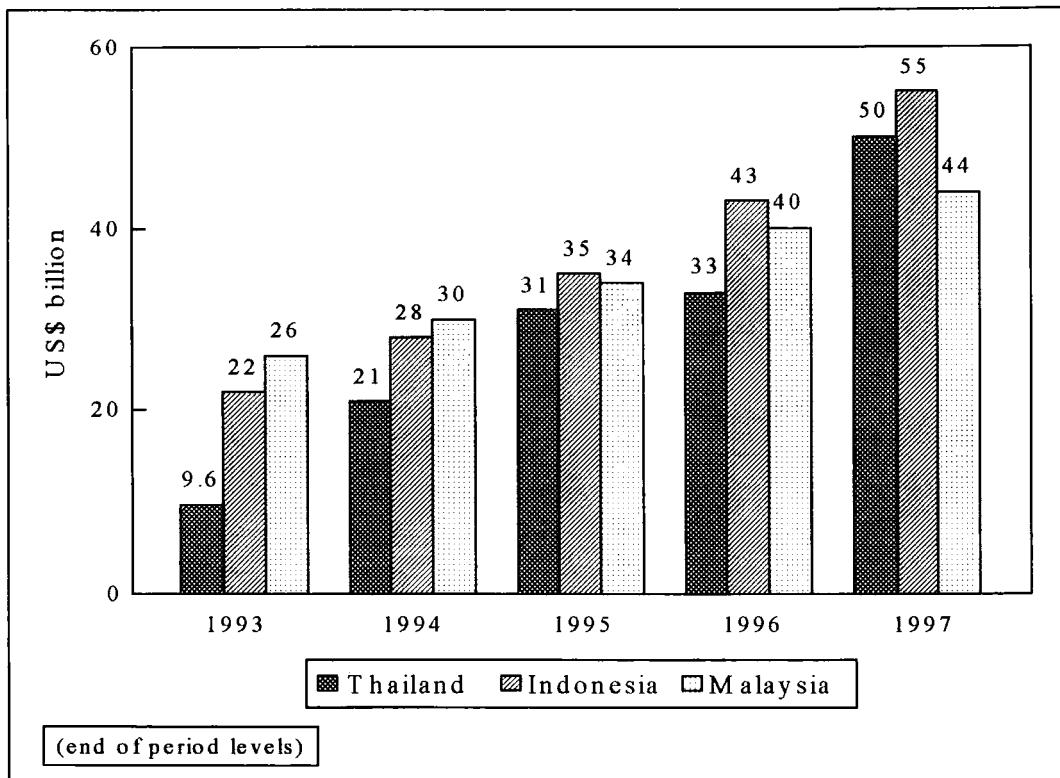
(A.1.1) Explosion of liquidity and reliance on external borrowing

Since 1987, economic growth in Thailand and Malaysia remained steadily high at about 8% per annum and 7% for Indonesia. Such steadiness in growth had attracted large capital inflows from Japan and continental Europe through direct investments as well as bank credit. Domestic investors were also allowed access to cheap offshore funds. Dollars flowed in at interest rates way below those offered by domestic banks. Many development projects too were funded by private foreign borrowing denominated in foreign currency. Figure 5.1 shows that the total external debt of Thailand, Indonesia and Malaysia soared from US\$9.6bn, US\$22bn and US\$26bn in 1993 to US\$50bn, US\$55bn and US\$44bn in 1997 respectively. The reliance on short-term external borrowing not only increased these economies' exposure to exchange rate risk, but it also made them more vulnerable to a sudden reversal of capital inflows.

(A.1.2) Mismanagement of short-term macro-economic policy

Despite the large influx of foreign capital, the three governments were reluctant to let their currencies appreciate during the boom years. Instead, they maintained an inflexible fixed exchange rate regime against a basket that had a high US dollar weighting. As a result, the exchange rates of their currencies against the US dollar remained constant in the 1990s until 1997 as shown in Figure 5.2. They failed to recognise that misalignment of real exchange rates might occur when they were unable to manage demand within the limit required to validate the rate. As a result of such macro-economic mismanagement, there was an explosion of liquidity and much of this money was invested in property.

Figure 5.1 *Total external debts of Thailand, Malaysia and Indonesia*

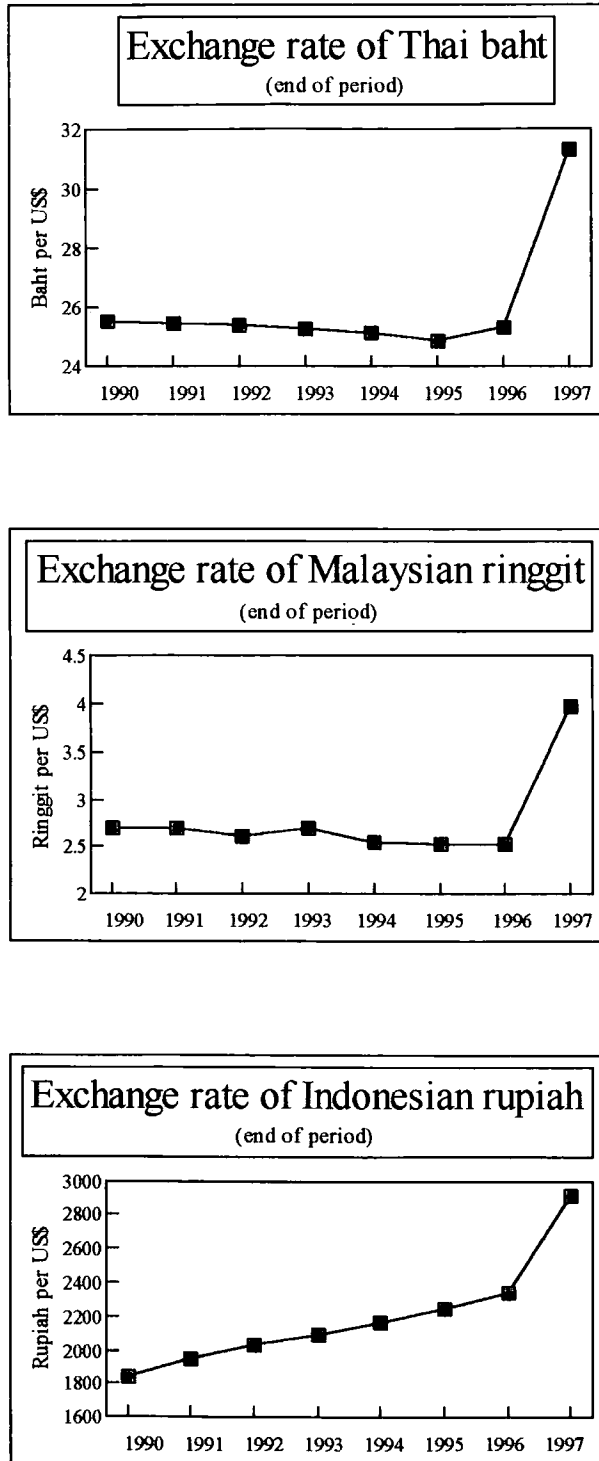


Source : EIU Country profile : Malaysia (1995-1998) and Datastream

(A.1.3) Banking problems – exposure to property loans

Banks in these countries helped fuel an unsustainable burst of property development by lending to property developers and home buyers. For instance, Thai banks' exposure to property loans was about 13% of their outstanding credit in 1996. In Malaysia, as much as 23% of outstanding bank loans was linked to property. They failed to allow for the possibility that once their economies slowed down, large amounts of unwanted property would come on the market. Banks and newly established financial companies that had heavy exposure to the property market would be faced with huge losses on their property lending and might even become bankrupt. Such an economic downturn finally occurred with the slowdown in their exports.

Figure 5.2 Exchange rates against the US\$ of the Thai baht, Malaysian ringgit and Indonesian rupiah



Source : IMF Balance of Payment Statistics Yearbook (1998)

(A.1.4) Export slowdown

The slowdown of exports came under the influence of three factors. First, demand for electronic goods, which are one of Asia's specialities, from the US was weak. This greatly reduced the terms of trade and sales growth in Malaysia and Thailand. Second, nominal exchange rates in Thailand, Malaysia and Indonesia appreciated sharply during the same year as the yen had weakened against the dollar, thus lowering their export competitiveness. Finally, competition from China with its export capacity had further aggravated the situation, resulting in the slowing down of exports. Overall, export growth in dollar terms dropped from 25% in 1995 to 1% in 1996 in Thailand, from 22% to 5% in Malaysia and from 18% to 4% in Indonesia. This set the scene for the currency crisis in July 1997.

(A.2) Onset of the crisis

As mentioned before, economic slowdown in these countries would trigger misalignment of real exchange rates as they failed to manage demand within the limit required to validate the rate. It would also make local banks with heavy exposure to property loans face huge losses and companies relying on unhedged external borrowing run into difficulties in repaying their loans. This was precisely the effect of the economic slowdown in these countries. It raised doubts about the authorities' continued willingness to support the exchange rate by maintaining high interest rates as well as their banks' and companies' ability to repay their foreign debts. The sustainability of the existing exchange rate peg to a basket dominated by the US\$ was questioned. At last in mid-May 1997, it prompted a run on the currency and on 2 July 1997, the Thai government abandoned its peg and allowed the baht to float. As a

result, it suffered a sharp depreciation. Soon afterwards, pressure of capital outflow also forced Malaysia and Indonesia to follow Thailand in floating their currencies. Their stock markets fell sharply too, as a result of exchange rate weakness and high interest rates. By the end of August 1997, Malaysia's equity market was 11% down, Thailand was 10% down and Indonesian shares fell by 14%.

(A.3) Reacting to the crisis

The International Monetary Fund (IMF) assembled a US\$17bn (£10.6bn) rescue package to bail out Thailand after the baht was devalued under pressure in early July 1997, on condition that it implemented a series of policy reforms. At first, the Thai government proceeded with the reforms cautiously. For instance, foreigners had been given permission to take majority control of suspended finance companies, but had to lower their stakes to 49% within five years. As time went on, the new Thai government was more ruthless in putting the country on the road to recovery. Its current account turned to surplus for a third time since the baht's devaluation. As a result, the Thai stock market gained more than 200 points in the main Bangkok index in February 1998 and the baht was also up against the US dollar by 42% from its low of Bt57 to the US dollar. The dilemma facing Thailand now is that its currency may be at a level which is too strong to help its exporters and yet too weak to induce major capital inflows. Hence a full recovery of the Thai economy from the current financial crisis might still take a long time.

Malaysia first reacted to its currency crisis by blaming foreigners for their speculative activities in its foreign exchange market. Since Malaysian shares can also be traded in

Singapore, it alleged that foreign speculators involved in short-selling of Malaysian shares via the Singapore's Central Limit Order. It therefore imposed sanctions by putting up impediments to sales and banning the short-selling of some stocks. The market sank as a result. Then within days, the prime minister moved policy in an opposite direction to open further its markets to foreigners. The short-selling ban was removed, and an indefinite delay put on tens of billions of ringgit worth of infrastructure projects. Since then Malaysian stock prices began to rise again. However, foreign banks and investors had lost their confidence in Malaysia as a result of the finger pointing and ad hoc rule changes within a short space of time. By now, Malaysia's main stock index had fallen by about 75%, more than any other index in the region. Its currency had also weakened nearly 40% against the US currency within a year, since the start of the crisis. Despite this setback, Malaysia did not ask for bailing out from the IMF. Instead, it recently passed legislation to control foreign exchange outflow from the country to halt its currency crisis. Share transactions must also go through the Kuala Lumpur Stock Exchange to avoid speculative attacks being conducted via other stock exchanges.

As for Indonesia, it received US\$37 billion from the IMF to bail it out. In return, it immediately waived foreign ownership restrictions and imposed selective currency controls in September to protect the rupiah from further depreciation and to ease domestic interest rates. Sixteen troubled private banks were also closed in an attempt to restore public confidence. Plans to merge four out of seven state-owned banks were also announced. However, on 6th January 1998, president Suharto presented a draft budget which breached IMF targets. Two days later the rupiah plunged and

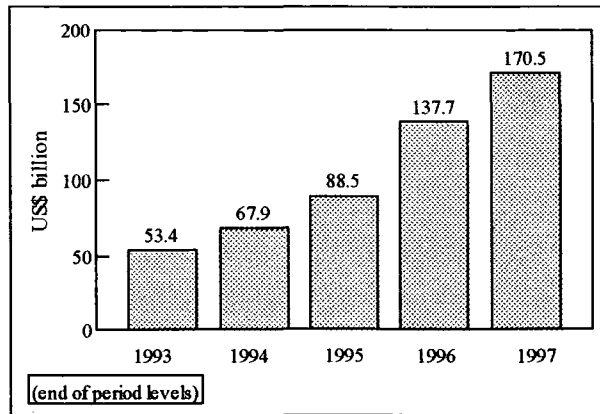
sparked widespread social and political unrest in Indonesia calling for the president's resignation. In March 1998, president Suharto finally stepped down but the new president Habibie is a Suharto loyalist. This gave little confidence to both businessmen and Indonesian people of the new government's commitment to introduce democracy and modernise the country's economy. To date, Indonesia is still struggling with its social unrest as well as economic deterioration.

(B) The financial crisis in South Korea

(B.1) Background to the crisis

South Korea was the next casualty of Asia's mix of competitive currency devaluation and financial market crisis. It was exposed to the same pressures that had beset the rest of the region. Its problems could be dated back to 1993 when Kim Young-Sam became President. He turned his country from a mild-recession into growth by encouraging Korea's giant diversified conglomerates to invest heavily in new factories, but its investment-led economic boom in 1994-95 incurred huge debts through borrowing and excess production capacity. Its total external debts rocketed from US\$53 billion in 1993 to US\$170 billion in 1997 as shown in Figure 5.3. By 1996, over-capacity led to falling prices for the nation's main export products – computer memory chips. The earnings of chip-makers fell by 90%. Cars, shipbuilding, steel and petrochemicals were also affected. Short-term foreign borrowing rose rapidly as they struggled to service their long-term debts.

Figure 5.3 Total external debts of South Korea



Source : EIU Country Profile : S. Korea (1995-1998)

Corporate collapses caused credit downgrades for many banks with heavy exposure to failed industrial groups. In January 1997, Hanbo Steel collapsed under \$6bn in debts. The loans were given by banks under government pressure. In March, Kia Motor, the third biggest car maker in Korea asked for emergency bank loans to avoid bankruptcy. It was later nationalised by the government under public pressure, when the bank refused to forward the loan. Meanwhile, Jinro, Korea's largest liquor group became the third conglomerate to go bust in 1997.

(B.2) Onset of the crisis

The crisis began when international credit agencies began down grading ratings for banks with heavy exposure to troubled conglomerates. After the nationalisation of Kia in October 1997, Standard and Poor's, the US credit rating agency, promptly downgraded Korea's debt. It coincided with the speculative attack on the Hong Kong dollar and the crash of the stock markets in Asia. The two events then triggered an outflow of foreign capital. The South Korean won dropped sharply from 844 won per US\$ to 1695 won per US\$ between the end of 1996 and the end of 1997.

Foreign banks began refusing to roll over short-term loans to Korea and its foreign currency reserves started to deplete.

(B.3) Reacting to the crisis

The Korean government had to ask the IMF to help bail it out in December. By this time, Korea's short-term foreign debt was thought to be more than \$100bn. IMF had arranged the biggest ever rescue package worth \$55 billion for Korea for fear that the collapse of Korea, the world's eleventh largest economy, would have a significant impact on the rest of the world. Since then, Korea was co-operative in implementing the IMF's rescue programme by:

(i) raising the foreign ownership ceiling in listed companies to 55%. As a result, net foreign investment in the Seoul bourse totalled won 906 billion in January 1998 in the month when the restriction was first relaxed.

(ii) approving hostile foreign take-over of Korean companies in an effort to attract overseas investment once overseas investors acquired 15% or more of a company's shares which has at least £710m worth of assets.

(iii) keeping interest rates high at about 20% to 30% with an aim of tightening lending policies.

One year on, these policies seemed to have stabilised the Korean market and prevented the Korean won from free fall, yet the cost to pay was high. A large number of workers became unemployed as inefficient and unproductive firms were shut down and troubled banks were merged or closed. To sum up, some underlying factors leading to the financial crisis in Korea were similar to those affecting Thailand,

Indonesia and Malaysia. These include exposure to foreign loans denominated in foreign currencies without hedging, over-investment and poor quality bank lending. However, the Korean government itself also played a major role in this crisis by pressurising banks to lend to inefficient firms and protecting them from becoming insolvent.

(C) The financial crisis in Hong Kong

The initial impact of Thailand's currency crisis on Hong Kong was fairly limited. In fact, share prices in Hong Kong soared to a new peak between July and August 1997 when the smooth transition of Hong Kong back to China had boosted business confidence in the market. However, things got worse in October when Hong Kong was under immense speculative pressure to break its peg with the US dollar. Inter-bank interest rates soared from 7% to 28% as the authority was determined to defend the peg. Property and bank stocks plummeted, bringing down the whole of the stock market. Then in January 1998, Peregrine Investment Holdings filed for liquidation, sending Hong Kong's market into turmoil. By the end of 1998, its market's value had dropped by more than half since its peak in July 1997. In order to prop up the market and to discourage speculation on Hong Kong's currency devaluation, the government took the unprecedented step of intervening in the stock market by using foreign reserves to buy blue chip stocks and imposing restrictions on short-selling in the futures market. Such intervention seems to be working for the time being but the future of Hong Kong's currency peg and its stock market performance remain uncertain.

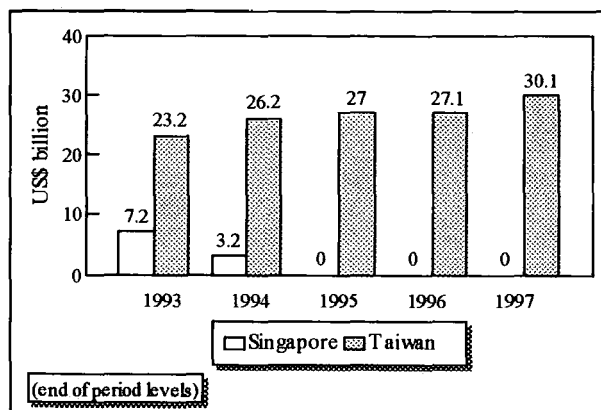
The problems facing Hong Kong prior to the crisis could well be its 'asset bubble' as well as over-optimism on the part of investors. Property prices in Hong Kong are notoriously high thanks to the US dollar peg, which helped provide cheap borrowing and fuel the property boom. Investors gambled on continued growth and stability after the hand-over of Hong Kong back to China. At the height of the property boom in early 1997, house prices rose by 30%. Meanwhile, property companies were the leading players in the stock market boom in the summer of 1997. Suddenly, with the speculative pressure mounting in attacking the dollar peg and the government's determination to defend the peg by putting up interest rates, the property market slumped. A large quantity of unwanted properties came onto the market as many people were unable to repay their mortgages. Banks in Hong Kong, whose property loans exposure amounted to 44% of their total lending, faced huge losses as bad debts rocketed. Property companies' shares too fell sharply, dragging down the whole of the stock exchange. Thus as with Thailand, Indonesia and Malaysia, poor quality bank loans as well as market over-optimism are the underlying problems that precipitated a financial crisis in Hong Kong.

(D) Singapore and Taiwan

Singapore and Taiwan are the two countries in the region which do not share similar foreign debt and over-investments problems as in other regional countries. As shown in Figure 5.4, Singapore has had no foreign debts at all since 1995. Yet it should be noted that many of the regional countries in trouble like Hong Kong, Thailand, Malaysia and South Korea have significant trading relationships with Singapore either through exports or imports. The falling world demand for electronic goods might

also hit it hard, as the key exports of Singapore are computer peripherals as shown in Figure 1.18 in Chapter One. It is thus possible that the Asian financial crisis would be spread to Singapore through such trading links. When the currency crisis broke out in Thailand in July 1997, the Singapore dollar, backed by large reserves and a large current account balance of payments surplus, only weakened moderately. However, the continual fall of neighbouring markets like Malaysia and Indonesia added pressure to its currency and the Singapore dollar began to slide. This could be attributed to the exposure of its banks to Thailand, Malaysia and Indonesia, which accounted for 15% of their total assets. As Singapore has only a small amount of foreign debt, the currency's slide is unlikely to create massive repayment problems, as is the case for its neighbouring countries.

Figure 5.4 *Total external debts of Singapore and Taiwan*



Source : EIU Country Profile : Singapore and Taiwan (1995-1998)

Taiwan is the only one of the Asian markets which was not seriously affected by the existing economic turmoil until mid 1998. There are several reasons for that. First, its exposure to foreign debts during the past five years has been constant at around

US\$20 billion to US\$30 billion and is less than that of other regional countries. Second, its banking sector is better regulated than other countries. Third, it does not protect inefficient companies at the expense of the economy. Instead, it allows them to become bankrupt and encourages new ones to spring up. Fourth, its current account remains healthily positive prior to the crisis as shown in Figure 1.47 in Chapter One. Fifth, its domestic political stability is considered more important than external shocks in affecting stock prices. For instance, in November 1997 when all other six markets in the region had experienced sharp falls, the market in Taiwan actually rose after the presidential election had removed uncertainty about who would be ruling Taiwan in the coming years. Moreover, the Taiwanese government is heavy handed in forbidding local brokerages from dealing with international speculators, thus avoiding the same sort of speculative problems experienced elsewhere in the region.

(III) Regional influence on the movements of Asian stock markets

The Asian financial crisis itself has provided us with an opportunity to examine the effects of regional shocks on local markets' returns variation. However, an examination of regional markets inter-relationships based on an extra-ordinary event alone gives little understanding of the different ways the Four Tigers might relate to the regional and world markets following their liberalisation. Thus there is a need to examine regional markets inter-relationships over the pre-crisis period as well. Since cross-market equity investment among Asian stock markets is not common, except between Singapore and Malaysia, it would be interesting to find out if their substantial trade relations alone could generate stock market relationships. This would allow a

comparison to be made to the findings of Chapters Three and Four regarding the Four Tigers' relationships with three major world markets.

As for the Asian financial crisis itself, interest will focus on the channels through which the impact of the crisis is transmitted across the region. There are three possible channels through which the crisis can be spread to regional markets. These include the pure contagion effect and fundamentals contagion effect as described in Chapter Four, as well as the presence of common risk factors. The pure contagion argument is well reflected in the remarks by Jeffrey Sachs, head of the Harvard Institute for International Development, on the Asian crisis:

'There is no "fundamental" reason for Asia's financial calamity except financial panic itself. Asia's need for significant financial sector reform is real, but not a sufficient cause for the panic, and not a justification for harsh macro-economic policy adjustments (imposed by the IMF). Asia's fundamentals are adequate to forestall an economic contraction: budgets are in balance or surplus, inflation is low, private saving rates are high, economies are poised for export growth. Asia is reeling not from a crisis of fundamentals but from a self-fulfilling withdrawal of short-term loans, one that is fuelled by each investor's recognition that all other investors are withdrawing their claims. Since short-term debts exceed foreign exchange reserves, it is "rational" for each investor to join in the panic.' (Financial Times 4 December 1997).

The fundamentals contagion effect differs from the pure contagion effect in that the former causes the crisis to spread indirectly across the region through their substantial trade relations. It involves a knock-on effect from the fall of one stock market to the economy of another regional country which then feeds through to its stock market as well. This chain effect is less to do with market psychology, but more to do with market expectation on the prospects of corporate earnings.

The common risk factors argument, on the other hand, suggests that markets with similar problems to those facing Thailand, where the crisis first broke out, are more likely to see the spread of the crisis to them. These common risk factors include over-indulgence in real estate and stock market investment, lax bank lending policies, over-borrowing of short-term loans from foreign banks, as well as a worsening current account position. In fact, among the Asian markets that suffered from the crisis, Thailand, Indonesia, Malaysia, Korea and Hong Kong all shared the same problem of misusing financial resources. First, large amounts of money were invested in property and unproductive businesses in these countries. Second, banks' exposure to property loans was enormous, 23% in Malaysia, 44% in Hong Kong and 13% in Thailand. Third, they had sizeable foreign debt, for example, Korea had US\$170 billion of foreign debts in 1997, Indonesia had US\$ 55 billion, Thailand had US\$ 50 billion and Malaysia had US\$ 44 billion. Fourth, they all had current account deficits for many years prior to the outbreak of the crisis. Only Taiwan and Singapore had substantial current account surpluses year after year since 1987, as shown in Figures 1.21 and 1.47 in Chapter One. Hence there is a possibility that the presence of common risk factors is the major mechanism for transmitting the financial crisis across Asia.

An investigation into the major forces behind the transmission of the crisis could give some indication to investors about the length of time the crisis might last and the prospects of staying in or returning to the Asian stock markets. If the pure contagion effect is the major mechanism for the spreading of the crisis, we would expect a market correction, once investors realise that the market movements during the time of the crisis are not warranted by their economic fundamentals. On the other hand, if the fundamentals contagion effect is the main driving force, recovery of the markets would depend on the extent of their exposure to the troubled markets and the nature of their economic ties. Markets that are major exporters to the troubled markets would have to expect a longer road to recovery. Investors wishing to stay in the Asian markets might need to avoid those companies that have exposure to such economic risks. Alternatively, if common risk factors are the basis of the transmission, then recovery of those markets that share the common economic problems would depend on how efficiently they are dealt with so as to restore investors' confidence. Markets which do not have such common problems should be a better choice for foreign investors wishing to return to Asia.

One way to determine which effect is the main driving force is to look at the intensity and persistence of the regional shocks, as well as the speed with which they are responded to by individual markets. If only the main trading partners experience a large impact of shocks from the troubled market, this would be an indication that the fundamentals contagion effect is the major force at work. However, if only those markets with common risk factors were significantly affected, it would indicate that

the presence of common risk factors is the main driving force. The finding of all markets responding to the same shock from one market in unison, with a similar degree of intensity would suggest that the pure contagion effect is the main channel for the spread of the crisis. The implication of the existence of time lags in responding to regional shocks as well as a high persistence of the impact of the shocks are less clear cut. It would be further support for the market psychology argument, as an individual markets adopt a wait and see policy to take directions from other regional or world markets. Alternatively, it would suggest that the fundamentals contagion effect is at work, as it takes more time for the knock-on effects of a shock from a troubled market to feed through to the stock market of its trading partner. Thus in general, the finding of sluggish responses to, and high persistence of, regional shocks might indicate the presence of either one or both of the contagion effects in spreading the crisis.

As a brief summary, four main issues will be investigated in this chapter.

- (1) Is the degree of influence of a common initial shock from a troubled market different across regional markets? If so, why?
- (2) How persistent is a shock in affecting the regional markets' returns?
- (3) How rapidly does each market respond to the shocks arising from other regional markets?
- (4) In what ways have these regional effects of shocks on the Four Tigers' stock markets changed from the pre-crisis period?

(IV) Methodology, data and sample periods

A potential method in examining the main issues in this chapter is the vector autoregression (VAR) method. The variance decomposition and impulse response functions derived from the VAR modelling can give a descriptive picture of how the Asian regional markets are inter-related through a particular time period, with regard to the strength and persistence of the effect of a shock in one market on the other markets within the system. This method has been widely used in the finance literature on the subject of market integration. Examples include Eun & Shim (1989), Chowdhury (1994), Bracato (1994), Rogers (1994) and von Furstenberg and Jeon (1990). A brief description of the VAR method is given below.

(A) The empirical model

The general form of the VAR models used to estimate the impulse response functions and variance decomposition are given in equation (1) below:

$$Y_t = A(L)Y_t + e_t \quad (1)$$

where Y_t is a non-deterministic jointly covariance stationary column vector of n endogenous variables, that is, the daily price series of n stock markets. The n by 1 vector of innovation terms, e_t , are assumed to be white noise. $A(L)$ is a polynomial in the lag operator whereby $A(L)y_t = A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_k y_{t-k}$. The optimal lag lengths in model (1) is determined by minimising Akaike's Information Criterion (AIC). It is a method of comparing alternative specifications by adjusting the residual sum of squares (RSS) for the sample size and the number of explanatory variables as shown in equation (2).

$$AIC = \frac{RSS(n+k)}{(n-k)} \quad (2)$$

where n is the sample size and k is the number of explanatory variables. The specification chosen is that which minimises AIC.

Sims (1980) noted that an autoregressive system such as model (1) was difficult to describe, especially the coefficients of the regression equations containing complicated cross-equation feed-backs. He found that it was better to analyse the system's reaction to typical random shocks by tracing out the moving average representation of model (1) as shown in model (3) below.

$$Y_t = \sum_{s=0}^{\infty} B_s e_{t-s} \quad (3)$$

where Y_t is represented as a linear combination of current and past one-step-ahead forecast errors or 'innovations'.

Sims also proposed to apply the Cholesky decomposition method in (3) to purge the innovations in e_t of any contemporaneous correlation, which may be caused by system-wide shocks. The orthogonalised innovations obtained in this way have the property that they are uncorrelated both across time and across equations. In fact, it can be misleading to examine a shock to a single variable in isolation, when historically it has always moved together with several other variables. Orthogonalisation simply takes this co-movement into account.

Variance decomposition (VDC) and impulse response functions (IRF) are computed from the moving average representation shown in (3) with orthogonalised

innovations. The VDC shows the fraction of forecast error variance for each price series that results from its own innovations and from shocks to prices in other markets. As noted by Bracato, 'VDC provides a measure of the overall relative importance of the markets in generating the fluctuations in stock returns in their own and other markets. At any horizon, individual decomposition percentages will lie between 0 and 100 and the summation of all percentage magnitudes for a given horizon will be equal to 100. A market whose total error variances are explained mostly by its own shocks will produce percentage magnitudes close to 100; lower percentages will be recorded for markets whose error variances are increasingly accounted for by the comovement of other markets in the system.' (1994, p.649) Thus if a large percentage of a market's error variances is explained by its own shocks, it will be considered exogenous to other markets in the system. In other words, foreign shocks have little impact on its price variations. On the other hand, if the error variances are substantially accounted for by shocks in other markets, then it is said to be endogenous to the system. It is strongly affected by shocks from other markets.

The impulse response functions (IRF) show the predictable response of each price series to a one-standard error shock to one of the system's prices. They can help measure the speed with which a shock is being transmitted to other markets and also its persistence over time. If the IRF remains high for a long horizon, it indicates that the shock is persistent and the market is sluggish in responding to the shock. However, impulse responses are highly non-linear functions of the estimated parameters, with a huge number of terms. This makes calculating confidence bands

by linearisation infeasible. Therefore, a Monte Carlo integration procedure is employed to estimate the confidence intervals for the IRFs. This procedure involves taking 500 draws for the coefficients and seeing how the responses change. The confidence interval or band will be shown as a two-standard deviation band around the point estimates in the diagrams. If this band includes zero, the effect of a shock is then considered insignificant.

(B) Data and sample periods

The data set in this chapter consists of the logarithm of daily price indices for seven Asian markets, namely the Hang Seng Price Index for Hong Kong, Straits Times Industrial Index for Singapore, Composite Price Index for Korea, Weighted Price Index for Taiwan, Kuala Lumpur Composite Price Index for Malaysia, Jakarta Composite Price Index for Indonesia and Bangkok Price Index for Thailand. These indices are the most representative indices in reflecting each market's performance. Raw data series are used in the analysis without pre-filtering for the day-of-the-week effects or autoregressive effects as had been the case in Chapters Two and Four. The main reason is that pre-filtering helps produce a series of unpredictable returns which is vital for examining the impact of news on volatility in previous chapters. As our focus in this chapter is on the strength and persistence of the effect of a shock from one market on another, instead of news impacts on volatility, pre-filtering of the data is not essential.

There is one potential problem associated with investigating the strength and persistence of the effect of one market's innovation or shock on other markets in the

model. The substantial overlapping trading hours among the seven regional stock markets could make it difficult for us to distinguish whether a movement in a market is due to shifts in another market's fundamentals or 'herd' effects as noted in Chowdhury (1994 p.637). In theory, the use of non-overlapping data such as open-close, close-open and intra-daily data could help resolve this problem. However, the unavailability of these types of data for the seven Asian markets means that we have to stick to overlapping data. The possible effects of such problems of overlapping data will be addressed when interpreting our empirical results.

The VAR model will be examined over two sample periods, one starts from 1 October 1993 to 31 July 1996 and the other is from 1 August 1996 to 31 July 1998 with 739 and 522 observations respectively. The former represents the post-liberalisation period for Hong Kong, Singapore, Korea and Taiwan which was used in Chapter Three when investigating the cointegrating relationship between these four markets and three major world markets. The latter represents the time surrounding the crisis period. It covers the one year period both before and after the Asian crisis broke out in July 1997. The reason for estimating the VAR model over two sample periods is that it allows us to trace possible differences in the way markets influence one another particularly during the recent financial crisis. An examination of the crash period alone cannot tell us whether the seven Asian regional markets have become more inter-related during the crisis, that is, whether they are more affected by other regional markets during the crisis than they were previously. Such a method of comparison is not uncommon in the finance literature looking at the issue of market integration. In Bracato (1994), the sample period of 1980 to 1987 is split in two

halves to examine if markets have become more integrated over the 1980s. Rogers (1994) divides his samples into three categories, before, during and after the 1987 crash, so as to test whether the markets under investigation experienced an increase in volatility and price spillovers during and after the crash.

(V) Empirical Results and Discussion

(A) Unit roots and cointegration

There are two reasons for carrying out unit root tests and cointegration tests on the daily price series of the seven Asian markets before examining the VAR model as shown in equation (1). First, the use of non-stationary variables in a regression model would invalidate the standard inference procedures. As we are interested in a VAR model for returns in this chapter, that is, the first differences of log prices, it is important to ensure that such returns series are stationary. Second, if prices of the seven Asian markets are cointegrated, the VAR model for returns will be incorrectly specified because the error correction term is omitted. Due to these two reasons, unit root tests and cointegration tests on the daily price series of the seven Asian markets will be carried out first.

A unit root in the log level and the first difference of each series is tested using the Dickey-Fuller unit root test. A detailed discussion of the test is provided in Section IV part B of Chapter Three. Table 5.1 reports the unit root test statistics from the unit root regressions under the null hypotheses that the variables are not stationary, against the alternatives that they are stationary in levels or after taking first differences. Two lags are included in each unit root regression. The critical value for

all regressions without a time trend is -3.42. Results show that all daily price indices in both sub-sample periods are stationary in their first differences, thus they are all integrated of order one.

Table 5.1 *Unit Root Test Results*

Markets	(1:10:1993 - 31:7:1996)		(1:8:1996 - 31:7:1998)	
	Level	1 st difference	Level	1 st difference
Hong Kong	-2.3000	-18.157*	-1.615	-23.476*
Singapore	-2.8875	-18.715*	-2.219	-17.938*
Korea	-2.7948	-17.861*	-2.1414	-19.802*
Taiwan	-2.7996	-18.969*	-1.6089	-22.491*
Thailand	-2.8000	-17.620*	-2.4568	-18.466*
Indonesia	-1.8874	-15.342*	-2.1883	-18.481*
Malaysia	-3.2030	-18.803*	-2.2977	-19.574*

An asterisk denotes that the null of non-stationarity in the corresponding market can be rejected.

The hypothesis of no cointegration between the prices in the seven stock markets is then tested using the Johansen procedure. Details of the test can be found in Chapter Three Section IV. In Tables 5.2 and 5.3, the null hypothesis of the trace test that there are at most r cointegrating vectors is tested against a general alternative hypothesis (i.e. H_0 is not true), while in the maximum eigenvalue test, the null hypothesis of at most r cointegrating vectors is tested against the alternative of $r + 1$ cointegrating vectors. Results show that both the trace and the maximal eigenvalue test statistics are smaller than the 95% critical values, thus the null of no cointegration cannot be rejected for all markets in both periods. Thus we will proceed to the VAR analysis.

Table 5.2 *Cointegration test results over the first sample period*

<i>rank</i>	<i>trace statistics</i>	<i>95% critical value</i>	<i>maximum eigenvalue statistics</i>	<i>95% critical value</i>
$r = 0$	119.0084	132.45	36.9009	46.47
$r \leq 1$	82.1075	102.56	26.5125	40.53
$r \leq 2$	55.5949	75.98	21.6262	34.4
$r \leq 3$	33.9687	53.78	18.6018	28.27
$r \leq 4$	15.3669	34.87	8.8162	22.04
$r \leq 5$	6.5507	17.88	5.7669	15.87
$r \leq 6$	0.7837	9.16	0.7837	9.16

(N.B. VAR₍₅₎ is used in the cointegration test according to Akaike's Information Criterion)

Table 5.3 *Cointegration test results over the second sample period*

<i>rank</i>	<i>trace statistics</i>	<i>95% critical value</i>	<i>maximum eigenvalue statistics</i>	<i>95% critical value</i>
$r = 0$	37.08	41.5	109.3	110.0
$r \leq 1$	26.32	36.4	72.67	82.5
$r \leq 2$	24.82	30.0	46.70	59.5
$r \leq 3$	10.92	23.8	22.23	39.9
$r \leq 4$	7.218	17.9	11.45	24.3
$r \leq 5$	4.299	11.4	4.328	12.5
$r \leq 6$	0.088	3.80	0.086	3.80

(N.B. VAR₍₁₎ is used in the cointegration test according to Akaike's Information Criterion)

(B) Variance decomposition results

(B.1) Variance decomposition results over the first sample period

Due to the strong evidence from Tables 5.1 to 5.3 of the presence of unit roots in all seven markets and the absence of cointegration in the stock prices, the seven-market VAR model is estimated after transforming the daily price series into daily rates of return. The optimal lag order of five is determined using Akaike's Information Criterion. Point estimates of variance decomposition expressed in percentages for the seven stock market variables over the first sample period from 1 October 1993 to 31 July 1996 are given in Table 5.4. A forecast horizon of 25 days is used to allow the dynamics of the system to work out. To conserve space, only the results for 3 different days following the initial shocks are reported. The ordering of explanatory variables shown at the top of the table corresponds to the order in which each stock market series enters the VAR system. It is based on the closing time of each markets so that the effect of unexpected innovations from the closing market can be felt by other markets which are still open. If they have the same trading hours, then the market with relatively larger capitalisation will appear first. The markets listed in the first column represent the recipient markets of the regional shocks. The markets labelled at the top of the table represent the source markets of the regional shocks. The table should be read horizontally. Returns variation in each recipient market can be explained by the shocks to its own market and the other six regional markets. Percentages of forecast error variances of each market's returns due to shocks to other or the own markets on the first, fifth and tenth day after the shock are given by the numbers in the fourth to tenth entries of each row. The seven percentages in each

Table 5.4 : *Point estimates of variance decomposition (1.10.93-31.7.96)*

Returns variation in	Days ahead	Forecast standard error	Explained by shocks from						
			Korea	Taiwan	HK	Malay	Sing	Thai	Indo
Korea	1	1.07	100	0	0	0	0	0	0
	5	1.08	97.76	1.09	0.00	0.15	0.18	0.80	0.02
	10	1.08	97.76	1.10	0.08	0.22	0.19	0.83	0.02
Taiwan	1	1.54	0.01	99.99	0	0	0	0	0
	5	1.57	0.01	96.77	0.45	1.56	0.35	0.87	0.00
	10	1.57	0.01	96.67	0.52	1.57	0.35	0.86	0.01
HK	1	1.51	0.28	1.74	97.98	0	0	0	0
	5	1.53	0.52	1.76	95.87	0.85	0.31	0.64	0.05
	10	1.53	0.53	1.77	95.82	0.87	0.31	0.65	0.06
Malay	1	1.33	0.04	0.86	25.47	73.63	0	0	0
	5	1.35	0.44	0.86	26.01	72.02	0.07	0.35	0.24
	10	1.35	0.46	0.87	26.01	71.95	0.07	0.35	0.29
Sing	1	0.93	0.15	1.79	27.23	18.83	51.99	0	0
	5	0.95	0.87	1.73	27.67	18.94	49.84	0.29	0.66
	10	0.95	0.88	1.75	27.65	18.91	49.76	0.30	0.74
Thai	1	1.36	1.10	0.38	22.24	7.16	1.71	67.40	0
	5	1.39	1.06	1.04	23.58	7.95	1.70	64.67	0.01
	10	1.40	1.07	1.04	23.61	8.00	1.70	64.56	0.02
Indo	1	0.83	0.24	0.00	9.07	5.01	3.66	0.25	81.77
	5	0.89	0.27	0.03	11.07	9.31	3.35	1.66	74.32
	10	0.90	0.28	0.04	11.55	9.81	3.32	1.80	73.20

(VAR₍₅₎ is used based on AIC)

row represent the impact strength that a one-standard deviation shock from each source market might have on a recipient market. At any horizon, individual decomposition percentages will lie between 0 to 100 and the seven percentages in each row should sum up to 100. A market whose total error variance is explained mainly by its own shocks will produce a percentage magnitude close to 100. A market whose total error variance is substantially accounted for by shocks from other markets will have lower percentages for its own shocks.

There are two major findings from the VDC results in Table 5.4. The first finding is that there is no strong evidence of the Four Tigers being significantly affected by regional innovations following their liberalisation except for Singapore. South Korea, Taiwan and Hong Kong are the most independent markets within the region while Singapore is found to be the market most affected by regional shocks. Variations in the stock returns of South Korea, Taiwan and Hong Kong are explained mostly by their own innovations. They account for more than 95% of their forecast error variances at all time horizons shown. Only Singapore has just 50% of its variance accounted for by its own innovations, 27% of its error variance is accounted for by innovations from Hong Kong and 19% from Malaysia. Among the other three regional emerging markets, only Malaysia is found to have a substantial influence on one of the Four Tigers – Singapore. Thailand and Indonesia have only negligible influences on their returns. Thus the interaction between the Four Tigers and the three regional emerging markets is not strong.

The lack of response from the markets of South Korea and Taiwan to regional shocks could be related to its limited degree of openness and a low level of direct participation by regional markets. They are the least open markets among the seven regional markets, with foreign investment ceilings below 20% of each company's shares, even after their liberalisation during the sample period. Moreover, each of them have contingency plans to stabilise the markets. In South Korea, market stabilisation funds are used to prop up the market when it is too low and sell when the market is overheated. In Taiwan, daily price limits are used to avoid excessive price fluctuations. Political factors, such as its relationship with mainland China as well as its local and presidential election activities, are often known to have a great influence on its market movement. That could be why they are the least inter-active markets within the region.

The insensitivity of Hong Kong to movements in other regional markets, on the other hand, could be attributed to its importance as a major regional financial centre after Japan. It is the most open market within the region and has the largest market capitalisation among the seven markets. Instead of being driven by the regional markets, most of them are taking the lead from it. For instance, shocks to Hong Kong account for more than 20% of returns variations in Singapore, Malaysia and Thailand and 11% for Indonesia over the sample period. Therefore, regional markets have no influence on the Hong Kong market at all while the opposite is true instead.

Singapore is the market among the Four Tigers most sensitive to regional effects particularly from Hong Kong and Malaysia. The reason could be due to Singapore

being more exposed to regional financial markets and economies. For instance, as at 31 December 1995, 10 Hong Kong stocks and 112 Malaysian stocks were quoted on CLOB International, Singapore's over-the-counter market and 25% of the volume in Malaysian shares is executed on the CLOB International (Source : Stock Exchange of Singapore Fact Sheet, 1995 and the South China Morning Post 1 September 1998). This could be why nearly half of Singapore's returns variations are due to shocks to other markets within the region, especially from Hong Kong and Malaysia.

As far as the three emerging Asian stock markets are concerned, only Malaysia is found to exert some influence on one of the Four Tigers – Singapore. This could be due to its substantial trade relation with Singapore and the high level of cross-market equity investment between them. In contrast, shocks to Thailand and Indonesia bear little significance in explaining returns variations in other regional markets. They hardly explain more than 1% of the forecast error variances of any markets in the region. Their relatively less developed financial systems and small market capitalisation could be responsible for this. Thus on the whole, the Four Tigers are not strongly linked with their regional markets. Regional effects have limited impact on their market movement before the outbreak of the Asian financial crisis.

The second major finding is that the spill-over effects of innovations from the three regional markets to the Four Tigers are constant over different time horizons. When comparing the percentages of variances in the Four Tigers which are accounted for by Malaysia, Thailand and Indonesia over the three horizons, there are no noticeable changes. The same is true for the spill-over effects from the Four Tigers to these

three emerging markets. Thus the spill-over effects of regional shocks within the region are stable over time. The intensity of the impacts from the shocks on each market in the region does not seem to increase over a long horizon. This suggests that information contained in the innovations is fully and efficiently incorporated into prices from the first day they arise. Hence there is no need for the markets to adjust to the ways they react to the innovations in a longer horizon.

(B.2) Impulse response functions over the first sample period

The impulse response functions (IRF) for the seven markets are shown in Figures 5.5 to 5.11⁵. The point estimates of the IRF of each market to a one-standard deviation shock to other markets are represented by the solid line. The two-standard deviation confidence band is represented by two broken lines. If this band includes zero, the effect of a shock to a market is considered insignificant. The IRF results are consistent with the findings from VDC results. First, the interactions between the seven regional markets are not strong. This is manifested in the overall low level of responses to regional shocks from each market. Second, the effects of all regional shocks are not persistent, as all IRFs show signs of decaying after one or two days. Below is a brief description of the findings from the IRFs for each market.

South Korea, Taiwan and Hong Kong (Figures 5.5 to 5.7)

Impacts of innovations from all markets on Korea's returns are neither big nor persistent. Responses to all regional shocks are very weak. All IRFs tail off around

⁵ The response of each market to its own shock will not be shown as this chapter focuses on the responses of each market to other regional shocks.

zero one day after the shock, indicating that impacts of the shocks become insignificant beyond the one-day horizon. The same is true for Taiwan and Hong Kong in Figures 5.6 and 5.7. Despite the overall minimal effects on these three markets from other regional markets, one interesting point should be raised regarding the nature of the spill-over effects. Not all shocks spill over to the three markets contemporaneously, despite their substantial over-lapping trading hours with other regional markets. For instance, the peak effect of the shock from Thailand is felt with a one-day lag in South Korea. Similarly, both Hong Kong and Taiwan respond to shocks from Thailand and Malaysia with a one-day lag. This perhaps reflects the time difference between the markets' closing time when one has closed while the other is still trading. Thus the full effect of a shock from Thailand and Malaysia can only be responded to in the next day in South Korea, Hong Kong and Taiwan.

Singapore (Figure 5.8)

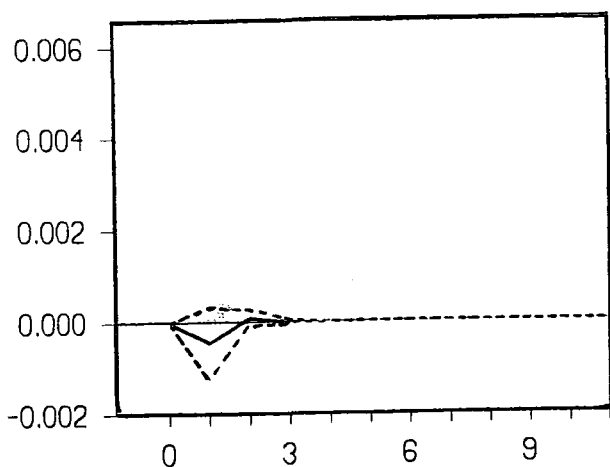
Shocks from Hong Kong and Malaysia have big impacts on its returns, with the peak effects being felt on the first day of the shock. Nevertheless, effects of these shocks are not persistent, as they appear to decay rapidly in one or two days' time. Shocks from South Korea, Taiwan, Thailand and Indonesia have very minimal effects on Singapore and they are not persistent either.

Malaysia, Thailand and Indonesia (Figures 5.9 to 5.11)

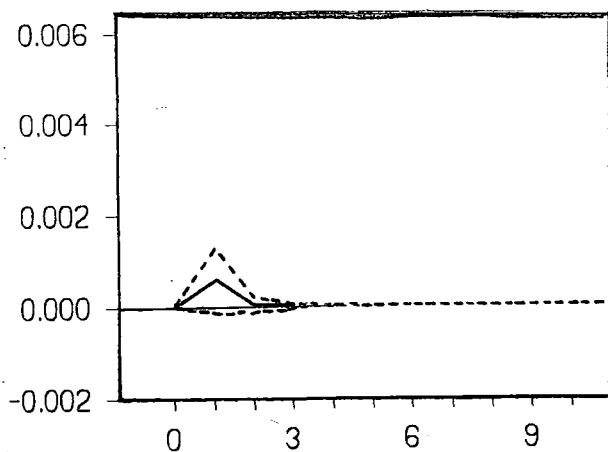
Shocks from Hong Kong are the main source of their returns variations. Among them, Malaysia is the market least sensitive to shocks from the Four Tigers, whilst Thailand and Indonesia are the opposite. The initial impacts of shocks from the Four

Figure 5.5 *Orthogonalised Response of S. Korea to regional shocks (Oct 93 to Jul 96)*

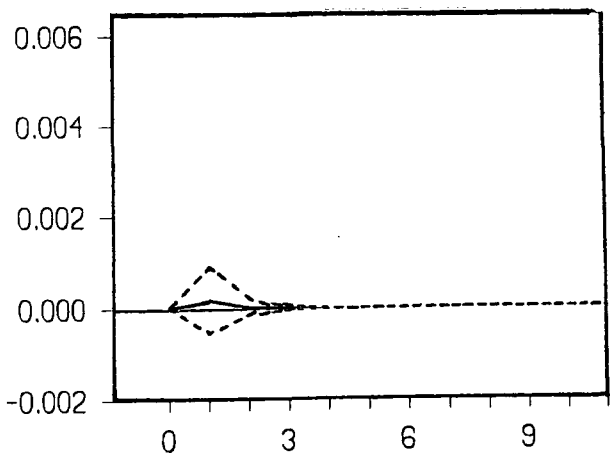
Response to a shock to Hong Kong



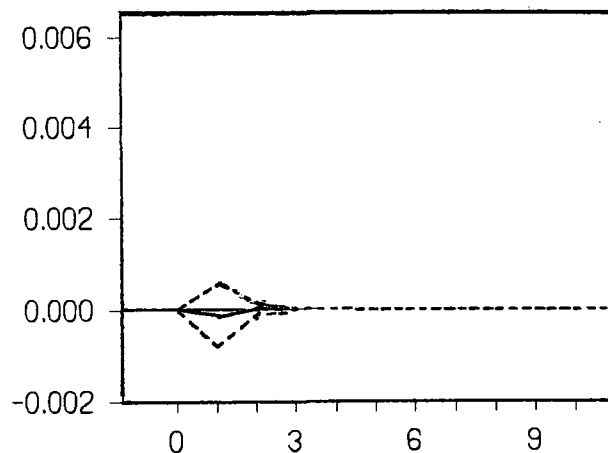
Response to a shock to Taiwan



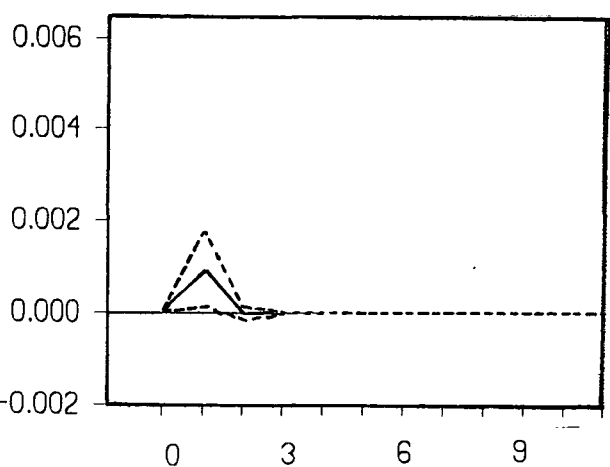
Response to a shock to Malaysia



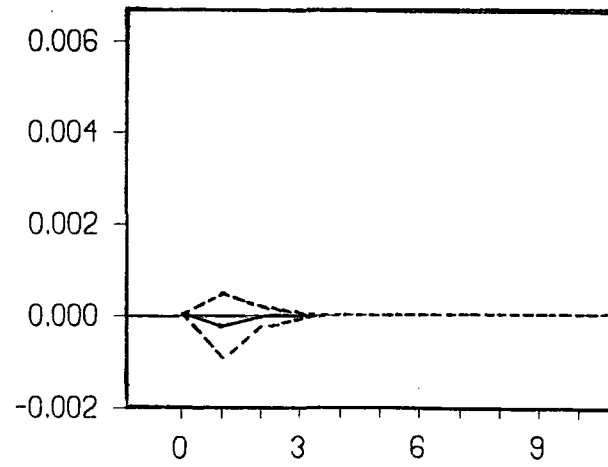
Response to a shock to Singapore



Response to a shock to Thailand



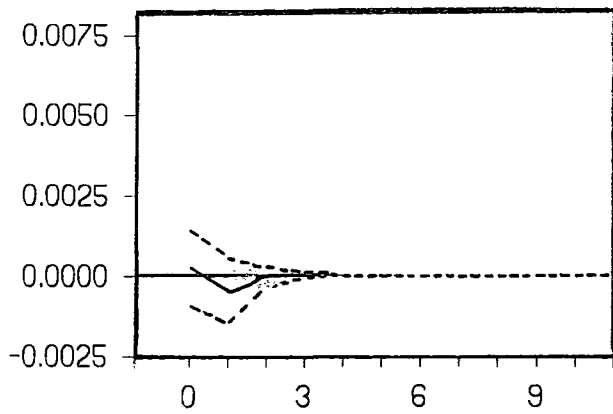
Response to a shock to Indonesia



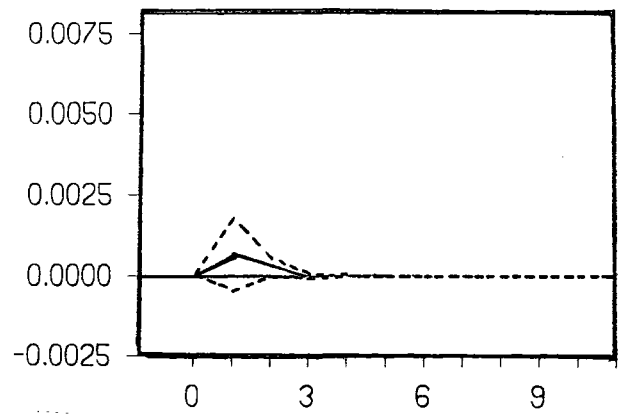
*Number of days following a shock and the value of response to the shock are shown in the x-axis and y-axis respectively.

Figure 5.6 *Orthogonalised Response of Taiwan to regional shocks (Oct 93 to Jul 96)*

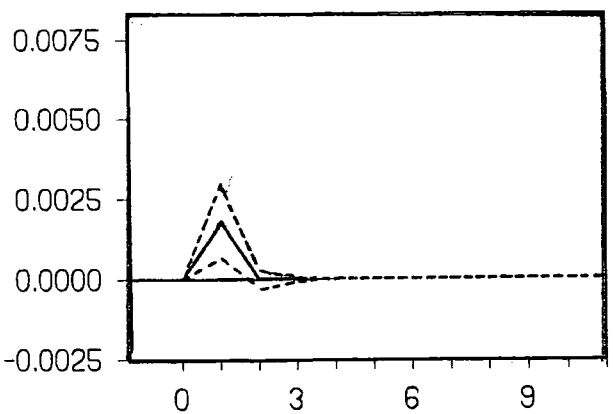
Response to a shock to South Korea



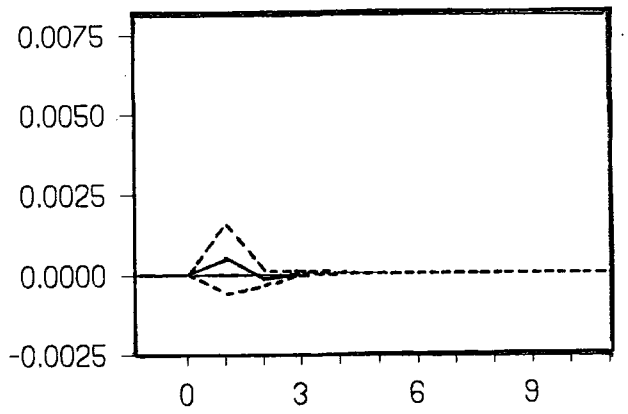
Response to a shock to Hong Kong



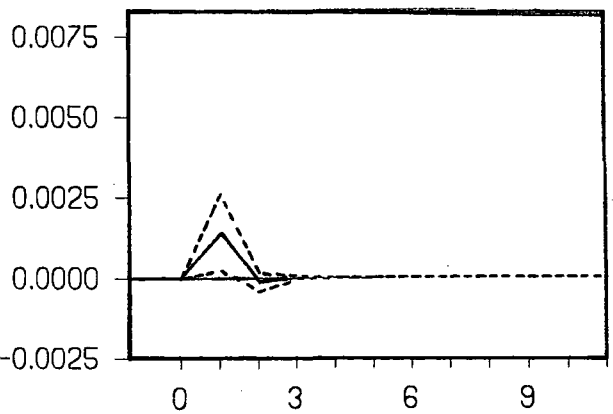
Response to a shock to Malaysia



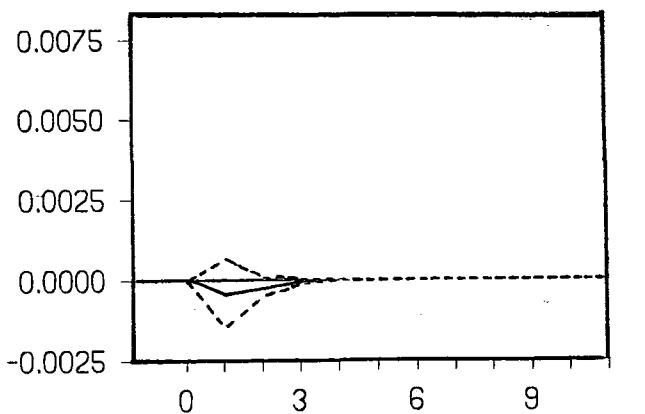
Response to a shock to Singapore



Response to a shock to Thailand



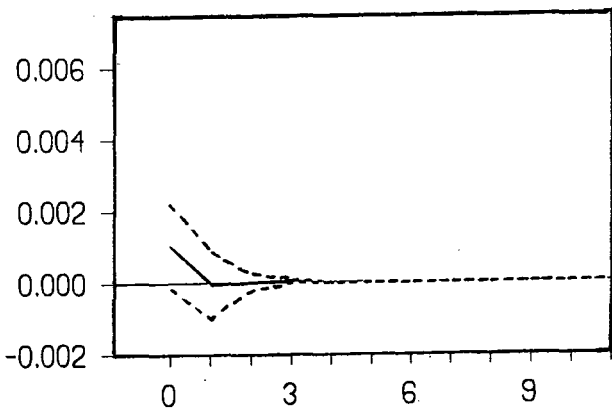
Response to a shock to Indonesia



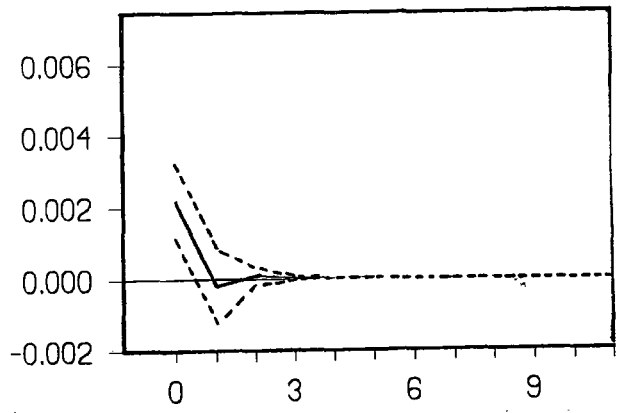
*Footnote as Figure 5.5

Figure 5.7 *Orthogonalised Response of HK to regional shocks (Oct 93 to Jul 96)*

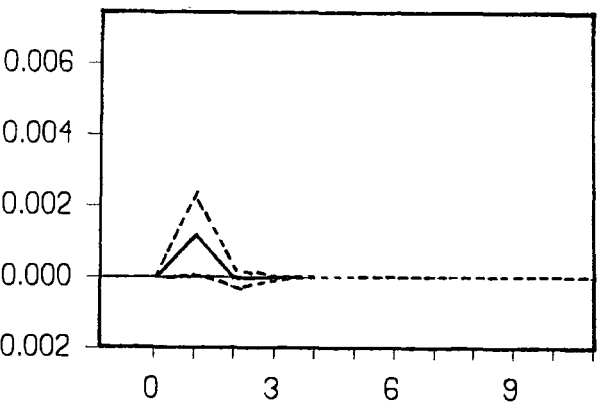
Response to a shock to South Korea



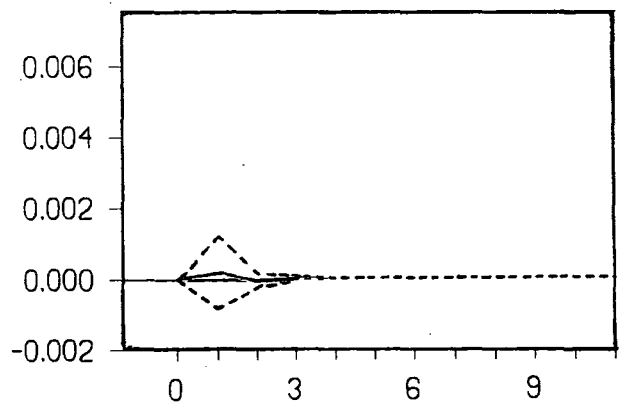
Response to a shock to Taiwan



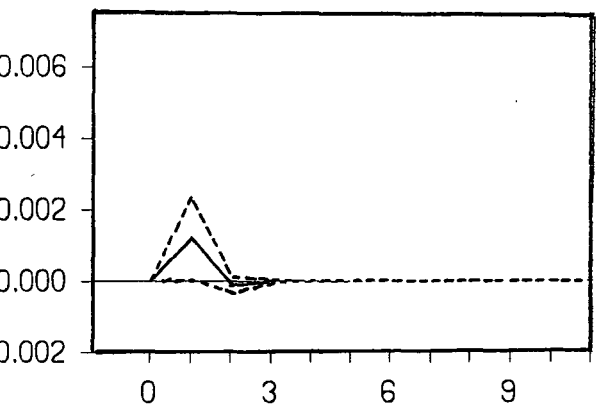
Response to a shock to Malaysia



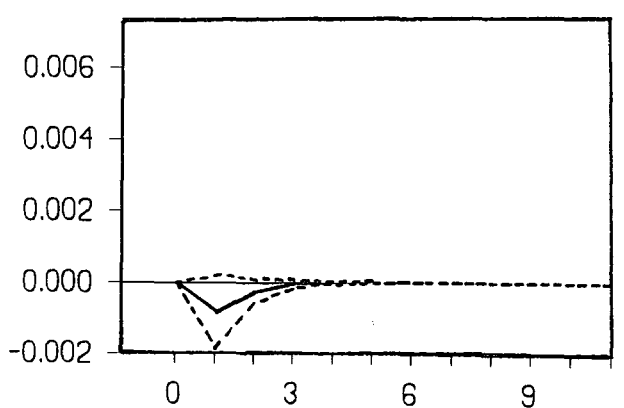
Response to a shock to Singapore



Response to a shock to Thailand



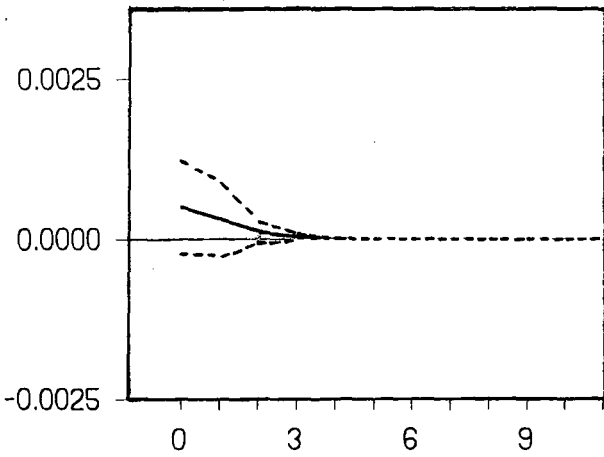
Response to a shock to Indonesia



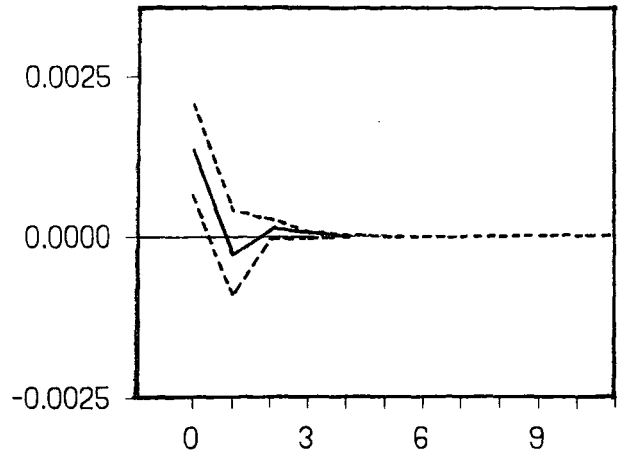
*Footnote as Figure 5.5

Figure 5.8 *Orthogonalised Response of Singapore to regional shocks (Oct 93 to Jul 96)*

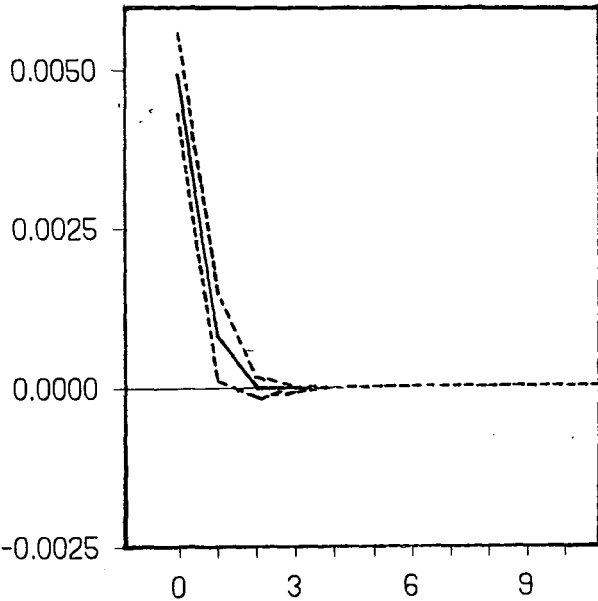
Response to a shock to South Korea



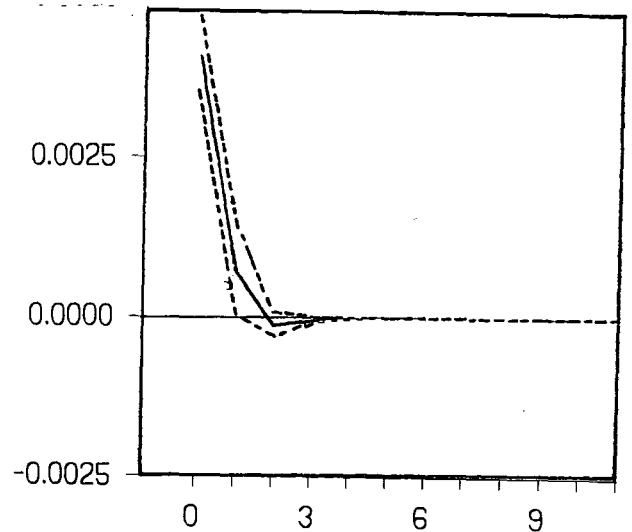
Response to a shock to Taiwan



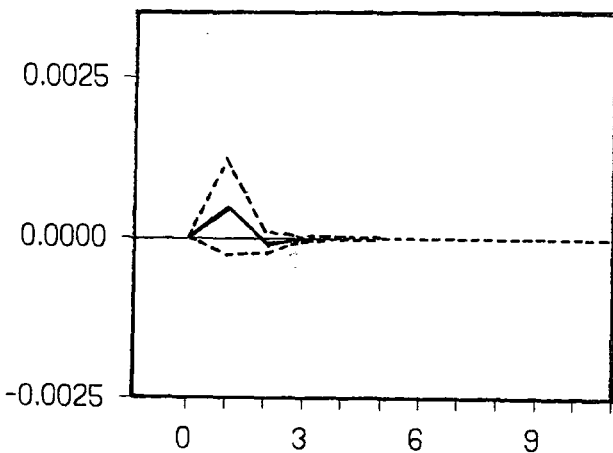
Response to a shock to Hong Kong



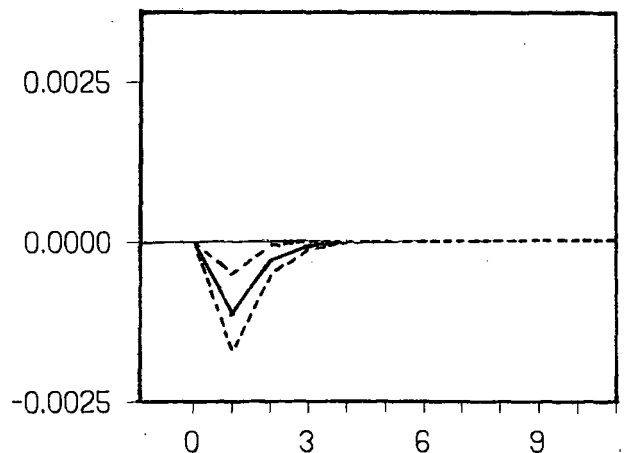
Response to a shock to Malaysia



Response to a shock to Thailand



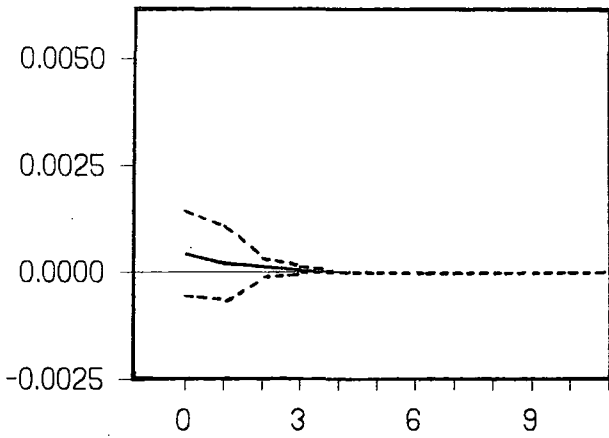
Response to a shock to Indonesia



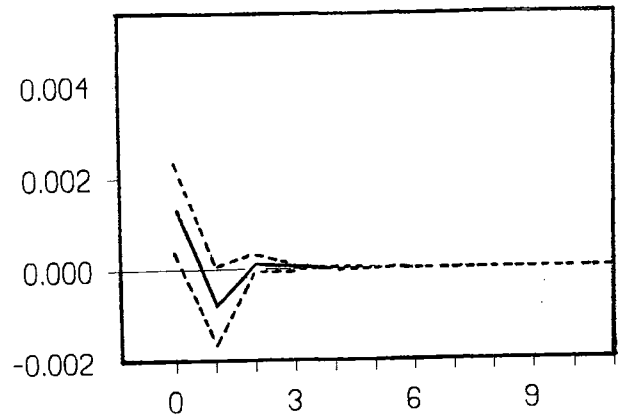
*Footnote as Figure 5.5

Figure 5.9 *Orthogonalised Response of Malaysia to regional shocks (Oct 93 to Jul 96)*

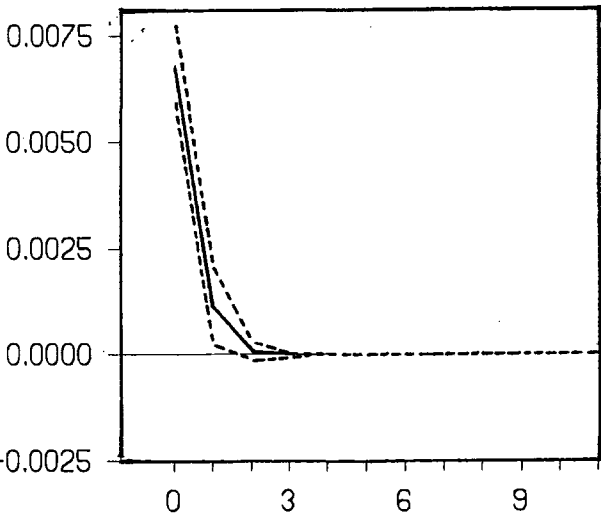
Response to a shock to South Korea



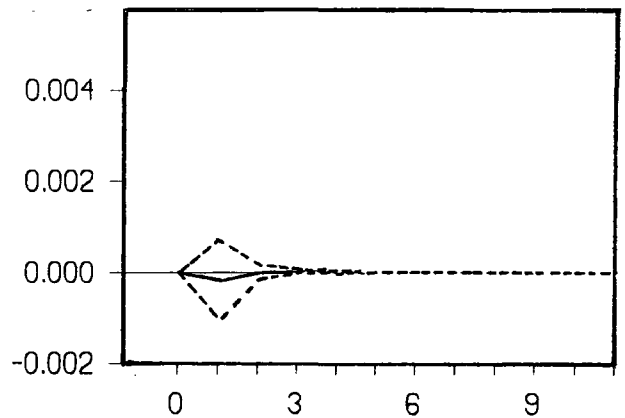
Response to a shock to Taiwan



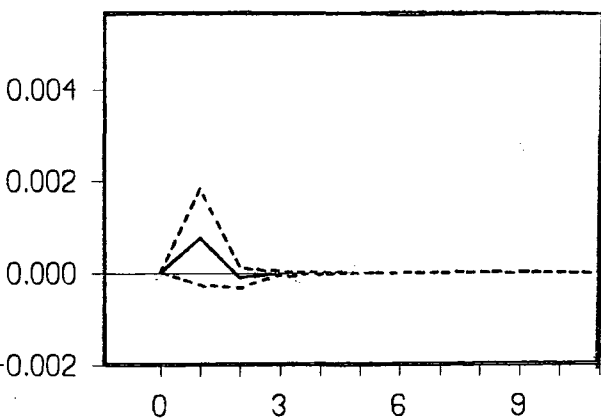
Response to a shock to Hong Kong



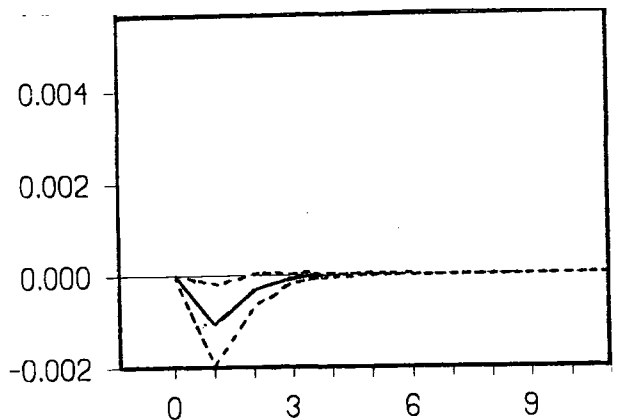
Response to a shock to Singapore



Response to a shock to Thailand



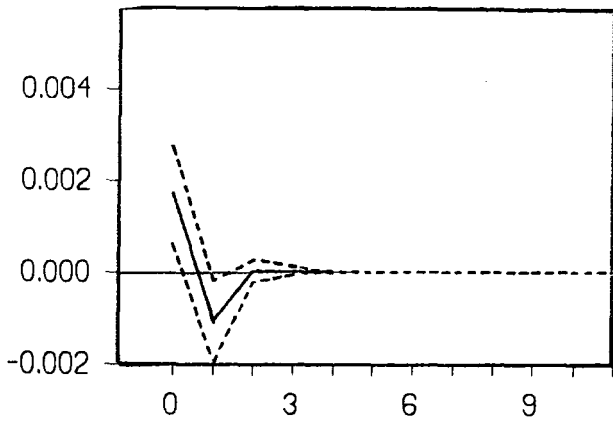
Response to a shock to Indonesia



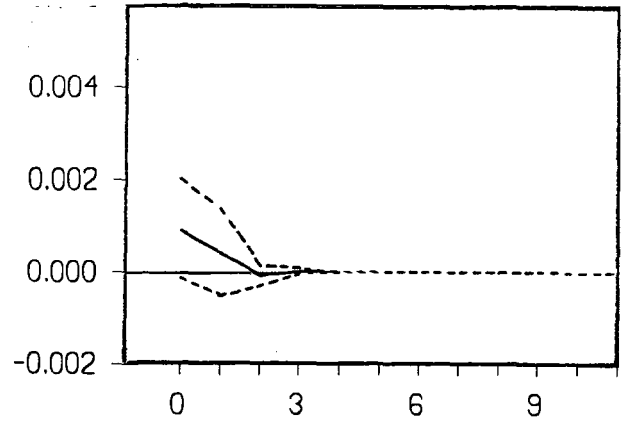
*Footnote as Figure 5.5

Figure 5.10 *Orthogonalised Response of Thailand to regional shocks (Oct 93 to Jul 96)*

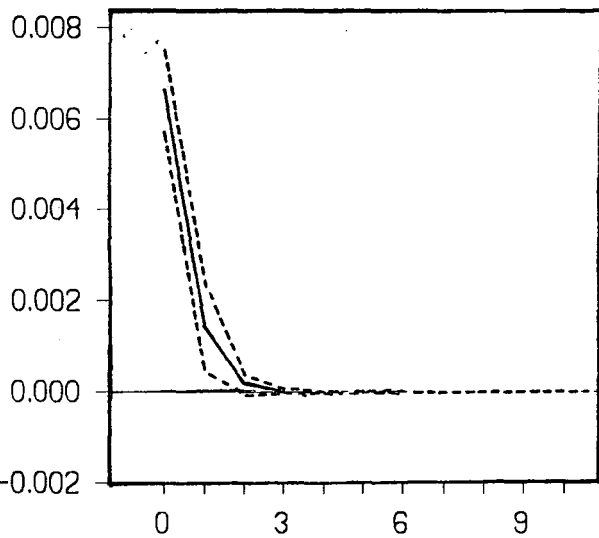
Response to a shock to South Korea



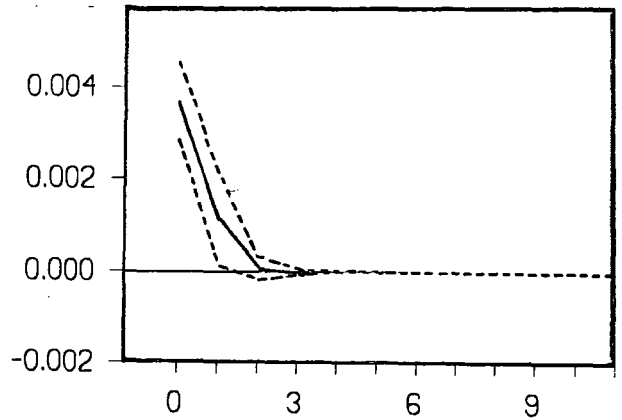
Response to a shock to Taiwan



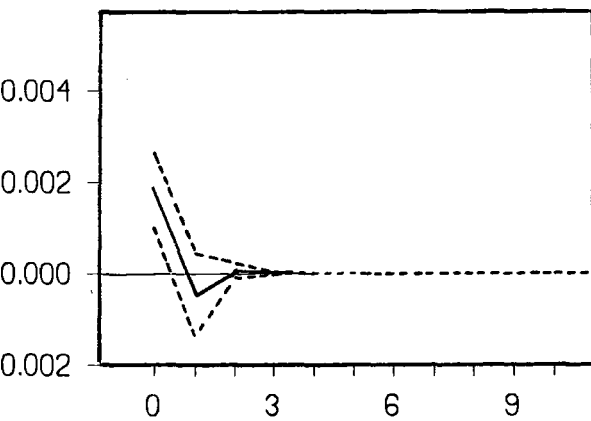
Response to a shock to Hong Kong



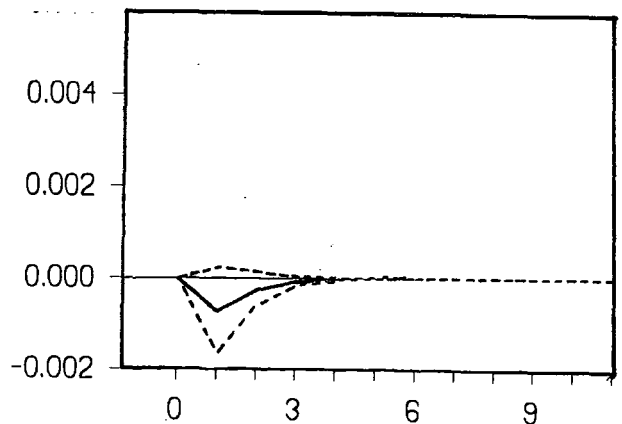
Response to a shock to Malaysia



Response to a shock to Singapore



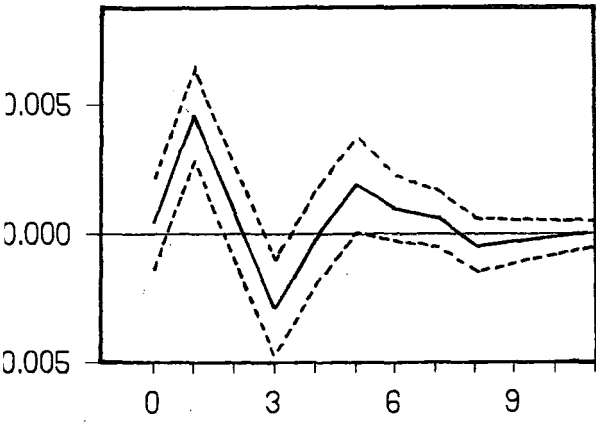
Response to a shock to Indonesia



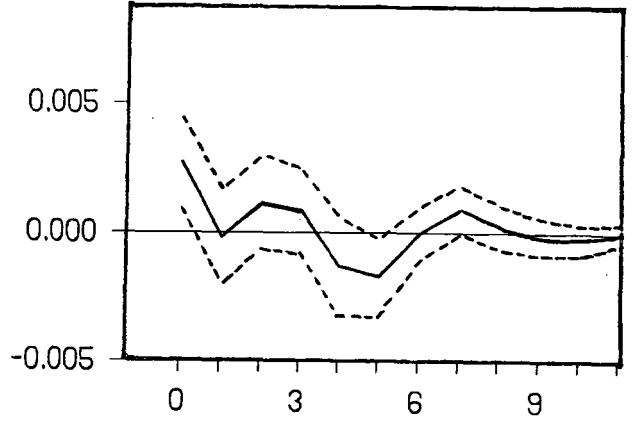
*Footnote as Figure 5.5

Figure 5.11 *Orthogonalised Response of Indonesia to regional shocks*
(Oct 93 to Jul 98)

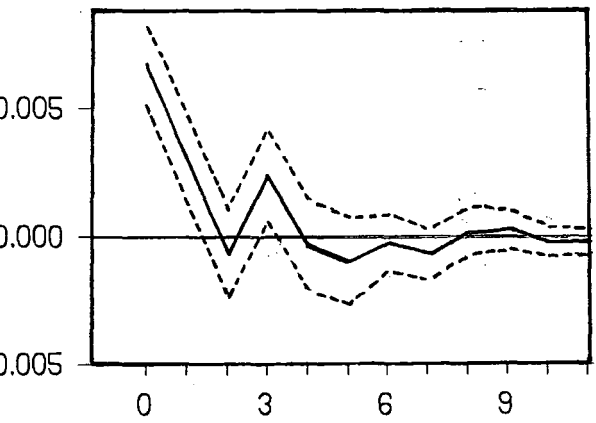
Response to a shock to South Korea



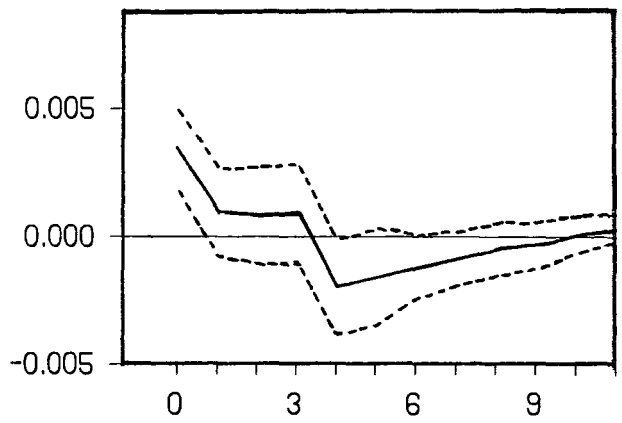
Response to a shock to Taiwan



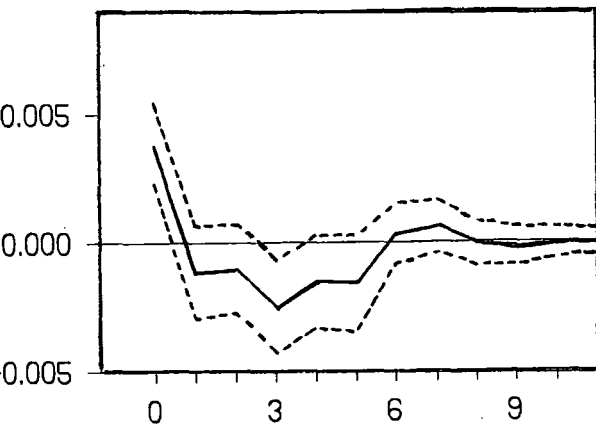
Response to a shock to Hong Kong



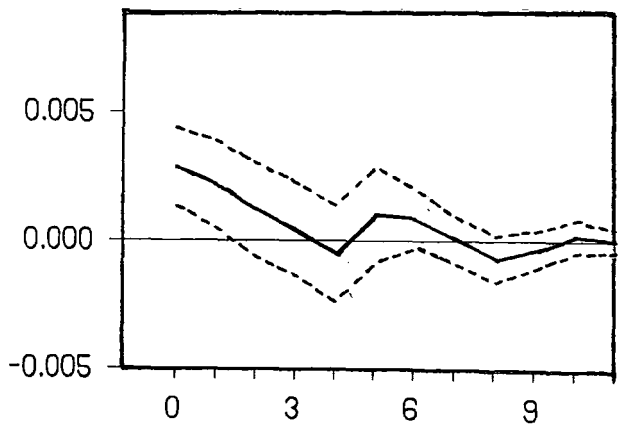
Response to a shock to Malaysia



Response to a shock to Singapore



Response to a shock to Thailand



*Footnote as Figure 5.5

Tigers on the latter two markets are noticeably bigger than on any other markets. Thus instead of being influential in the region, Thailand and Indonesia are in fact the most influenced by market movements in its neighbouring markets.

To sum up the main findings from the VDC and IRFs over the period of October 1993 to July 1996, there are no substantial regional effects on the market movements of the Four Tigers nor are the effects persistent. Adding to the results already found in Chapters Three and Four, a fuller picture of how the Four Tigers interact with the world and regional markets following their liberalisation has emerged. Among them, Hong Kong, South Korea and Taiwan seem to respond to world innovations more than to regional ones while the opposite is true for Singapore. Nevertheless, local market news or innovations are still the most important factors behind the movement of each market.

(B.3) Variance decomposition results over the recent crash period

Table 5.5 reports the VDC results for the seven Asian markets in the recent crash period over three different time horizons. As the point estimates beyond the 10-day horizon do not change at all, they are not reported in the table. There are two main observations from the results. First, regional markets appear to be more interactive during the crisis than in the first sample period. Returns variations in all seven markets are increasingly accounted for by shocks from other markets, regardless of whether they share the common risk problems faced by the troubled markets or not. There are differences though, in the extent of impacts the shocks have on individual markets.

Table 5.5 : Point estimates of variance decomposition (1.8.96-31.7.98)

Returns variation in	Days ahead	Forecast standard error	Explained by shocks from						
			Korea	Taiwan	HK	Malay	Sing	Thai	Indo
Korea	1	2.40	100	0	0	0	0	0	0
	5	2.53	92.66	1.60	1.30	0.27	1.72	1.15	1.32
	10	2.59	89.64	2.27	2.30	0.60	1.79	1.82	1.62
Taiwan	1	1.29	0.84	99.16	0	0	0	0	0
	5	1.39	3.54	86.65	5.68	2.22	0.64	0.16	1.10
	10	1.40	3.58	85.46	5.80	2.38	0.88	0.64	1.26
HK	1	2.06	0.94	5.60	93.46	0	0	0	0
	5	2.27	4.74	6.34	82.86	0.94	0.86	1.24	3.03
	10	2.31	5.20	6.43	80.91	1.06	1.06	1.37	3.96
Malay	1	2.02	3.61	3.84	11.33	81.21	0	0	0
	5	2.24	5.93	3.47	16.80	66.41	2.21	1.75	3.42
	10	2.28	6.22	4.63	16.99	64.43	2.59	1.72	3.41
Sing	1	1.47	0.20	5.21	31.86	3.66	59.07	0	0
	5	1.64	1.74	4.69	34.47	5.81	48.94	0.27	4.08
	10	1.66	1.84	5.20	33.97	6.24	48.07	0.60	4.08
Thai	1	2.09	2.85	1.97	5.68	1.64	4.52	83.33	0
	5	2.27	8.33	2.55	6.68	2.01	4.84	74.27	1.32
	10	2.30	8.27	3.09	7.19	2.09	5.45	72.42	1.48
Indo	1	1.91	1.01	1.95	12.43	2.48	3.31	1.93	77.89
	5	2.13	6.11	2.27	13.56	3.08	4.84	3.10	67.05
	10	2.21	6.27	4.07	13.46	4.07	5.37	3.28	63.48

(VAR₍₅₎ is used based on AIC)

Second, effects of the regional shocks on each market have intensified over time. The percentages of variances in each local market accounted for by regional shocks become larger from day 1 to day 10 after they arise. These observations have important implications on the major channels through which the crisis spread across the region.

(B.3.1) Increasing inter-dependence among the Asian markets during the crisis

The stronger interactions among the seven Asian markets during the financial crisis can be shown by the increasing importance of shocks from each Asian market in explaining returns variations of one another. For instance, before the crisis, shocks from South Korea and Taiwan hardly explained more than 1% of returns variations in other markets. During the crisis, they account for 3% to 8% of their variances over the 10-day horizon. For Hong Kong, shocks from the other six markets seldom explained more than 1% of its returns variation before the crisis. Now, their impacts could be as high as 5.8%. For Singapore, shocks from Hong Kong and Malaysia used to have a dominant influence on its market movements before the crisis. Now, the sources of influence are more diversified and include Taiwan, Indonesia and South Korea as well. Similarly in Malaysia, the dominant role of influence from Hong Kong, which used to account for 26% of its returns variations, has been eroded. Instead, shocks from all other six markets have a larger percentage impact on it during the crisis. They account for 18% of its forecast variances in aggregate while that for Hong Kong has dropped to 17%. Indonesia was the least influential market in the region before the crisis, with its shocks on the whole having a minute impact of 0.05% on the forecast variances of other markets. Now during the crisis, its impacts

have reached to as high as 1.5% to 4%. The only market which shows an overall reduction in the spill-over effects of regional shocks over the crisis period is Thailand. Before the crisis, regional shocks, most of which were from Hong Kong, account for about 35% of its forecast variances in aggregate over the 10-day horizon. Now during the crisis, they only account for 28% in aggregate.

Such a changing pattern of interaction among the seven markets over the recent financial crisis period has provided further insights into the forces that are at work during the crisis. In particular, there is little support for the argument that the Asian crisis is spread across the region simply through the common risk factors. Markets such as Taiwan and Singapore that do not have similar economic problems facing many troubled markets, such as Thailand, Indonesia and South Korea, have also experienced increasing spill-over effects from markets around the region. Moreover, the spill-over effects from the troubled markets could be far less than the effects from those markets without the common economic and financial problems. Again take Taiwan as an example, its shocks have stronger impacts on Hong Kong and Singapore than those from South Korea, Thailand and Indonesia. Thus the common risk factors argument is not sufficient in explaining the spread of the Asian crisis throughout the region.

(B.3.2) Intensifying spill-over effects from regional markets

The second major observation from Table 5.5, the intensification of regional spill-over effects to individual markets over time, can be illustrated by the decreasing influence of own market innovations in explaining returns variations. The percentages of

variances accounted for by own market innovations in all seven markets have dropped by 10% to 17% from day 1 to day 10. For instance, on day 1, own market innovations account for 100%, 99%, 93% and 59% of returns variations in South Korea, Taiwan, Hong Kong and Singapore respectively. By day 10, they have dropped to 89%, 85%, 80% and 48% respectively. Such a decrease is made up for by an intensification of influence from other regional shocks. For instance, in Korea no regional shocks have any impacts on its returns on day 1. Now over a 10-day horizon, shocks to all six regional markets each account for 1% to 2% of its returns variation. In Taiwan, less than 1% of its returns variation is explained by shocks to other regional markets on day 1. On day 10, however, the percentages have increased to as high as 5.8%. In Hong Kong, there are little or no spill-over effects from all regional markets except Taiwan on day 1, but on day 10, they explain 11% of its returns variations in aggregate. In Singapore, the impacts from Malaysia and Indonesia have doubled and quadrupled respectively over the 10-day horizon while the increase from other markets is much less.

The implication of such intensifying regional effects is that the spread of the crisis might be driven by market contagion and/or trade effects. As all the seven markets have substantial over-lapping trading hours, relevant information contained in the innovations from one market should be incorporated into prices immediately in another market. The fact that the same shocks could exert more influence on other markets as time passes indicates that there is a time-lag for the full effects of the regional shocks to be transmitted across the regional markets. This time-lag might suggest the existence of knock-on effects of the shocks on the markets' economies,

which could only be felt over a longer time horizon. Alternatively, such an intensification of regional effects over time could be caused by 'herd' effects. That is, there could be a tendency for markets to wait and see how others react to the shocks before responding to them. This situation may arise when there is uncertainty over the extent of effects that the shocks might have in affecting other parts of the world. The substantial over-lapping trading hours among the seven Asian markets may also suggest that the intensified regional effects on each market is related not only to the original shocks, but to the reactions on shocks from other markets as well.

(B.4) Impulse response functions over the recent crash period

The IRF results for the period surrounding the Asian crisis are very much in line with the VDC results. There are three major findings from Figures 5.12 to 5.18. First, Asian markets are more responsive to regional shocks during the crisis. Second, effects of regional shocks on each local market are more persistent. Third, some regional shocks are transmitted with time-lags. Taken together, these findings suggest that either market psychology and/or the fundamentals contagion effect might be at work in spreading the crisis across the region. A brief description of each market's response to regional shocks is given below.

South Korea (Figure 5.12)

Returns in South Korea are not responsive to shocks from Taiwan and Malaysia, as the two-standard deviation confidence band represented by the two broken lines includes zero from the first day of the shocks. Responses to the shocks from Hong

Kong, Singapore, Thailand and Indonesia appear to become significant only after the second, third or fifth day of the initial shock as the confidence bands do not include zero over these time horizons. Thus indicating that there is a time-lag for South Korea to respond to some of the regional shocks.

Taiwan (Figure 5.13)

Returns in Taiwan are not responsive to shocks from Singapore, Thailand nor Indonesia. Responses to shocks from South Korea, Hong Kong and Malaysia are significant. However, the peak effect of shocks from Malaysia is transmitted to Taiwan with a four-day lag while fresh responses to the shocks from South Korea and Hong Kong recur on the fourth and third day respectively after the effects die down on the second day.

Hong Kong (Figure 5.14)

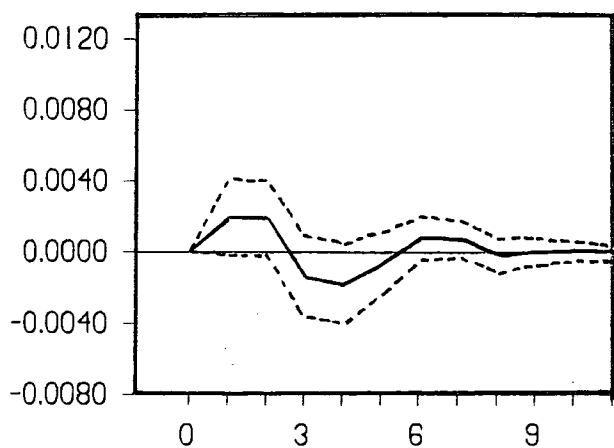
Returns in Hong Kong do not have a significant response to shocks from Malaysia, Singapore and Thailand. Responses to shocks from Taiwan, South Korea and Indonesia are sluggish. The peak effect of a Korean shock is felt on the first and fourth day while that of an Indonesian shock is felt on the second and fifth day. The effect of a shock from Taiwan also shows signs of recurring on the third day after decaying on the second day.

Singapore (Figure 5.15)

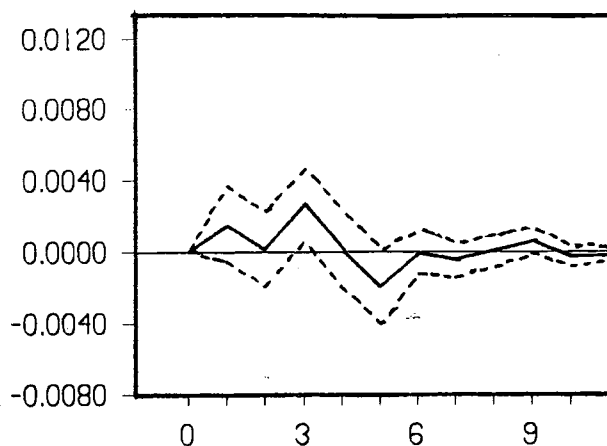
Returns in Singapore do not appear to have a significant response to shocks from Thailand. The response to shocks from Taiwan is efficient in that the shocks are

Figure 5.12 *Orthogonalised Response of S.Korea to regional shocks (Aug 96 to Jul 98)*

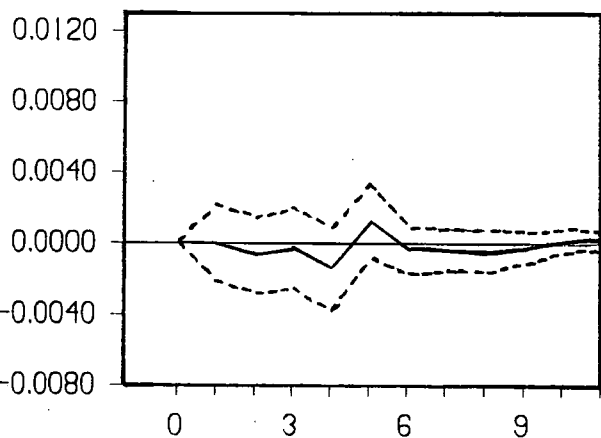
Response to a shock to Taiwan



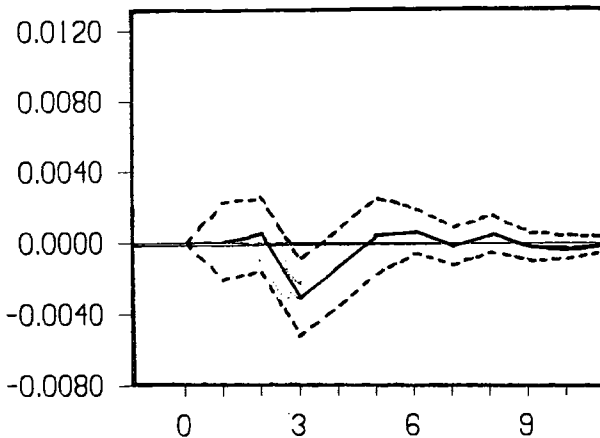
Response to a shock to Hong Kong



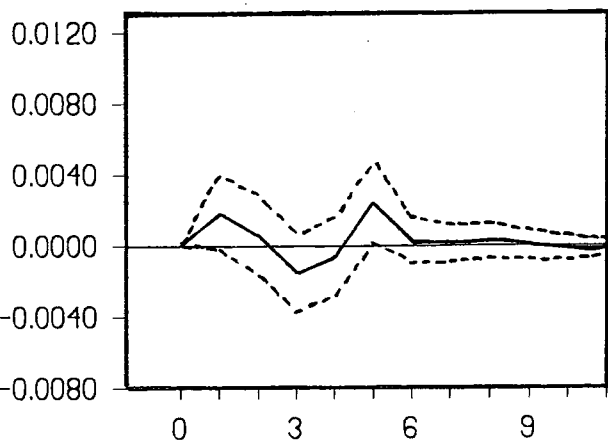
Response to a shock to Malaysia



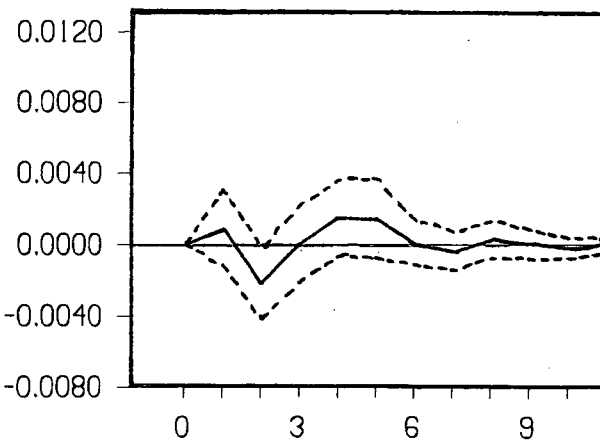
Response to a shock to Singapore



Response to a shock to Thailand



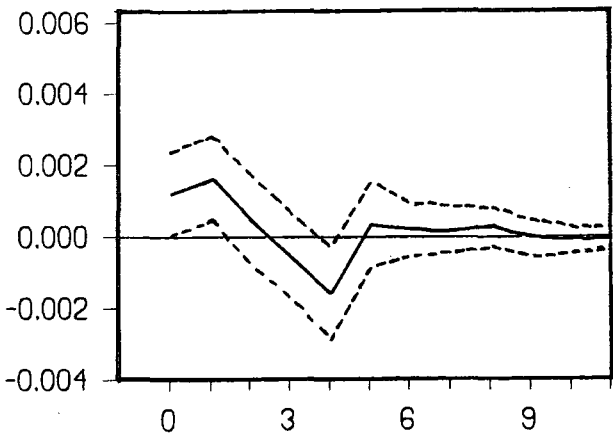
Response to a shock to Indonesia



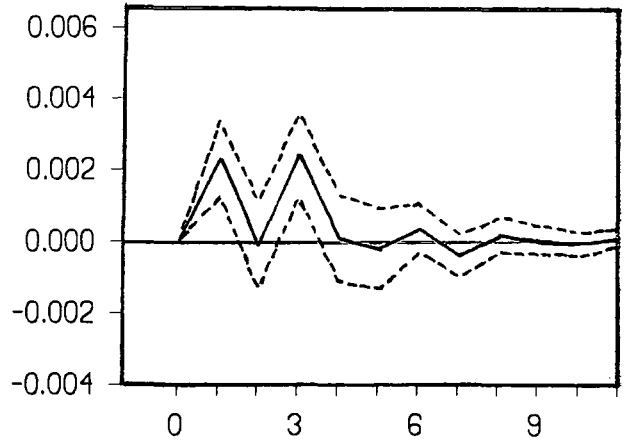
*Footnote as Figure 5.5

Figure 5.13 *Orthogonalised Response of Taiwan to regional shocks (Aug 96 to Jul 98)*

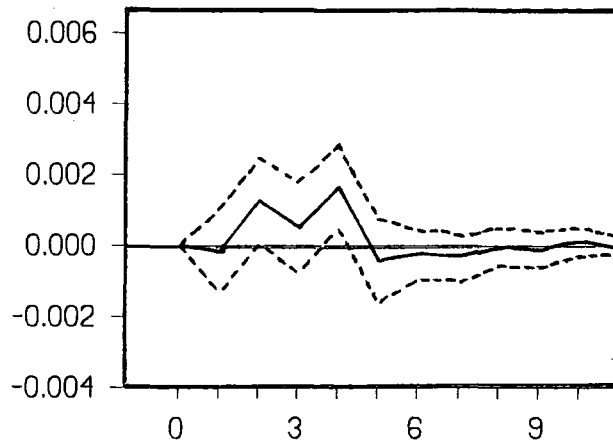
Response to a shock to South Korea



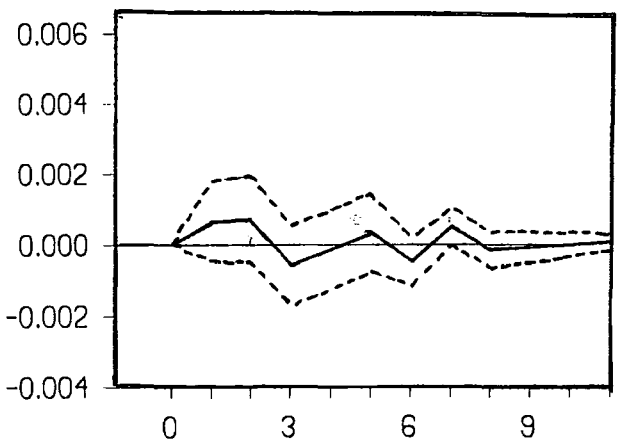
Response to a shock to Hong Kong



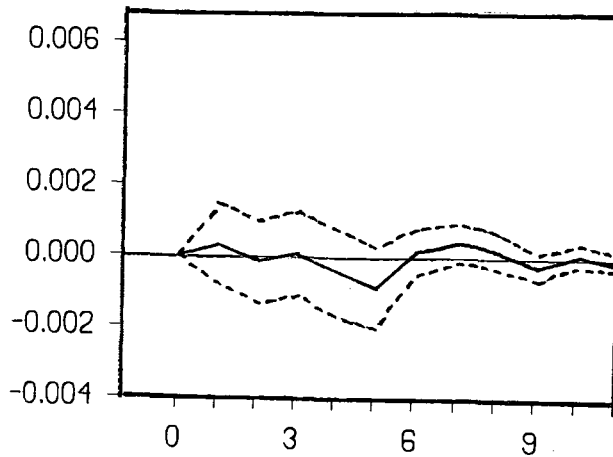
Response to a shock to Malaysia



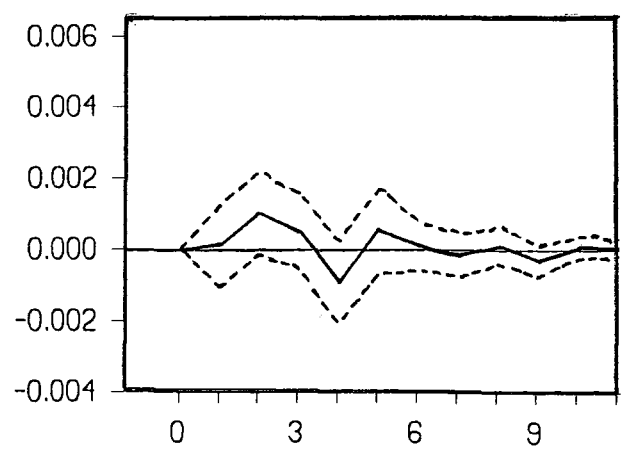
Response to a shock to Singapore



Response to a shock to Thailand



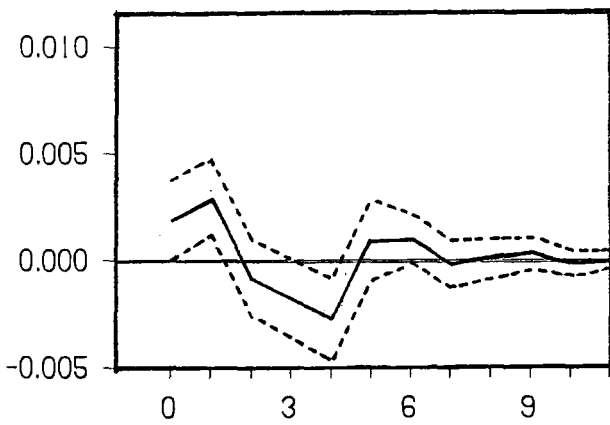
Response to a shock to Indonesia



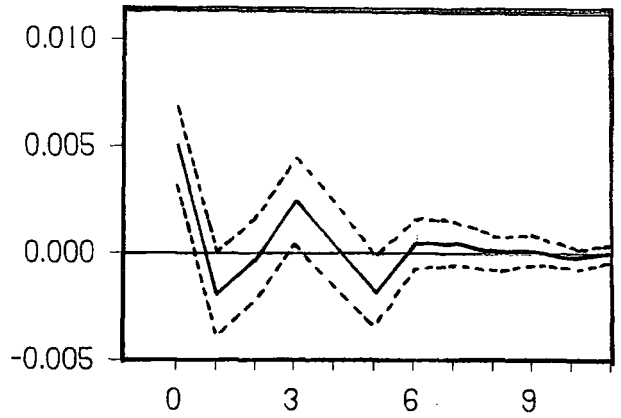
*Footnote as Figure 5.5

Figure 5.14 *Orthogonalised Response of HK to regional shocks (Aug 96 to Jul 98)*

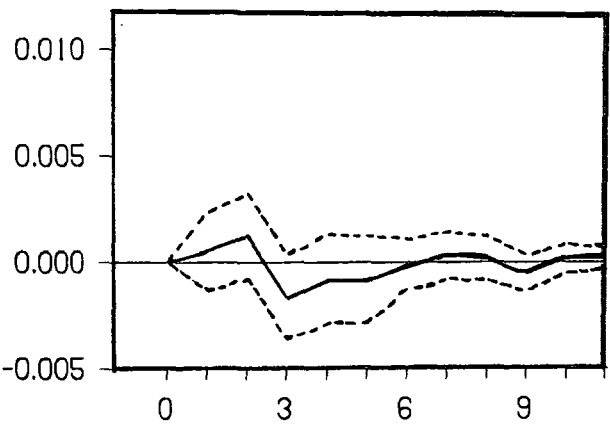
Response to a shock to South Korea



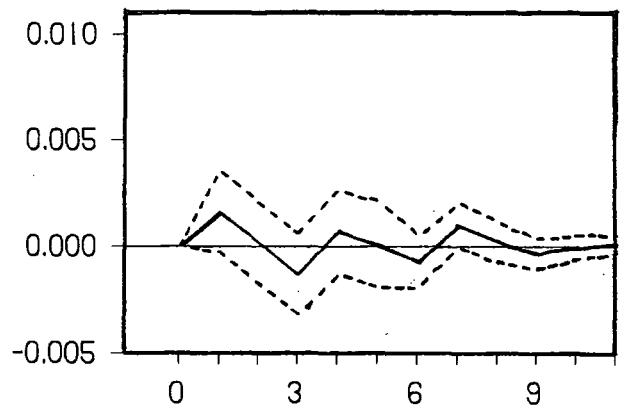
Response to a shock to Taiwan



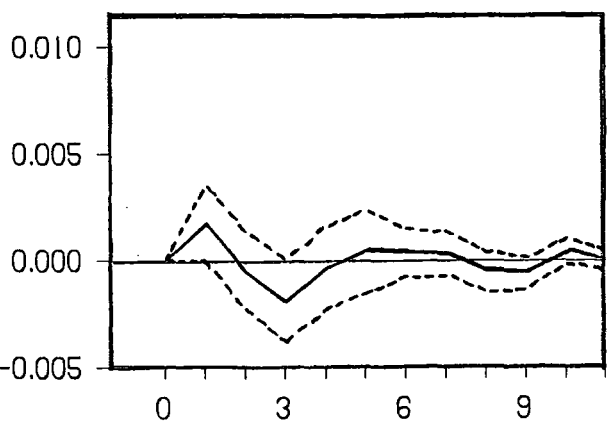
Response to a shock to Malaysia



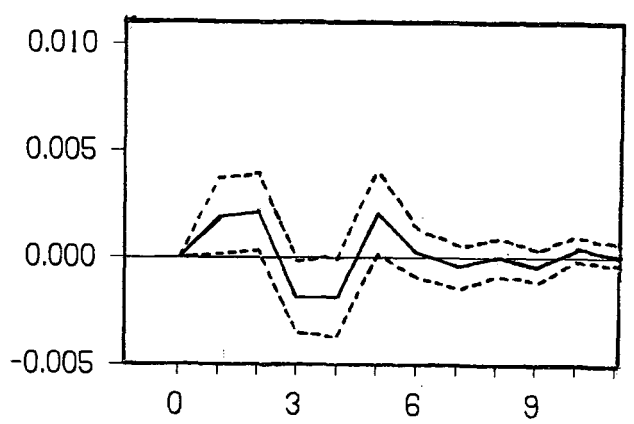
Response to a shock to Singapore



Response to a shock to Thailand

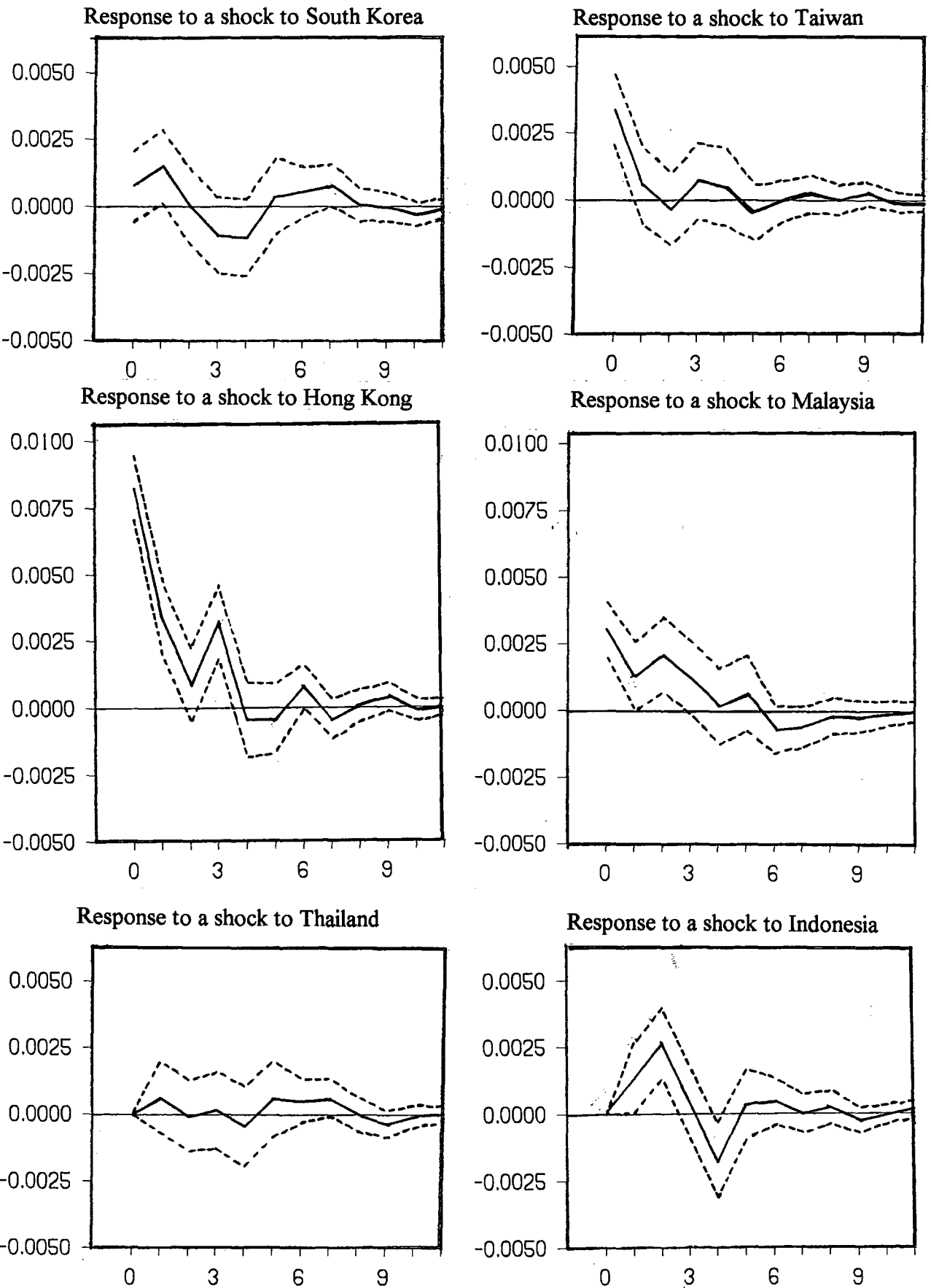


Response to a shock to Indonesia



*Footnote as Figure 5.5

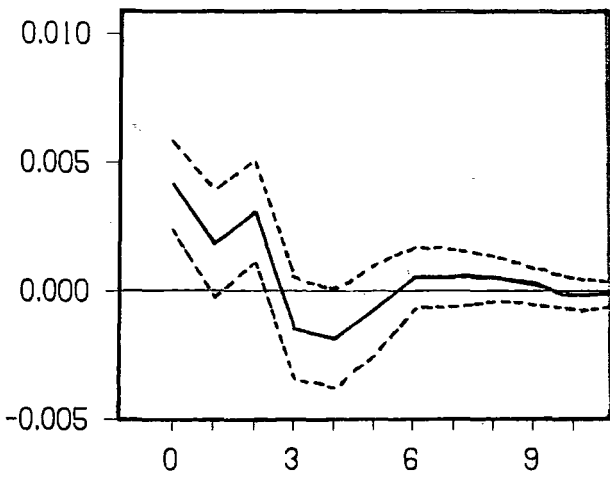
Figure 5.15 *Orthogonalised Response of Singapore to regional shocks*
(Aug 96 to Jul 98)



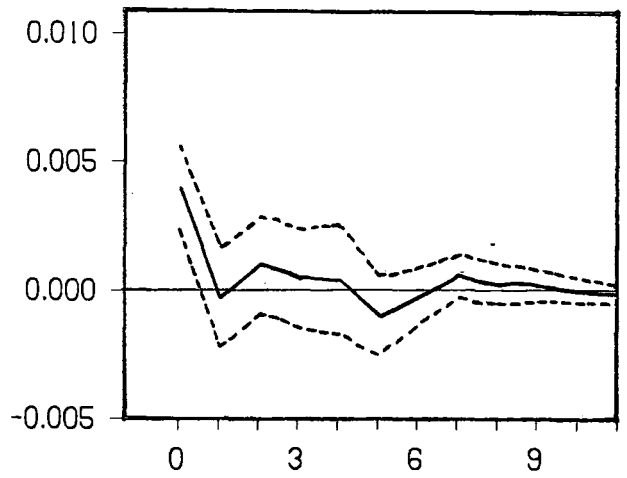
*Footnote as Figure 5.5

Figure 5.16 *Orthogonalised Response of Malaysia to regional shocks (Aug 96 to Jul 98)*

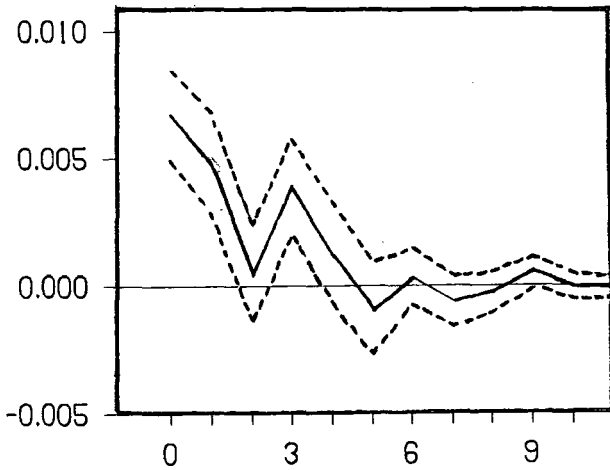
Response to a shock to South Korea



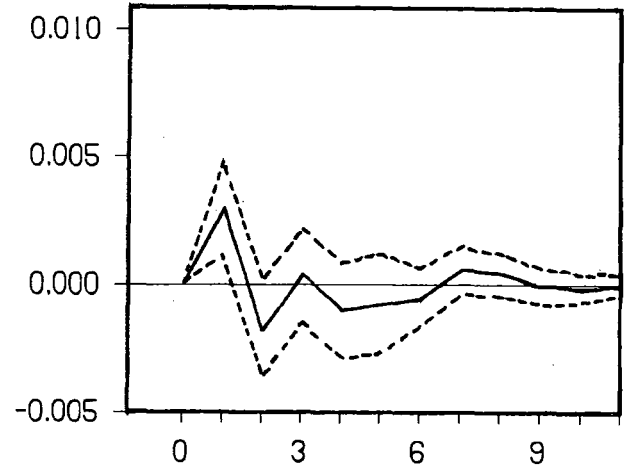
Response to a shock to Taiwan



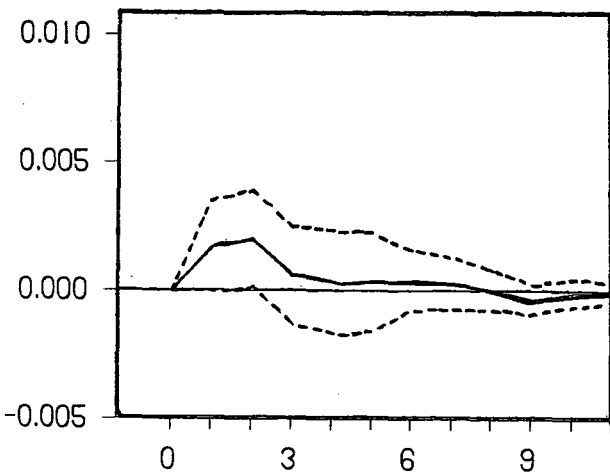
Response to a shock to Hong Kong



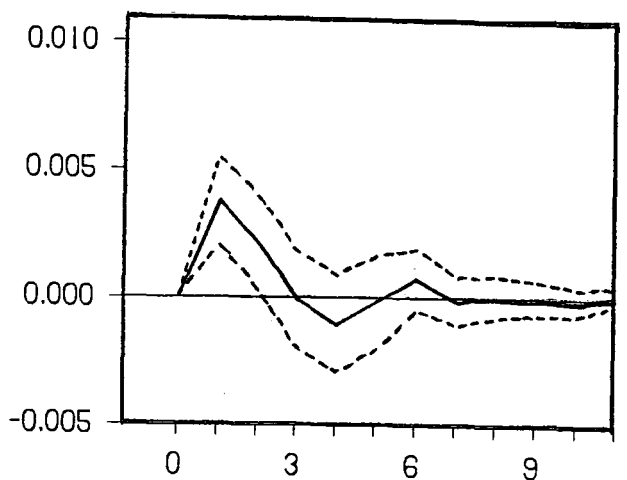
Response to a shock to Singapore



Response to a shock to Thailand



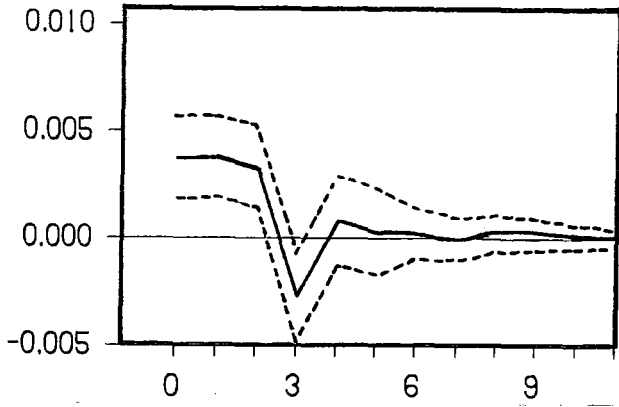
Response to a shock to Indonesia



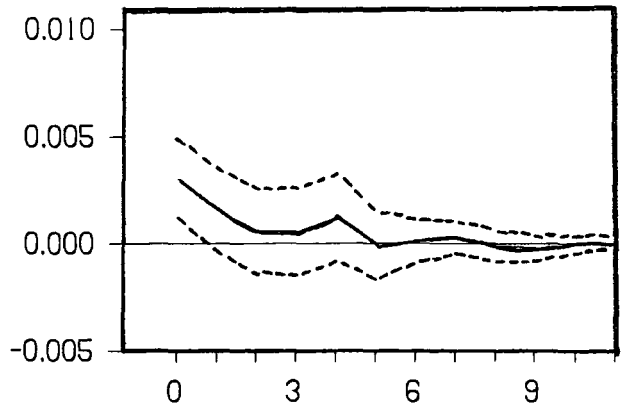
*Footnote as Figure 5.5

Figure 5.17 *Orthogonalised Response of Thailand to regional shocks (Aug 96 to Jul 98)*

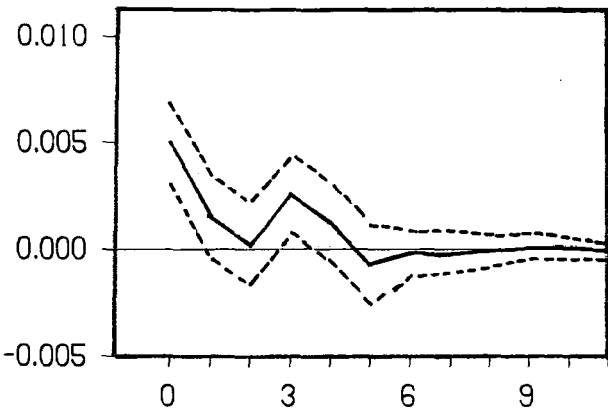
Response to a shock to South Korea



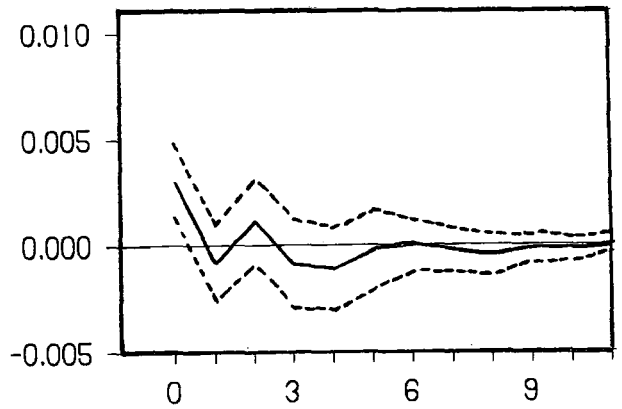
Response to a shock to Taiwan



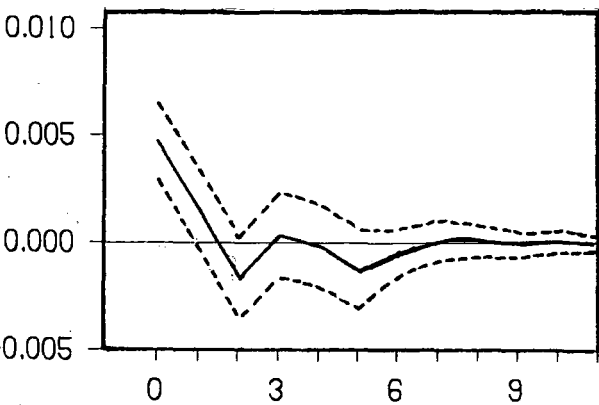
Response to a shock to Hong Kong



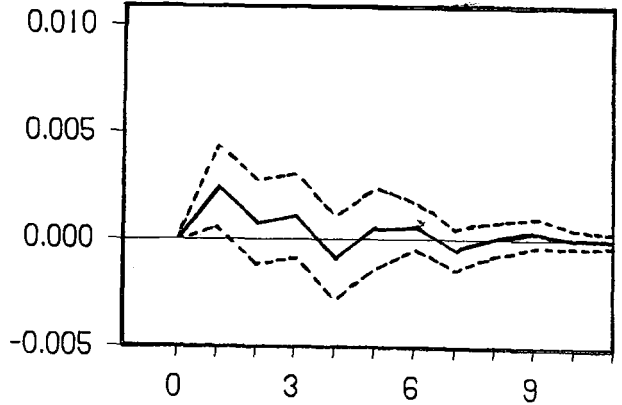
Response to a shock to Malaysia



Response to a shock to Singapore



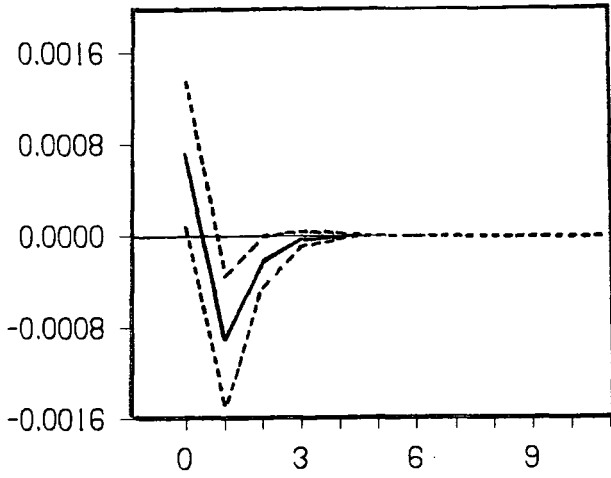
Response to a shock to Indonesia



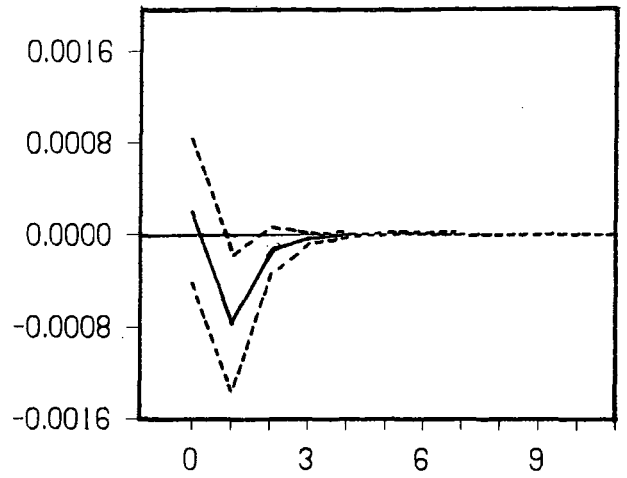
*Footnote as Figure 5.5

Figure 5.18 *Orthogonalised Response of Indonesia to regional shocks (Aug 96 to Jul 98)*

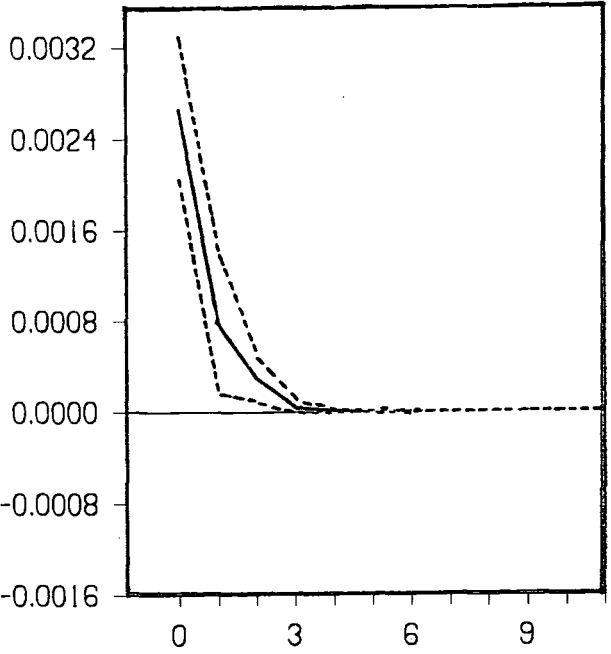
Response to a shock to South Korea



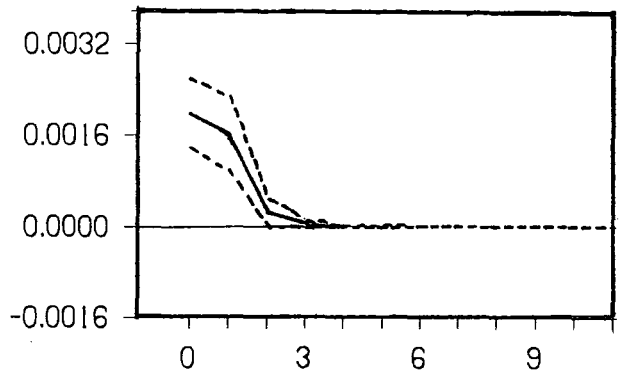
Response to a shock to Taiwan



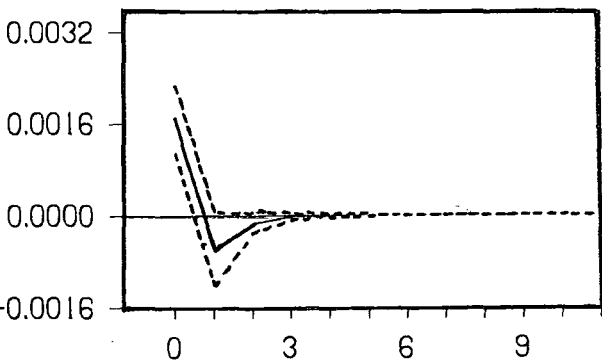
Response to a shock to Hong Kong



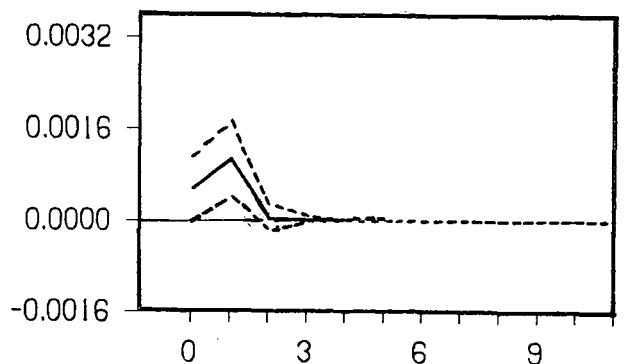
Response to a shock to Malaysia



Response to a shock to Singapore



Response to a shock to Thailand



*Footnote as Figure 5.5

transmitted to Singapore on the same day. Transmission of shocks from Hong Kong, Malaysia and Indonesia lasts for three, two and four days respectively before the responses finally become insignificant. The peak effects of the shocks from Taiwan, Hong Kong and Malaysia are felt on the same day, but on the first and second day respectively for shocks from South Korea and Indonesia.

Malaysia (Figure 5.16)

Returns in Malaysia are responsive to shocks from all over the region albeit with a varying degree. The response to a Thailand shock is marginally significant while the response to a Hong Kong shock is the strongest. As regards the length of time taken for regional shocks to be transmitted to Malaysia, only a shock from Taiwan is transmitted within the same day. Shocks from Singapore and Indonesia are transmitted with a one-day lag, whilst the transmission of shocks from South Korea, Hong Kong and Thailand takes two to four days before the responses become completely insignificant.

Thailand (Figure 5.17)

Similar to Malaysia, returns to Thailand are responsive to all regional shocks. Shocks from Taiwan, Singapore and Malaysia are transmitted within the same day, while the shock from Indonesia is transmitted with a one-day lag. Responses to shocks from South Korea and Hong Kong are more sluggish, for it takes them on and off for three days to be transmitted to Thailand.

Indonesia (Figure 5.18)

Returns of Indonesia are responsive to all regional shocks, particularly to shocks from Hong Kong followed by Malaysia and Singapore. The peak effects of the shocks are transmitted on the same day for shocks from Hong Kong, Singapore and Malaysia, but with a one-day lag for shocks from South Korea, Taiwan and Thailand. The effects of shocks from Hong Kong and Malaysia are more persistent and last for three to four days while others last for two days.

To sum up, there are three special features of the findings from Figures 5.12 to 5.18. First is that all seven markets are now more responsive to shocks from around the region than they were before the crisis. Second, the impacts of regional shocks are becoming more persistent during the crisis than before. Recalling the IRF results from Figures 5.5 to 5.11, the transmission of regional shocks normally takes place within one day. Now during the crisis period, the impacts of some shocks could last for up to 5 days. Third, there are time-lags for markets to respond to regional shocks even when the markets involved are located in the same international time zone. There is also evidence of a rising response to shocks a few days after it falls or becoming insignificant in some markets. All these suggest that either the pure market contagion effect and/or the fundamentals contagion effect through the presence of substantial trade relations is at work during the crisis. The pure contagion effect could manifest itself in the form of herd effects, whereby Asian markets react not only to a shock itself, but to other markets' reaction to the same shock as well, particularly the western markets. Since they open after the Asian markets are closed, their responses to the Asian shocks will only be known to the Asian markets with a one-day lag.

Taking directions from these western responses, which may either help aggravate or alleviate the situation, there could be a need for the Asian markets to adjust their response to the original shock. That could be why impacts of the regional shocks have become more persistent and the peak effects of some shocks are transmitted with time-lags. Alternatively, the persistence of some regional shocks and the sluggish response by some markets could be attributed to the fundamentals contagion effect. Due to the presence of substantial trade relations among the seven markets, the fall of one or more markets could trigger a wave of knock-on effects on the economies of their trading partners, which then feed through to their stock markets as well. Such a process of an indirect transmission of market shocks to other regional markets might take longer to complete as regional markets need more time to digest the innovations and assess their implications on their economies. This could result in the increasing persistence of regional shocks and a hesitant response to the shocks during the crisis.

(VI) Conclusion

The inter-relationships between the Four Tigers and three emerging markets in Asia are investigated using the VAR methodology over two sample periods representing the time before and during the recent Asian financial crisis. Results from the variance decompositions and impulse response functions derived from the VAR model suggest that there is no strong interaction between the seven markets before the crisis. Returns variations in Hong Kong, South Korea and Taiwan are mostly explained by their own innovations. Innovations from the three emerging markets namely Thailand, Malaysia and Indonesia have just negligible impacts on them. Only Singapore is found to be more responsive to innovations from both Hong Kong and

Malaysia. This has been attributed to the fact that Singapore has more exposure to these two markets than to others. During the Asian financial crisis period, interactions between the seven markets become much stronger. Every market is becoming more responsive to innovations from around the region, regardless of whether they share the same economic and financial problems facing the troubled markets such as South Korea and Thailand. There is also strong evidence of intensifying effects of the same regional shocks on each market over time during the crisis period. This suggests that the regional shocks have more persistent effects than those before the crisis and the regional markets are less efficient in incorporating such information into prices. Findings from the impulse response functions for the seven markets show a similar picture of persistent shocks and sluggish response. All these indicate that the Asian financial crisis is not spread through common risk factors, nor should the flight of foreign capital be blamed as the major cause of the crisis. Instead, a combination of a pure contagion effect and a fundamentals contagion effect could be at work during the crisis that has caused a wide-spread downfall of the Asian stock markets. It might not take long for the pure contagion effect to diminish once investors realise that their panic reaction to other markets' reaction is not justified by economic fundamentals. However, full recovery of the Asian markets to their pre-crisis levels is still remote as most Asian economies have dramatically slowed down or even slipped into recession. Thus international investors wishing to return to Asia now might need to be thinking of long term investment instead of profit taking in the short-term.

Chapter Six : Conclusion

The last ten years have seen a remarkable rise and fall of Asian economies as well as the growth and slump of their stock markets. It provides a good opportunity to examine how price and volatility behaviour of the Asian markets and their relationships with other world markets might have changed over time. There are two major events in particular that could have special implications to their market behaviour in the past ten years. One is liberalising their markets to allow or encourage foreign direct participation and the other is the outbreak of the Asian financial crisis. The investigation of market behaviour of four Asian countries as well as their inter-relationships with other major world markets and regional markets thus revolves around these two events. It has been the fear of some Asian governments that opening up of their markets for foreign investment would risk being led by major markets. This in turn might cause market instability as the chances of price and volatility spill-over from them become higher. An empirical investigation into the changing volatility behaviour of individual markets as well as their inter-relationships with other world markets following liberalisation could help provide evidence to support or refute this argument. Meanwhile, international investors would also be able to assess whether there exist the benefits of risk diversification by investing into Asian markets if they are found to be increasingly integrated with other world markets.

The Four Tigers in Asia, namely Hong Kong, Singapore, South Korea and Taiwan, are the markets whose price and volatility behaviour are the major interests of this thesis. Hong Kong is the most open market of all, while Singapore is one of the least restricted markets in Asia, although real opportunities for foreign participation might be lacking. South Korea and Taiwan are newly opened markets and still have tight restrictions in place on foreign direct participation. Apart from their varying degrees of market openness, they also have different economic structures. Hong Kong's economy is based on the service and financial sectors; Singapore relies on manufacturing and service sectors, whilst South Korea and Taiwan emphasise manufacturing industries. Nonetheless, all four of them have experienced substantial economic growth in the late 1980s and early 1990s. The surge of foreign equity capital from international investors seeking higher investment returns has also led to substantial growth in their stock markets. An examination of these four markets could thus provide further insights into the possible effects that differing degrees of market openness and different economic structures might have in affecting their market relationships with others.

The overall finding of the thesis is that the nature and structure of volatility in individual markets have changed over the past ten years with the increase in foreign participation. Volatility is more a reflection of rapid impounding of information into prices through better informed trading rather than noise trading activities as before. However, their relationships with three world major markets, the US, the UK and Japan, are not getting much stronger. There is no evidence to suggest that their prices are being increasingly led by the world markets, nor is their volatility becoming

more sensitive to foreign news. The presence of cross-market stock investment is thus argued as not being a necessary pre-condition for price and volatility spill-over to the four Asian Tigers. Instead, such spill-over effects are more determined by their differing policies towards intervening in the stock markets and the level of trading links they have with the world markets. Their price and volatility relationships with three regional markets, Thailand, Malaysia and Indonesia, are not particularly strong either, until recently when the Asian financial crisis has made them more responsive to shocks from one another. This has been attributed to the presence of market contagion, both pure contagion and fundamentals contagion, that is at work during the crisis which help spread the crisis across the region. A brief summary of the findings from each Chapter is given below.

After giving an account of the economic and financial developments in the Four Tigers in Chapter One, Chapter Two looks at the changing nature and structure of volatility in each individual market. The unpredictable daily returns series of the four markets are each fitted into an asymmetric GARCH model along the lines advanced by Glosten, Jagannathan and Runkle (1989) to capture the possible asymmetric response of volatility to negative news. The presence of negative news asymmetries has been argued as an indication of a noise trading effect rather than the leverage effect. Results show that there are indeed negative news asymmetries in the four markets and such asymmetries have reduced following their liberalisation. This is interpreted as an indication of a reduction in the impact of noise trading activities, with an increasing participation of foreign investors that helps improve the impact of informed trading within these markets. Thus volatility in the four individual markets

following their liberalisation should not be seen as detrimental, since it is now more related to the impounding of information into prices rather than noise trading activities.

In Chapter Three, the price relationships between the Four Tigers and three major world markets, the US, the UK and Japan, are examined. The focus is on whether a closer international price relationship has also been enhanced through an increasing participation of foreign investors in the four markets. Weekly price series of the seven markets are fitted into a Johansen cointegration framework over the pre- and post-liberalisation periods to mitigate the problem of overlapping trading hours of the Four Tigers. No cointegrating relationship exists during the first period while one is found during the second period. Nevertheless, only Hong Kong, Taiwan and the UK are found to enter significantly into this cointegrating relationship following their liberalisation. Their prices adjust to the price discrepancies from one another too in the short-run to maintain such a long-run relationship. The lack of significant cointegration of South Korea and Singapore with any of the major markets is attributed to their governments' influence over the movements of their stock markets and/or the limited actual investment opportunities available to foreign investors. The lack of a significant long-run relationship between Japan and the US to any of the Four Tigers, on the other hand, is attributed to their low level of actual participation in these markets as well as their changing economic conditions at home. Thus only the UK is found to be more related to Hong Kong and Taiwan following their liberalisation.

The lack of a significant long-run relationship between some of the seven markets does not preclude the possibility that they might be related to each other in the short-run. Therefore in Chapter Four, the issue of whether foreign news impacts on the volatility of the Four Tigers in the short-run is investigated. The unpredictable daily returns series of the four markets are each fitted into a GJR type GARCH model with lagged news from each of the three major markets included one at a time. Apart from finding whether the Four Tigers and the three major world markets are inter-related through volatility spill-over, another purpose of the investigation is to establish the channels through which the spill-over effects are transmitted. Results indicate the presence of volatility spill-over from the three major world markets to the Four Tigers even before South Korea and Taiwan were opened to foreign direct participation. Meanwhile, market liberalisation in Hong Kong and Singapore does not seem to have intensified the spill-over effects from the overseas markets. This is suggestive that the presence of cross-market direct investment is not the key mechanism for volatility transmission. Instead, foreign news could impact on their stock markets indirectly through trading links. However, the exact way in which foreign negative and positive news impacts on the local markets depends much on the nature of the economic ties they have with the foreign countries. The actual size of the impacts on each local market does vary according to the different levels of foreign direct participation in the local markets. Thus the forces behind cross-market volatility transmission are manifold and inter-related themselves.

With the outbreak of the Asian financial crisis in July 1997, an investigation into the regional market inter-relationships in Chapter Five is in part related to this extra-

ordinary event. The way the Four Tigers interact with three regional emerging markets, namely Thailand, Malaysia and Indonesia, is examined from a different perspective. Instead of looking at the impact of foreign news on local market volatility, the intensity and persistence of regional shocks in explaining returns variations in the Four Tigers are addressed. Daily returns from the seven markets are fitted into a seven dimensional vector autoregression model over two sample periods before and during the Asian crisis. Variance decomposition and impulse response functions are derived from the VAR model on which the interpretations of regional market inter-relationships are based. Results for the period before the crisis suggest that there is little interaction between the Four Tigers and the three regional emerging markets except for Singapore which is found to be responsive to shocks from both Hong Kong and Malaysia. The effects of regional shocks are not found to be persistent either. However all these have changed during the crisis. There are stronger interactions among regional markets. Effects of regional shocks on each individual market, regardless of whether they share the common economic problems facing all troubled markets or not, have all intensified over a long horizon. Responses to the shocks, however, are slow and uncertain. It is thus argued that market contagion is at work to spread the crisis across the region during this period. Without such an extraordinary event, the Four Tigers are not found to be more closely inter-related with the regional markets than with the world's major stock markets even after opening their markets to foreign participation.

The implication of the findings from this thesis on the Asian governments' policies towards their stock markets is clear. Increased foreign direct participation in their

markets should not be seen as detrimental to their stability. Activities of foreign investors have not made their markets more volatile nor more reliant on the lead of foreign markets. Just the opposite, they have helped bring better informed trading to their markets. Their investment in high communication technology not only enhances international information flow but also facilitates them to adjust their global investment strategies efficiently. Thus, in a way, their presence has helped reduce the impact of noise trading activities in the Asian developing markets. The spill-over of volatility from foreign markets could happen with or without foreign direct participation in the stock markets. The economic ties they have with overseas countries are able to help transmit foreign market volatility to their local markets indirectly through the knock-on effects to their economies. In the end, the major source of their market volatility comes not from overseas markets but from within the local markets. Hence the Asian governments should continue opening their markets to tap the pool of international investment capital. Meanwhile, they should concentrate on the efficient use of acquired resources on profitable investments and ensure a sound management of their macroeconomics so as to attract further investments from international investors. Returning to the old path of a closed-door policy by shutting off foreign investors could help little to improve their stock market developments now or in the future.

The findings of this thesis have pointed at least three ways in which future research on the stock markets of the Four Tigers and/or other emerging stock market could be undertaken. First, the changing nature of volatility in individual Asian markets following their liberalisation suggests that emerging stock markets in other parts of

the world, such as the Middle East, South America and Eastern Europe, may also experience similar changes. If this was true, it would support the argument that stock market liberalisation is beneficial rather than detrimental to the operation of the markets concerned. Second, as volatility of stock prices in the stock exchanges of the Four Tigers was found to respond to both local and foreign innovations, it would be useful if such volatility could be predicted. In the past few years, a number of studies examining the predictability of volatility in the capital markets were made. These include Fleming et. al. (1995), Jorion (1995) and Franses and van Dijk (1996), to name a few. An investigation into the predictability of stock price volatility in the Four Tigers could help provide more insights for the local governments to determine whether there is any need to regulate the activities of both local and foreign investors. Last but not least, with the gradual recovery of the stock markets in Asia from the beginning of 1999, it would be interesting to investigate the factors contributing to their recovery. While some countries, such as South Korea and Thailand, continued to ease their restrictions on foreign investment in their stock markets during the Asian financial crisis, other countries, such as Malaysia, Taiwan and Hong Kong, tightened their restrictions and even intervened in their markets. It thus provides us with an opportunity to assess the effectiveness of these two differing government policies in affecting the recovery of their stock markets. This could also help the local Asian governments design policies to manage their stock markets in the future.

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