VSB — TECHNICAL UNIVERSITY OF OSTRAVA
FACULTY OF ECONOMICS

Ekonometrická analýza interakcí čínského akciového trhu s asijskými a vyspělými světovými trhy

Econometric Analysis of Interactions of Chinese Stock Market with Asian and Developed Global Markets

DEPARTMENT OF FINANCE

Student: Xiaoyin Chen

Supervisor of the diploma thesis: Ing.Petr Sed'a, Ph.D.

Ostrava, 2017

VŠB - Technical University of Ostrava
Faculty of Economics
Department of Finance

Diploma Thesis Assignment

Student: **Bc. Xiaoyin Chen**

Study Programme: N6202 Economic Policy and Administration

Study Branch: 6202T010 Finance

Title: Econometric Analysis of Interactions of Chinese Stock Market with Asian and Developed Global Markets
Ekonometrická analýza interakcí čínského akciového trhu s asijskými a vyspělými světovými trhy

The thesis language: English

Description:

1. Introduction
2. Characteristics of Stock Markets
3. Applied Econometric Methods
4. Data Sample
5. Results of Empirical Analysis
6. Conclusion

Bibliography
List of Abbreviations
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Extent and terms of a thesis are specified in directions for its elaboration that are opened to the public on the web sites of the faculty.

Supervisor: **Ing. Petr Sed'a, Ph.D.**

Date of issue: 18.11.2016

Date of submission: 21.04.2017

VYSOKÁ ŠKOLA BÁŇSKA-TECHNICKÁ UNIVERZITA Ekonomická fakulta 1 OSTRAVA

Ing. Iveta Ratmanová, Ph.D.
Head of Department

prof. Dr. Ing. Zdeněk Zmeškal
Dean

The declaration

"Herewith I declare that I elaborated the entire thesis, including all annexes, independently."

Ostrava dated 19.04.2017

XIAOYU CHEN

Student's name and surname

Contents

1. Introduction

Due to the globalization of the world economy, cross-border activities in the financial sector are also the rapid development of the surging trend. Financial globalization has not only become one of the most critical aspects of world economic development, but also become the most sensitive part of the link.

Financial globalization has led to the reallocation of capitals around the world. On one hand, it is the reason why that Europe and the United States and other countries of the financial center to flourish, on the other hand. It also promotes developing countries. Especially emerging market economies have received a lot of much-needed economic development start-up capital. It can be said that the development of the world economy can not be separated from the promotion of financial globalization.

Before the financial crisis in 2008, the importance of global financial market channels was increasing before that the new financial system was established. The strong contusion of the financial crisis was on the real economy and the spread of the global economy. It includes its spread to the macroeconomic stability of the emerging market economy. All shows the importance of financial market channels.

The main aim of this thesis is the econometric analysis of interactions of Chinese stock markets with Asian and developed global stock markets during 2003-2015 years. The main aim of this thesis is supported by two sub-goals. The first sub-goal is to evaluate an impact of the global financial crisis on interactions of Chinese stock market with Asian and developed global markets. The second sub-goal is to compare the degree of interaction of Hong Kong, Shanghai and Shenzhen stock markets.

For the propose of this thesis, we will utilize daily closing prices of stock indexes of Shang Hai, Shen Zhen, Hong Kong, Singapore, Japan, European and U.S. stock markets. The methods used in this thesis will be correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition.

This thesis will be divided into six parts. The first and last one will be the introduction and conclusion of the thesis. In the chapter 2, the basic characteristics, classification and main studios of stock markets will be introduced.

The chapter 3 is introduction of methodology of econometrics which are Shang Hai, Shen Zhen, Hong Kong, Singapore and Japan, European and U.S. Stock Markets. We will describe the basic

information of econometrics and types of data which we estimate in this thesis. The main contents and steps of correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition will be stated.

In the chapter 4, the basic information of stock markets of Chinese, Singapore, Japan, United State and European will be introduced. Further more, we will describe the data sample and basic characteristics of used time series of stock indexes which we will analysis in this thesis. They are Shanghai Composite Stock Index (SSE), Hang Seng Stock Index(HSI), Shenzhen SZCOMP Stock Index (SZ), Straits Times Index(STI), Nikkei 225 Stock Index (Nikkei 225), EUROSTOCK 50 Stock Index (ESTX50 or EU), S&P500 Stock Index (S&P 500). This testing period will be divided into three main sub-periods in this thesis: Pre-crisis (01/01/2003-01/10/2007), Crisis (01/10/2007-01/03/2009) and Post-crisis (01/03/2009-30/12/2015).

The chapter 5 will be the estimations and descriptions of all the data of correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition in pre-crisis, crisis and post-crisis periods.

In this thesis, the main contents in chapter 2 and chapter 3 are references from books. All the results of charts and tables of chapter 4 and chapter 5 are from the MS Excel and EViews calculated by the author.

2. Characteristics of Stock Markets

The financial market is a mechanism to deal with financial assets and to determine the price of financial assets. Financial market is also called financial intermediation. It includes money market and capital market. Money market is the market which is short-term (less than one year) financing. It can be divided into several different submarkets, such as repo market, commercial paper market, short-term government bond market and so on. Capital market is the market which are long-term (more than one year) financing. It can be divided into a number of submarkets as well, such as securities market, bond market, fund market, stock market and so on. In this thesis, we will focus on stock market and discuss about classification and characteristics of stock market. Moreover, the importance of stock markets will be discussed crises. In addition, crisis on stock markets will be described as well. Finally, summary of studies on interactions of Chinese stock market with other stock market will be added.

The stock market is a place that has been issued for the transfer, sale and circulation of shares. It includes primary market and secondary market (Mishkin and Eakins, 2016).

2.1Basic Characteristics and Classification of Stock Markets

In this section, there will be introduced primary market and secondary market. Primary market is an issuing market. Secondary market is a trading market.

2.1.1 Primary Market

Primary market is a financial market through which the companies or government agencies sell their new stocks or securities to the initial buyer (Mishkin and Eakins, 2016). Primary market is also called securities issue market or original financial market. In this market, capital demanders (issuer) can earn capital by means of issue stocks, bonds or securities. However, issuers do not trade with capital holder directly, they need intermediate institutions (securities broker). That is why, primary market is also called securities broker market. The main function of primary market is to achieve the transformation of saving to investment. It can provide capital for capital demanders and capital holders have chance to invest their capital in the market.

Because of the different financial market regulations and structures in different countries, there are different ways to sell the stock. In general, it can be divided into public and non-public offering according to difference issuing object. Public offering refers to uncertain investors. The company

sell their shares by public way. Non-public offering is also called private placement, which means that the issuers publish their shares to specific issuing investors only (Madura, 2008).

IPO (Initial Public Offering) is the first public issue that a company sell their shares. IPO can provide capital for company. Such a company can invest more sources when earning capital by IPO. It is a good way to raise their value.

IPO process was six basic steps:

1.Selection of an issue manager:

They need to plan for the IPO process, to determine the time of IPO and so on.

2. Registration of IPO with the market supervisor:

For Instance, in USA, the company needs to register with SEC (Securities & Exchange Commission) 3. Handing out the preliminary prospectus:

Company needs to seek interest from potential investor, to estimate price range of a share of stock and then make some legal documents.

4. Road show:

Manager of company travel around the world to show investor their presentations. It can raise their interest, get more potential purchasers.

5.Pricing:

After road show, the managers of company can estimate price of shares and expected demand for the shares. This step is important for secondary market.

6. Selling shares:

Managers can choose the date, time and so on, but they have to be carefully chosen according to situation actual on financial market.

2.1.2 Secondary Market

Secondary market is a capital market in which trade, transferred and circulated of securities had been sold. In secondary market, the revenue of sale of securities belongs to investors who sell securities. It is a trade market of any type of financial products, such as stocks, bonds, mortgage, life insurance and so on. Secondary market is able to provide liquidity for securities which makes the investors can sell their stocks all the time. Cecchetti and Schoenholtz (2011) found the market provides a way of realization for investors.

The main functions of secondary market are follows:

1. To ensure the flow of funds from surplus unit to deficit unit.
2. To Maintain the prices of stocks.
3. To be well-informed.
4. To ensure free trade.
5. To Protect investors.

In stock market, investors can earn a return of stock by two ways: either the stock price rises during purchase period, or get stockholder dividends by a company. Investors can earn return from both ways as well, but stock market is a risky market. One can't estimate the exactly prices and dividends during investment period. Investors can estimate expected return, future value of stock by mathematician way.

There are two types of stocks that can measure the ability of stockholder:

a) Common stock is one kind of stock which changes according to changes of return of company. It is the basic part of capital of stock company. The characteristics of common stock's dividends is according to business performance of stock company, the dividends of stock are pretty high if company earn high profit, otherwise common stockholders will get loss when the stock company earn negative business performance. Common stock is the most common type of stock, but it is the biggest risk's stock.

b) Preferred stock is dividends from a legal and tax standpoint. It is a kind of fixed dividends, but common stock is a kind of return according to business performance of stock company. This is the difference between common stock and preferred stock, there is no relationship between preferred stock and business situation of stock company, but preferred stockholders cannot earn surplus profits, they will get loss if stock company in insolvency. They don't have voting right as well. In case of stock company dissolved, the priority of claiming on assets of different types of stockholders are: a) creditors, b) preferred stockholders and c) common stockholders.

Secondary market can be divided into two types: Organized securities exchanges and Over-The-Counter (OTC) market.

a) Organized Securities Exchanges

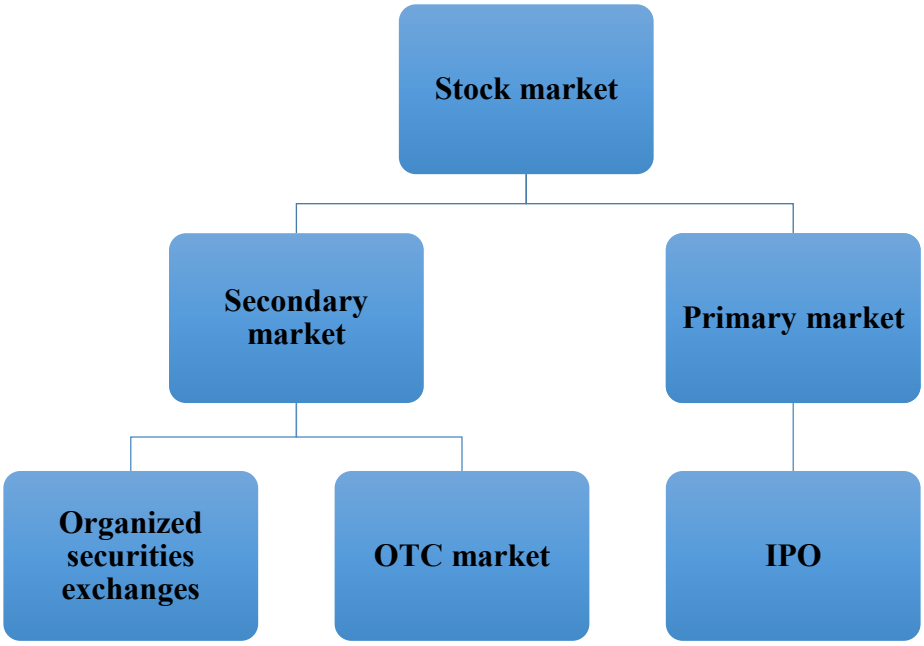
Organized securities exchanges is a place that can trade stock through the stock exchanges (Fabozzi; Mosigliani, Ferri 1994). Stock exchanges is an immobile place of stocks and securities trading that has all kind of facilities, such as computers, baffle board, telephone, management and service personnel and so on. Most of stocks trading are conducted in stock exchanges in the world. That is why stock exchanges is the core of stock markets.

In stock market, each stock exchange has fixed opening time and closing time. New York Stock Exchange (NYSE), Tokyo Stock Exchange (TSE) and London Stock Exchange (LSE) are three largest stock exchanges in the world. Investors have to get membership of stock exchange, otherwise they cannot trade in stock exchange. Companies must file an application and meet certain from securities administration departments if they want to have a stock listed for trading.

b) OTC market

Over-the-counter is a trading activity where not listed or listed securities are traded without any stock exchanges. This market has no trading place, it is composed by companies, securities companies, investment companies and ordinary investors. It is an unfixed invisible market (Dixon and Holmes, 1992). Two transactions sides can decide their means of exchange and place of exchange. It can be networks. OTC market has its own market structure, management structure and trading methods. The biggest difference between OTC market and organized exchanges is that there are standardized contracts and regulated. OTC market can be traded by opening way, investors can trade in face to face way. Contrary to that stock exchange must be traded by closing way. Investors on stock exchange can trade securities under securities companies only because they cannot go to trading floor directly. There exist so many limited conditions in stock markets. That is why only a few stocks can be traded in stock markets. In OTC market exist investor can trade unlisted securities. It does not mean those stocks are inferior, there a special management, so that securities regulators can take charge of OTC market by indirect way. The main structure of stock market is shown in chart 1:

Chart 1 The basic structure of stock market



Source: OWN

2.2 Importance of Stock Markets

According to Mishkin and Eakins (2016), stock markets are undoubtedly a place that receives the most attention and scrutiny. Great fortunes and lost are made there as investors attempt to anticipate the market's ups and downs.

Depending on demands and supply factors, stock market helps to value the securities. The valuation of securities is useful for government, companies and investors. The government can develop economics, companies make the value of creditworthiness and investors can measure their investment's value (Copeland and Weston, 2004) and (Grant and Wilson, 2012). Summaries some information about stock market. Stock market is important for economics, companies and investors, because there are main participants in the stock market.

a) Importance for economics:

The stock market is a barometer of economics situation of a country. The economics situation is good if situation of stock market is stable. Stock market can forecast the cycle of economics. Normally the cycle of stock market is the same as the cycle of economy, but it is in advance of economy. There are lots of employees in stock exchange, the market provides lots of jobs. It is

good for employment rate. For monetary policy, it can influence stock market. The stock price will decrease if there is tightening of monetary policy, because the interest will increase during tightening period. People prefer rather than investing. Stock market is an important place to achieve optimal allocation of resources. Investors can invest their capital and companies can earn capital. Form investor without banks. Stock markets produce flexible and convenience's investment mechanism.

b) Importance for companies:

Stock markers are important for companies since they support accumulation of capital: In some countries without stock market, companies may need to go to banks when they want to earn capital. However, in countries where stock market, exist companies can earn capital in stock market. They can issue their shares. This is cheaper way than loans. Companies can use their capital all the time without interest payment. They are able to expanded reproduction. It is good for companies' management mechanism. It can be mentioned that less performances companies will be eliminated if those companies have no strategy for development, so that they will promote development of mechanism and so on for survive.

c) Importance for investors:

Stock market is a place for transfer of shares. One cannot imagine what may happen with shares without stock market. Investors can earn interest of bonds after maturity of bonds. Investors will be the shareholders of a company when they buy the shares of this company. They cannot get money back from company if there is stock market. Investors can transfer their shares in the market when they want to hold their capital in cash, stock market provide high liquidity and wide invest range of opportunities for investors

2.3 Crises on Stock Markets

Stock markets can effect economics, companies and investors. Crisis on stock market leads to high inflation, high unemployment, depreciation of currency and so on. In this section, we will introduce some specific financial crisis.

Financial crisis means a crisis in financial market. The specific performance can be crash of stock market and bond market or financial institutions failed (Kolb, 2010). Systemic financial crisis mean that it can effect whole financial system, such as financial crisis in 2008. Because of high liquidity of financial capital and its quite high international as well. The reason of crisis can be any stock

market of any country. The crisis can effect economics of a country. People lose jobs when companies failed, their currency will be depreciation as well. Financial crisis can be divided into currency crisis, debt crisis, bank crisis, subprime mortgage crisis and so on. Any type of those crises can effect stock market.

There are some examples of financial that occurred in previous periods:

1. First financial crisis in the world in 1637

Tulip bubble in Netherlands is the first bubble in the world. Tulip was the symbol of rich people. The value of one flower was $20000 in 1634, speculators earned huge capital during that time. When government began to take break action, the price of Tulip decreased about 90% in 6 weeks.

2. Financial panic in United States in 1837

There was no central bank at that time so there was no any types of paper money as well. When the Second bank of United States was set up by parliament, there were uniform money in United States and the Second bank set up subsidiary banks in 29 states for financial controlling of 29 states. In 1829 U.S president Andrew Jackson decided to close the Second bank of U.S, since he thought that problems of credit can effect development of economics of United States. He changed deposits from The Second bank to state banks, so there were lots of deposits in state banks. The state banks issued more bank notes and allowed more loans for properties. However, properties has pretty low liquidity, that was the reason in financial panic till 1843.

3. Crash of Stock market in 1929

There was trend of selling stocks in New York stock market, so the stock prices were fallen sharply by 40% during October. That was the reason of this crisis. It was the darkest day in United States, GDP fell around 30%. Investment fell around 80%. It led to unemployment of 15 million people.

4. Black Monday in 1987

Because of the market psychology and illiquidity. Dow-Jones average by 22% in one day, it effected London stock market and Tokyo Stock market. FT index fell 250 to 202.32 points Nikkei index.

5. Asia crisis of stock market in 1997

Thailand government implemented floating rate on 2nd July, the exchange rate of THB (Thai baht) and USD fell by 17% at the same day. It had effected stock market of Thailand, Malaysia, Philippines and Indonesia. There were lots of international speculators trade stocks. Hang Seng

Index decreased to 1211.47 points when Hong Kong was being financial central of those international speculators. In November, there was crisis in Korea, the exchange rate was bad during November. This crisis had affected Japanese stock market because they had huge investment in Korea market. This Asia crisis was maintaining till 1999.

6. Global financial crisis in 2008

It was the biggest financial market in the world. The reason was subprime crisis in United States. Mortgage institutions were broken, investment funds have to be closed and then caused huge floating in stock market. The property market in United States was so prosperous. However, there were so unaffordable repay for buyers when mortgage rate increased. People wanted to sell their properties. However, it was hard to refinance because of low liquidity of property, no repay of mortgage in time, banks were trying to recycle properties but they got crisis happened. It has effected international market, companies break, fearful economics recession.

According to Grant and Wilson (2012), after crisis 2008, lots of countries or country unions used their own way to recover the economy. United States implemented quantitative easing policy. Chinese government adopted higher regulations for financial market. Japanese government decided to increase fiscal expenses to financial market. European Union encouraged entrepreneurship and so on.

3. Applied Econometric Methods

In this chapter, we will introduce econometric methods which we will use in this thesis. We will analyze the methodology of correlation analysis, cointegration analysis, vector autoregression model and Granger causality.

3.1 Basic Introduction into Econometrics

a) What is Econometrics

Econometrics is that measurement in economics. Financial econometrics is that the application of statistical techniques to problems in finance (Brooks, 2014).

b) What the difference between Economics Econometrics and Financial Econometrics

The tools commonly used in financial applications are basically same as those used in economic applications. The focus and problem sets that may be encountered in analyzing the two sets of data are somewhat different. Financial data are often different from macroeconomic data in terms of frequency, accuracy, seasonality and other attributes.

Economics are frequently interested in relationships between different quantities, for example between inflation and GDP (Verbeek, 2012). In economics, a serious problem is that the "small sample problem." It is often a lack of data at hand for testing the theory of interest. For example, data on government budget deficits or population figures may be required, which are measured only once a year. If the methods used to measure these quantities changed before the quarter of a century, only a maximum of twenty-five of these annual observations were useful.

Financial data can be observed at a much higher frequency than macroeconomic data. The stock index can be daily, hourly or minute basis. As a result, the number of observations available for analysis can be very large - possibly thousands or even million. This means that more powerful technology can usually be applied to financial rather than economic data.

Financial data can take many forms. There is the possibility of typing errors and possibilities for data measurement method changes (due to rebalancing or recalculation of stock indices). But in general, in the financial environment, measurement errors and correction problems are not serious

c) Types of Data

In the quantitative analysis of financial problems, roughly three types of data can be used: time series data, section data, and panel data. In this thesis, we will use time series data (Brooks, 2014).

Time series data are data collected over a period of time on one or more variables. The time series data have particular frequency with which they are associated with the finance. Frequency is a measure of the interval or regularity of data collection or recording. The data can be quantitative (exchange rate, inflation) or qualitative (education level).

d) Returns in financial modelling

There are two methods for calculating the return of a series of prices, which involve the formation of simple returns and the continuously compounded returns. In this thesis, we will use continuous compound returns.

The formulation as follow:

$$R_t = In\frac{P_t}{P_{t-1}} * 100\%, \tag{3.1}$$

where R_t is that the continuously compounded return at time t. The P_t is that the stock price at time t the P_{t-1} is that the stock price at time $t-1$.

e) Method of Calculation

In this thesis, we will use eviews to estimate all the models. eviews is an easy-to-use interactive econometrics package that provides the most commonly used tools in practical econometrics. eviews is built around the concept of objects, and each object has its own window, its own menu, its own process, and its own data view (Brooks, 2014)

3.2 Correlation Analysis

Correlative analysis is a kind of statistical method to study the correlation between random variables. There is a certain dependency relationship among the phenomena and the related direction and correlation degree.

There are three types of correlation:

1) Positive correlation: If x_i, y_i change in the same direction, such as the relationship between height and weight, $r_{XY} > 0$ (where r_{XY} is the correlation).

2) Negative correlation: If x_i, y_i change in the opposite direction, such as smoking and lung function, $r_{XY}<0$.

3) Non correlation: $r_{XY}=0$

The correlation coefficient is denoted as r_{XY}, and its formula as follow:

$$r_{XY} = \frac{\sum_{i=1}^{n}(x_i-\bar{X})(y_i-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{X})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{Y})^2}}, \quad (3.2)$$

where x_i, y_i are the same as mentioned above.

If $x=x_i-X$, $y=y_i-Y$:

$$r_{XY} = \frac{\sum xy}{nS_XS_Y}, \quad (3.3)$$

where $\frac{\sum xy}{n}$ is called the covariance, the absolute value of $\frac{\sum xy}{n}$ intuitively reflects the degree of consistency of the two columns of variables.

Since variables X and variables Y have different units of measurement, they can not use their covariance $\frac{\sum xy}{n}$ to represent the consistency of the two columns of variables directly. Therefore, the deviation of each variable is divided by the respective standard deviation There is no actual unit of the standard score, and then ask for its covariance:

$$r_{XY} = \frac{\sum xy}{nS_XS_Y} = \frac{1}{N}\sum\left(\frac{x}{S_X}\right) * \left(\frac{y}{S_Y}\right). \quad (3.4)$$

In this way, the consistency of the two columns with different measured units can be measured

The main contents of correlation analysis are as follows:

a) Research the close degree between variables.

b) According to the sample data to infer whether the overall correlation.

c) Indicators of the degree of relationship between variables:

If $|r_{XY}| > 0.95$ means significant correlation; $|r_{XY}| \geq 0.8$ means highly correlated; $0.5 \leq |r_{XY}| < 0.8$ means moderate correlation; $0.3 \leq |r_{XY}| \leq 0.5$ means low correlation; $|r_{XY}| < 0.3$ means that the relationship is very weak.

3.3 Cointegration Analysis

In this section, we will introduce the theory of cointegration.

3.3.1 The Main Contents of Cointegration Analysis

Pseudo-regressions are a kind of "false regression" that may occur in the regression model. The cointegration test can test the regression model. cointegration means that there is a significant cointegration relationship between these time series if the time series considered having the same single integer order. Some linear combination (cointegration vector) makes the single order of the combined time series lower.

Since many economic problems are non-stationary. There is a significant limitation to classical regression analysis. Most of the time series in practice are non-stationary, the non-stationary trend in the sequence is usually eliminated by using the different method. So that the model is established by the sequence's stationary, such as the ARIMA model.

In this thesis, we will use Engle and Granger model test cointergration. Engle and Granger (1987) provide a new approach to the modeling of non-stationary sequences. Although some economic variables themselves are non-stationary series, their linear combinations may be stationary. This smooth linear combination is called the cointegration equation. It can be interpreted as a long-term stable equilibrium relationship between the variables.

Reasons for test non-stationary:

1.The stationary a series can affect their behavior and properties.

2. The use of non-stationary data may lead to spurious regressions. If two variables are produced as independent random sequences, the slope of the coefficient is not expected to be significantly different from zero when one of these variables is regressed on the other and the value of R^2 is expected to be very low.

3. If the variables used in the regression model are non-stationary, the standard assumption of asymptotic analysis can be proved to be ineffective.

3.3.2 Steps of Cointegration Analysis

There are at least two methods than can used in cointegration analysis: Engle-Granger (1987) and Johansen (1996). In this thesis, we will use Engle-Granger method to analyse the cointegration.

This cointegration test is a unit root test of the residuals of the regression equation. There is a cointegration relationship between the independent variable and the dependent variable. In other words, the dependent variable can be explained by the linear combination of independent variables, there is a stable equilibrium relationship between the two variables. The dependent variable can not be explained by the independent variables constitute a residual sequence, the residual sequence should be smooth.

We will use ADF (Dickey–Fuller test) to estimate the residual sequence. If it is stable, there is a stable equilibrium relationship between the dependent variable and the explanatory variable of the regression equation. On the other hand, there is no stable equilibrium relationship between the dependent variable and the explanatory variable of the regression equation. Even if the result of the parameter estimation is ideal, such a regression is meaningless. The regression model is pseudo-regression.

1. Test the residuals of parameters

The OLS method is used to estimate the long-run equilibrium relationship, and the regression coefficient is obtained. This step is usually called cointegration regression.The model for equilibrium the correction term can be further generalized to include *i* variables (*y* and *i*-1):

$$y_t = \beta_1 + \beta_2 x_{2t} + \beta_3 x_{2t} + \cdots + \beta_i x_{it} + \mu_t, \tag{3.5}$$

where μ_t is the error term. If the $y_t, x_{2t} \ldots x_{it}$ are cointegrated, the μ_t should be stationary. On the other hand, the μ_t will be non-stationary if $y_t, x_{2t} \ldots x_{it}$ are not cointegrated. So we can make a ADF to estimate the residual, to see whether they are stationary or non-stationary:

$$\widehat{\mu_t} = \psi\widehat{\mu_{t-1}} + \nu_{t,} \tag{3.6}$$

where v_t is the iid error term. We will do the hypothesis test. The null hypothesis(H_0), a test statistic is computed that it has a known distribution under the assumption that the null hypothesis is valid. If the null hypothesis is not true, we will accept the alternative hypothesis(H_1).

H_0: The residual $\widehat{\mu_t}$ are non-stationary

H_1: The residuals $\widehat{\mu_t}$ are stationary

If we accept H_1, we can proceed to step 2. If we accept H_0, we will estimate the first differences of a model.

2. Use the step 1 residuals as one variable in the error correction model.

$$y_t = \beta_1 x_t + \beta_2(\widehat{\mu_{t-1}}) + v_t, \tag{3.7}$$

where $\widehat{\mu_{t-1}} = y_{t-1} - \hat{\tau} x_{t-1}$. The cointegrating vector would be (1 − $\hat{\tau}$).

3.4 Vector Autoregression Model

Vector Autoregression Model (VAR) model proposed by Christopher Sims in 1980. In this sector, we will introduce the basic theory and methodology of VAR.

3.4.1 The Main Contents of Vector Autoregression Model

The VAR model is that a statistical model based on the statistical properties of the data. The VAR model constructs the model by taking each endogenous variable in the system as a function. The function of the hysteresis value of all endogenous variables are belongs to the system. All the variables in VAR are symmetric.

Suppose there exists a relationship between $y_{1,t}$ and $y_{2,t}$. It is impossible to capture the relationship between the two variables if two autoregressive models are established separately:

$$y_{1,t} = f(y_{1,t-1}, y_{1,t-2} \cdots), \tag{3.8}$$

$$y_{2,t} = f(y_{2,t-1}, y_{2,t-2} \dots). \tag{3.9}$$

We can establish the relationship between the two variables if we choose the joint form. The structure of the VAR model is related to two parameters. One is the number of variables contained N, one is the maximum lag order k. According to (3.8) and (3.9), we can know:

$$y_{1,t} = c_1 + \beta_{11.1} y_{1,t-1} + \beta_{12.1} y_{2,t-1} + \mu_{1,t} \tag{3.10}$$

$$y_{2,t} = c_2 + \beta_{21.1} y_{1,t-1} + \beta_{22.1} y_{2,t-1} + \mu_{2,t} \tag{3.11}$$

or

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \beta_{11.1} & \beta_{12.1} \\ \beta_{21.1} & \beta_{22.1} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1,t} \\ \mu_{2,t} \end{bmatrix}, \tag{3.12}$$

where $\mu_{i,t}$ is a white noise disturbance term with $E(\mu_{i,t}) = 0, (i = 1,2)$ $E(\mu_{1,t}, \mu_{2,t})$=0. If $Y_t = \begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix}$, c=$\begin{bmatrix} c_1 \\ c_2 \end{bmatrix}$, $\beta = \begin{bmatrix} \beta_{11.1} & \beta_{12.1} \\ \beta_{21.1} & \beta_{22.1} \end{bmatrix}$, $\mu = \begin{bmatrix} \mu_{1,t} \\ \mu_{2,t} \end{bmatrix}$

$$Y_t = c + \beta_1 Y_{t-1} + \mu_t, \tag{3.13}$$

then, the VAR model with N variables lagging k periods is expressed as follows:

$$Y_t = c + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_k Y_{t-k} + \mu_t, \tag{3.14}$$

where $Y_t = (y_{1,t}, y_{2,t} \dots y_{N,t})'$,

$c = (c_1, c_2 \dots c_N)'$,

$\beta_j = \begin{bmatrix} \beta_{11,j} & \beta_{12,j} & \cdots & \beta_{1N,j} \\ \beta_{21\,j} & \beta_{22,j} & & \beta_{2N,j} \\ \vdots & & \ddots & \vdots \\ \beta_{N1,j} & \beta_{N2,j} & \cdots & \beta_{NN\,j} \end{bmatrix}$, j=1,2,…,k,

$\mu_t = (\mu_{1,t}, \mu_{2,t} \dots \mu_{Nt})'$,

where Y_t is the $N \times 1$ order time series column vector. c is a $N \times 1$ order constant term column vector. $\beta_1 \dots \beta_k$ is a $N \times N$ order random error column vector. μ_t is a $N \times 1$ order random error

column vector. Where each element is non-autocorrelation, but there may be a correlation between those elements.

3.4.2 The Characteristic of Vector Autoregression Model

1. Not based on strict economic theory

In the modelling process only need to clear two things: a) which variables are related to each other, the relationship between the variables included in the VAR model. b) determine the lag period *k.* So that the model can reflect the vast majority of the interaction between variables.

2. Not impose zero constraints on the parameters

The model does not impose zero constraints on the parameters. Estimates of parameters that are not significant are not removed from the model and do not analyze the economic significance of the regression parameters.

3. Not include any current variables

The explanatory variables of the VAR model do not include any current variables. All problems related to the simultaneous equations model do not exist in the VAR model.

4. Not good for short-term period

It is very accurate to use the VAR model to do the near future. When the long-term forecast is made, it can only predict the trend of change, while the short-term volatility forecast is not ideal.

3.4.3 The Steps of Vector Autoregression Model

1. Established preliminary VAR model

The data may be pre-stationary or partially stationary, even can be the same order non-stationary series with no cointegration relation. The lag order can be arbitrarily specified. All sequences are generally regarded as endogenous vectors. Choose the type of VAR model

2. Determine the appropriate lag length

Generally, financial theory does not make much sense about the appropriate lag length of VAR and how long variables should take to complete the entire system. In this case, there are two methods that can be used to obtain the optimal hysteresis length: the cross-equation constraint and the information criterion. We will do the likelihood ratio (*LR*) test in this thesis.

For obtaining the maximum log likelihood function:

$$L(\widehat{\Omega},\widehat{\Pi}) = -\left[\frac{Tn}{2}\right] In(2\pi) + \left(\frac{T}{2}\right) In\left|\widehat{\Omega^{-1}}\right| - \frac{1}{2}\sum_{i=1}^{T} \widehat{\mathcal{E}_t'}\widehat{\Omega^{-1}}\,\widehat{\mathcal{E}_t}, \tag{3.15}$$

where $\widehat{\Omega} = \frac{1}{T}\sum_{t=1}^{T} \widehat{\mathcal{E}_t}\,\widehat{\mathcal{E}_t'}$, T is the sample size.

$$\frac{1}{2}\sum_{t=1}^{T} \widehat{\varepsilon_t}'\,\widehat{\Omega}^{-1}\widehat{\varepsilon_t} = \frac{1}{2} trace\left[\sum_{t=1}^{T} \widehat{\varepsilon_t}'\,\widehat{\Omega}^{-1}\right] = \frac{1}{2} trace\left[\sum_{t=1}^{T} \widehat{\Omega}^{-1}\widehat{\varepsilon_t}'\,\widehat{\varepsilon_t}\right]$$
$$= \frac{1}{2} trace\left[\sum_{t=1}^{T} \widehat{\Omega}^{-1}\,(T\widehat{\Omega})\right] = \frac{1}{2} trace(TI_n) = \frac{T_n}{2}\ , \tag{3.16}$$

then

$$L(\widehat{\Omega},\widehat{\Pi}) = -\left[\frac{Tn}{2}\right] In(2\pi) + \left(\frac{T}{2}\right) In\left|\widehat{\Omega^{-1}}\right| - \left(\frac{Tn}{2}\right). \tag{3.17}$$

Set up the null hypothesis that a set of variables are generated by a Gaussian vector autocorrelation with order p_0 instead of $p_1 > p_0$. In order to estimate the system in the null hypothesis, we can find the regression of each variable with respecting to the constant term and the p_0 lag of all the variables in the system.

$$\widehat{\Omega_0} = \left(\frac{1}{T}\right)\sum_{t=1}^{T} \widehat{\varepsilon_t}\,(p_0)\left[\widehat{\varepsilon_t}(p_0)\right]'. \tag{3.18}$$

In the case of null hypothesis, the maximum of log likelihood function as:

$$L_0^{*} = -\left(\frac{T_n}{2}\right)\ln(2\pi) + \left(\frac{T}{2}\right)\ln\left|\widehat{\Omega_0}^{-1}\right| - \frac{T_n}{2}. \tag{3.19}$$

Then we can set up LR statistics:

$$LR = -2(logL(k) - logL(k+1)), \tag{3.20}$$

where k is the maximum lag of the lagged variable in the model, and $logL(k)$ and $logL\ (k+1)$ are the maximum likelihood estimates of VAR(k) and VAR(k+1) models.

The Akaike Information Criterion (AIC) is estimated as follow:

$$AIC = -\frac{2L}{n} + \frac{2k}{n}. \tag{3.21}$$

The Schwartz Criterion(SC) can be shown as follows:

$$SC = -\frac{2L}{n} + \frac{k\ logn}{n}. \tag{3.22}$$

Using AIC or SC method can determine the lag order k. We need to reduce the degree of freedom of k is too large. The error term will be more serious correlation if the k is small.

3. Causality Test

According to the causality test, we can know the exogenous variables. We will discuss more details in section 3.5.

4. Rebuild VAR model

Analysis of VAR chart are according to the result of lag order and exogenous variables and endogenous variables. We will make test of variance decomposition if the result of AR is smaller than 1. We will discuss more details in section 3.5.

5. Estimate final VAR model

3.5 Granger Causality

Determining whether a change in one variable is the cause of another variable is a common problem in econometrics. In this section, we will discuss how useful some variables are in predicting other variables in a vector autoregressive model. Firstly, we discuss the Granger causality test, which discusses whether a quantity y can be used to estimate another quantity x.

If *y* can affect *x*, or *y* is the cause of *x*. The change in *y* must precede the change in *x*. If *y* is not the Granger causality of *x*. or *x* in the time series sense that *y* is exogenous. In other words, the information of *y* does not have any information to predict *x*.

The Steps of Granger causality test:

1. Assume that a particular autoregressive lag p is estimated by OLS:

$$x_t = c_1 + a_1 x_{t-1} + a_2 x_{t-2} + \cdots + a_p x_{t-p} + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \cdots + \beta_p y_{t-p} + \mu_t , \quad (3.23)$$

2. H_0: $\beta_1 = \beta_2 = \cdots \beta_p = 0$ (*y* is not the Granger causality of *x*)
   H_1: $\beta_1 \neq 0 \; or \; \beta_2 \neq 0 \; or \; \beta_p \neq 0$ (*y* is the Granger causality of *x*)
3. Doing unrestricted regression to get unconstrained residual sum of squares (*RSS*):

$$RSS_1 = \sum_{t=1}^{T} \widehat{\mu_t^2}. \quad (3.24)$$

Restricting Least Square Regression:

$$x_t = c_0 + \delta_1 x_{t-1} + \delta_2 x_{t-2} + \cdots + \delta_p x_{t-p} + \varepsilon_t. \quad (3.25)$$

The sum of squared residuals is obtained:

$$RSS_2 = \sum_{t=1}^{T} \widehat{\varepsilon_t^2}, \quad (3.26)$$

$$\frac{(RSS_1 - RSS_2)/p}{RSS_2/(T-2P-1)} \sim F\,(p, T-2P-1). \quad (3.27)$$

According to the significance test or the confidence interval test. The *F* statistic was used to determine whether the unrestricted regression significantly improved the model's interpretation ability. If the statistic is greater than the critical value, the statistic is significant. Increasing the

hysteresis value of y can significantly improve the model's interpretation ability. We reject the null hypothesis: y is not the Granger cause of x.

3.6 Variance Decomposition

The variance decomposition or impulse response functions in VAR is the contribution of structural shocks that influence endogenous variables. It provides a slightly different method to check the VAR system dynamics. For example, there are a lot of industry demand for steel products which will change the impact of changes in demand for products, such as building materials industry, automobile industry, machinery industry, household appliances industry. If we want to know the changes in demand for these four industries on the steel industry changes in demand, we can do with the variance decomposition. Assuming that the contribution rate of the above four industries at one time point is 10%, 12%, 16%, 20%. It means that changes in demand for steel industry at this point in time, 10% is caused by changes in demand for the building materials industry. 12% is caused by changes un demand for the automotive industry and so on.

The Steps of variance decomposition in VAR:

1. Ordering of the variables

For calculating variance decompositions, the ordering of the variables is important. To see why this is the case, the error terms may be related to some extent between the equations. Therefore, assuming that they are completely independent will lead to a false representation of system dynamics. In practice, the error will have a common component that can not be associated with a single variable alone.

$$Y_t = B + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \varepsilon_t \,, \tag{3.28}$$

where Y_t is a k-dimensional vector composed of endogenous variables, A_i is a coefficient matrix, B is a constant vector, ε_t is a k-dimensional error vector, and its covariance matrix is Ω.

In general, if (3.28) is reversible, it can be expressed as a vector moving average model:

$$Y_t = C + \sum_{s=0}^{\infty} \Psi \varepsilon_{t-s} \,, \tag{3.29}$$

where Ψs is a coefficient matrix and C is a constant vector, which can be obtained by A_i and B in (3.28).

It can be seen from the equation (3.29) that the $i\text{-}th$ row of the coefficient matrix Ψ_s represents the $S\text{-}th$ column of the variable i generated by the variable j. The variable i in the VAR system is the S phase of the variable j impulse response**.**

Here is a hypothesis that the components of the error vector ε_t are not related. In generally, the above assumptions do not hold. So vector ε_t is not the standard vector white noise, Ω is not a diagonal matrix. To this end, often do the following transformation:

Since the covariance matrix Ω of the error vector is positive definite. There exists a non-singular matrix P such that $PP' = \Omega$, then (3.30) can be expressed as:

$$Y_t = C + \sum_{s=0}^{\infty}(\Psi_s\ P)(P^{-1}\ \varepsilon_{t-s}) = C + \sum_{s=0}^{\infty}(\Psi_s\ P)\omega_{\ t-s}\ . \qquad (3.30)$$

2. Calculating y_{1t} and y_{2t}

After transformation, the original error vector ε_t becomes the standard vector white noise ω_t. In this case, the $i\text{-}th$ row of the coefficient matrix Ψ_{sP} represents the S-phase impulse response of the orthogonal i of the variable i of the variable i to the standard error of the variable j in the system.

It is assumed that a particular ordering is required to variance decomposition, although the ordering constraints used may not be supported by the data. Ideally, financial theory should suggest an ordering. Otherwise, you can observe the sensitivity of the results to sort changes by assuming a rank, then completely reversing it and recalculating the variance decomposition.

4. Data sample

In this chapter, we will introduce basic characteristics of five stock markets which we estimate in this thesis. They are Chinese Stock Market (included Hong Kong Stock Market), Singapore Stock Market, Japan Stock Market, European Stock Market, the United State Stock Market.

We will use time series data (Brooks, 2014) and (Franke, 2011) analysis with financial data to measure the influences between stock markets from different countries. All the tables are from own calculation with Excel and EViews.

4.1 Characteristics of Selected Stock Markets

In this sector, we will introduce characteristics of selected stock markets which are Chinese stock market, Singapore stock market, Japanese stock market, Eurozone stock market and US stock market.

4.1.1 Chinese Stock Market

China's stock market is different from the stock market among developed countries in the West. Normally speaking, the stock market in western developed countries is to follow the natural law of the development of the stock market. In the soil of the market economy, the natural production of natural products: China's stock market is in the transition period of China's economic system, the socialist public ownership economy as the main body and simultaneously to explore the various forms of public ownership of the soil, in both to learn from the western developed countries, the natural law of the stock market, but also take into account China's national conditions, follow the natural law of China's economic development. This determines that the Chinese stock market is one kind of stock market with Chinese characteristics. To study the development of Chinese stock market and the history of the development of the Chinese stock market, we need to understand the special historical background of the emergence and development of Chinese stock market.

In China, the stock market is the product of the reform of the state-owned enterprise stock system. Because of the experience of the Soviet Union in the early days of the establishment of new China, there is a one-sided understanding of the form of public ownership and the emphasis on the development of the state-owned economy. The social operation of large industrial enterprises by means of the planned distribution system is highly centralized, government develop investment, the state all the way up in 1980s, China's economic system reform, mechanism of the various

problems and contradictions have become increasingly prominent, the specific performances are: the one hand, state-owned enterprises due to the traditional planned operation mechanism of the drawbacks and their own system reform, running machine system reform has not achieved a fundamental breakthrough, facing business difficulties, loss, high debt ratio asset structure is irrational. In the financial field, due to the long-term implementation of a single bank credit system and state-owned enterprises. Due to the financial field and the long-term implementation of a single bank credit system and state-owned enterprises, the financial risk was growing, the alarm of the regional financial crisis has been repeatedly sounded in other countries. Subsequently, in local government, the vigorous promotion of the reform of the stock system has been pushed to the front of the whole social economic system reform, the stock market has become the focus of attention of the Chinese people.

There are four stock exchange markets in China. They are Shanghai Stock Exchange, Shenzhen Stock Exchange, Hong Kong Stock Exchange, Taiwan Stock Exchange. Due to the results of calculation and the political problem, the Taiwan Stock Market won't be described in this thesis.

4.1.2 Singapore Stock Market

After the British occupation of Singapore in 1819. The trade of Singapore developed rapidly. Some limited liability joint venture company to follow. They often transfer the ownership of the company through a share transaction. At the end of the nineteenth century, the British company in the Malay Peninsula for the sale of mining and mining stocks.1910, The rubber market was good. Malay Peninsula tin mining industry is also rapidly developed. Some companies that mine tin mines have raised funds to start, stock trading activities and thus quite active.

After 1919, Singapore stock trading with the world economic crisis and the outbreak of the First World War and recession. After the First World War, tin mining industry revival, the stock market is active again. In 1929, with the Wall Street stock market recession, the Singapore stock market and into a low ebb. In June 1930, the Singapore Stockbroking Association was established. In August 1960, 19 brokers organized the Malayan Stock Exchange to replace the Singapore Equity Brokers Association. In August 1965, Singapore was independent from Malaysia. In 1973, Singapore, Malaysia currency officially separated, the two shares were formally traded. Singapore Stock Exchange came into being, independent activities.

In 1972, Singapore's rapid economic development, the influx of foreign trade lead to the stock market boom. From 1974 to 1975, the world economic recession. Singapore stock market sluggish. In 1978, the stock market with the economic recovery turned to the middle of 1981 to reach its peak. Later, the Singapore economy by the Western economic downturn, the stock market sluggish. At the end of 1982 began to gradually rise.

The Singapore Stock Exchange established the Singapore Institute of Securities in 1972. Its research program consultants consist of representatives from Singapore's institutions of higher learning, official and private institutions. The research topics include: the basic theory and problems of the securities industry, Singapore and overseas securities market systems and organizations, Singapore and overseas countries in the economic, financial and industrial development, Singapore and other financial central securities regulations. The Singapore government has appointed a regime board to manage the entire securities industry, including stocks and bonds. They are responsible for overseeing the implementation of the 1973 Singapore Securities Act.

The Singapore stock market has the same characteristics as other stock markets in the capitalist world. It is a part of the capital market. It not only from the community to individuals to absorb funds, but also from banks, financial companies, insurance companies and pension agencies to absorb funds. If a company listed on the stock exchange then you can raise funds to expand their business, but also increased the choice of funding options. In the stock market, investors can arbitrarily or according to their own liquidity needs, sell their own shares in exchange for cash or choose to buy stocks to invest. Therefore, the stock market on the one hand to attract public savings, and put it into the need for funds of enterprises; on the one hand is to facilitate enterprises to raise funds to carry out and expand their business. Through the stock trading, but also to the ownership of enterprises from a shareholder to the hands of a smooth transfer to another shareholder.

Singapore stock market has a long history. It is gradually developed, but since the seventies of the century since the development of any time than ever before. At present, in the world about 20 stock market, Singapore ranked ninth.

4.1.3 Japanese Stock Market

During the Sino-Japanese War. The stock market in this period played a certain role in the establishment of the stock company. In 1878, according to the stock exchange case, Tokyo and

Osaka took the lead in setting up a stock exchange. Initially the two exchanges specialize in public debt transactions. Later, due to government incentives, stock companies have set up, the exchange of stock trading volume began to increase.

During the Russo - Japanese War. Japan, as a result of the Sino-Japanese War reparations to establish the gold standard. The successful construction of the iron, railways, telecommunications and other basic industries. It ushered in the explosive rise of the new business climax, the stock market also frenzy. During the First World War. War to stimulate the great development of enterprises, the stock market to textile stocks as the central began to flourish.

Between the two world wars. Stock trading market to short-term settlement of the loan transactions as the central has been greatly expanded. At that time, the prevailing way of trading is in principle within seven years of short-term settlement of the stock price difference between the trading patterns. To the second half of the 20th century, 70% of the exchange stock trading is the short-term settlement of the loan transactions.

But the main backbone enterprises are strictly controlled in the hands of the gala. Their stock is tightly chased by the zaibatsu. So in addition to the textile industry and the food industry, the securities market is always the non-industry backbone of the second and third tier business stocks.

During the second world war, the Japanese stock market from the vacuum to the turning point of the period. Wartime Japan's national stock exchange merged to set up the Japanese stock exchange, the exchange is very short-lived, when Japan defeated to stop the business.

The reopening of stock trading from Japan's defeat to May 1949 was a period in which there was no securities trading in Japan. In this period of time is not long vacuum period. It began the democratization of securities movement. As the chaebol was forced to dissolve, their original monopoly stock was sold to the general masses through the hand of the Securities Dealer Adjustment Council. As a wedge, individual holdings increased significantly before the war. By 1950, individuals held the stock to account for 61.3 %of all stocks. The functions of the mobilization and concentration of social funds inherent in the stock market have been achieved from now on. After the war, the Japanese securities market in the United States on the basis of the legal system carried out a dramatic institutional reform, and the rapid expansion of unprecedented speed.

In less than 40 years after the war. Japan's securities market in the world's position has undergone a fundamental change. At the end of 1987, the Tokyo Stock Exchange stock trading for the first

time more than the long-term dominated the New York Wall Street stock market, ranking first in the world. At present, the impact of the Japanese stock market on the whole capitalist world stock market is widening.

In the 1970s, the oil crisis and inflation greatly weakened the global economy. US high-powered car fuel costs increase. On the contrary, Japanese car manufacturers, such as Honda cars. They quickly turned to the production of fuel-efficient cars. At the same time, the price of these cars is much cheaper than that made by the United States. These cars soon improved in quality. Even as early as the early 1960s, Japanese cars had been automated assembly, which made artificial errors almost non-existent. Which led to the US low-tech auto industry began to decline.

Between 1955 and 1990, land prices in Japan rose 70 times and the stock rose more than 100 times. In 1989, an average of 2 million dollars was spent on a suite in Tokyo. At that time, large-scale stock speculation in the global formation of a boom. Investors around the world competing to buy Japanese stocks, these crazy investors favored "forever bull" fallacy. Many of the latest riches of wealthy people to buy luxury goods. In order to cool the overheated economy, and at the same time remove the real estate and the stock market "rush" surge in cancer. The Japanese government to raise interest rates. However, shortly after the increase in interest rates, the brake stock market with a huge inertia. It toward the peak of the history of 40,000 dashed past, and finally stopped on 29th December 1989. The Nikkei index hit 38915 points. The highest historical record. Then suddenly fell more than a few months, the Nikkei stock index fell is beyond recognition.

After the Japanese house prices experienced a 14-year straight down. The future may also continue to fall. The Nikkei index from the end of 1989 nearly 40000 points has been slipped to the end of 2003 - 8000 points. It also spent 14 years. In addition, the Japanese government and the company also bear the back of the 20th century since the late 80s formed a tough debt burden. These debts come mainly from the year's stock speculation and high-priced land purchases. Until today, the Japanese economy is still in the "melancholy".

Japan has experienced a long bear market, even after the rally in 2005, the Japanese stock market from its highest point in history there are 70% away.

4.1.4 European Stock Market

Europe, or the world's first stock exchange in 1602 in the Netherlands by the East India Company was established. Its role is to gather the wealth of the people, for the company to seize greater

benefits, and then with the national dividends. With the development of capital markets, the 17th century 30's, the Dutch stock market quietly ushered in a nightmare.

Because of the psychological comparisons, the rich set off a tide of planting tulips, from around 1634, almost from the civilian population to hoarding tulips for their second career, until 1637, tulip prices in a month was raised Ten times or even several times, the price of a special breed of tulips can even buy a mansion on the edge of Amsterdam's canal. However, tulips itself does not produce any value, which is the so-called "asset bubble", since it is a bubble, come faster and faster. In February 1637, the market suddenly appeared to sell the scene. Investors scrambling to sell the hands of the tulip contract, and some prices even fell to the original price of 0.005%. In this bubble, some people even bankrupt, such a shock, for the Netherlands and even European countries to standardize and improve the securities market and the transaction sounded the alarm.

In the development of the European stock market, in order to obtain greater benefits, man-made intervention is another black hand. Speaking of which, we must talk about the development of the UK stock market.

The British stock market developed late in the Netherlands. It about the end of the 17th century, initially the Royal Exchange, which specializes in buying and selling government bonds. Because at that time in order to seize the interests of the United Kingdom need to expand the scale of war in Asia, so the issue of a large number of stocks, indirectly stimulated the development of the stock market.

Because at that time the United Kingdom did not have the relevant laws and regulations of stock trading, and thus can not be brought to the insider traders. It making more and more speculators have to follow the South China Sea company. Through various means clever, large number of stock investors deceived. Someone was exploited an empty, and some even bankrupt. The chaos in the stock market makes the whole social order unsettled.

The development of the situation shocked the British government. British House of Commons after the investigation pointed out: fanatical stock speculation is tantamount to disguised robbery. The law must be implemented on the stock market. As a result, the world's first securities trading regulations “soap bill Act” in 1721 in the United Kingdom was born. Later in 1812, the British government promulgated the <Securities Deal Regulations>.

From the end of the 17th century to the middle of the 19th century. Britain and France had erupted the bourgeois revolution, and the rapid development of industrial revolution in the form of large

machine production instead of manual production led to the great development of the commodity economy.

Due to the requirements of the big industry and the rapid development of the stock also developed accordingly. For the production of funds for the expansion and long-distance transport to expand the needs of the market, banks, transport companies need to raise funds in large numbers. Through the issuance of shares to raise funds to establish a limited liability company has become a popular way.

In the early twentieth century, the stock market gained initial development in the transition from capitalist stage to monopoly stage. It is in this process, in order to meet the needs of capitalist economic development, the securities market in its unique form effectively promote the accumulation and concentration of capital, at the same time, its own access to high-speed development.

After the outbreak of the stock market in 1929. The capitalist economy fell into the Great Depression. The stock market is also in a stagnant stage. The stock market crash caused by the stock market in the world, not only the volatility of the stock market volatility, but also the number of securities operators and business dropped.

By 8th July, 1932, the average price of Dow Jones industrial equities was only 41 points, only 11% of the highest level in 1929. After the crisis, the stock market is still depressed. At the same time, to increase the intensity of the securities market control calls more and more intense, so that the expansion of the securities market into an unprecedented stagnation.

After the Second World War, due to the recovery and development of the European economy and the economic growth of countries, making the stock market into the recovery stage. At that time, the company's securities issuance increased, the stock exchange began to recover, the size of the securities market continues to expand, more and more active trading. The European union has 27 member states. It is the main part of Euro. European GDP accounts for 23% of the world in 2012. So we have chose the ESTX 50 which is the blue chip representative in Europe.

4.1.5 US Stock Market

In 1811, the New York Stock Exchange was founded. Unlike other exchanges, the New York Stock Exchange bans Ponze fraud, which helped the New York Stock Exchange win in competing with other exchanges. The telegraph was founded in 1850s, Wall Street became the central of US

equities and securities transactions. The stock market began to develop rapidly in the last few decades of the nineteenth century. It became the protagonist of Wall Street. The US stock market is almost purely a speculative market during this period. This period of the US stock market is almost purely a speculative market. The US government's corruption contributed to the then the stock market manipulation and plunder. In the early trading of the New York Stock Exchange, political and financial speculation is closely related.

From 1886 - 1929, the US stock market was rapidly developing during this stage, but the market manipulation and insider trading were very serious. The United States gradually developed into the world's political and economic center in this period. From the late nineteenth century, the New York Stock Exchange's stock market became an important part of the US securities market in order to raise funds for railways, manufacturing and mining. 1886 New York Stock Exchange stock trading for the first time more than 100 million shares.

The Dow Jones index was established in 1896. At this point, price volatility in the stock market is not only significant for borrowers, investors and those working in the securities market, but also a barometer of US economic development and vitality. In 1900, industrial stocks became the mainstay of US stocks, which marked the development of the US stock market into a new stage. In the same year, the United States over Britain to became the world's first economic power.

In the 1920s, the US stock market entered an era of unprecedented prosperity. The post-war free trade expanded and inflation remained low. The management and competitiveness of American companies increased rapidly. Various inventions and technologies such as cars, Equipment, electrical and petrochemical products for the economic development of the infinite prospects.

Due to the lack of effective government regulation, the US stock market speculation and stock manipulation is still relatively serious. The stock market development accompanied by frequent stock market panic, the government began to regulate the stock market. During this period, the major US stock market crash occurred in 1893, 1901, 1903, 1907, 1914, 1917 and 1929 stock market crash.

From 1931, the Great Depression began to spread to the major capitalist countries. It became the world economic crisis of the capitalist countries. The US stock market really into the investment era, the value of investment ideas is the mainstream of this period of investment ideas. In the late 1960s, the government's huge fiscal deficit, inflation, rising oil prices. International balance of

payments became an important issue in the US economy. The devaluation of the dollar and the first oil in 1973 crisis.

By 1979, inflation was a heavy blow to the stock market, while the bond market was pretty good. Asset-backed securities (ABS) and junk bond markets developed rapidly and money market funds were growing rapidly.

The low inflation rate, long-term economic growth, and the short-term economic recession created the conditions for the long-term prosperity of the stock market after 1982. Securitization, internationalization, and Americanization were the characteristics of financial development during this period. Institutional investors in the stock market continue to mature to expand, the government's protection of investors are more perfectly. The stock market is unprecedented prosperity.

4.2 Basic Characteristics of Used Time Series

In this section, we will introduce basic characteristics of seven stock index in this thesis which we will analyze. They are Shanghai Composite Stock Index (SSE), Hang Seng Stock Index(HSI), Shenzhen SZCOMP Stock Index (SZ), Straits Times Index(STI), Nikkei 225 Stock Index (Nikkei 225), EUROSTOCK 50 Stock Index (ESTX50 or EU), S&P500 Stock Index (S&P 500).

The period from 2003-2015 was divided into three sub periods in order to distinguish different stock behaviour. The three main parts are: Pre-crisis (01/01/2003-01/10/2007), Crisis (01/10/2007-01/03/2009) and Post-crisis (01/03/2009-30/12/2015). Crisis period was defined on the basis of development of US stock market (see section 4.7). We have chosen the lowest time and the highest time of S&P stock index for the time tables, because the origin reason of financial crisis 2008 were from USA.

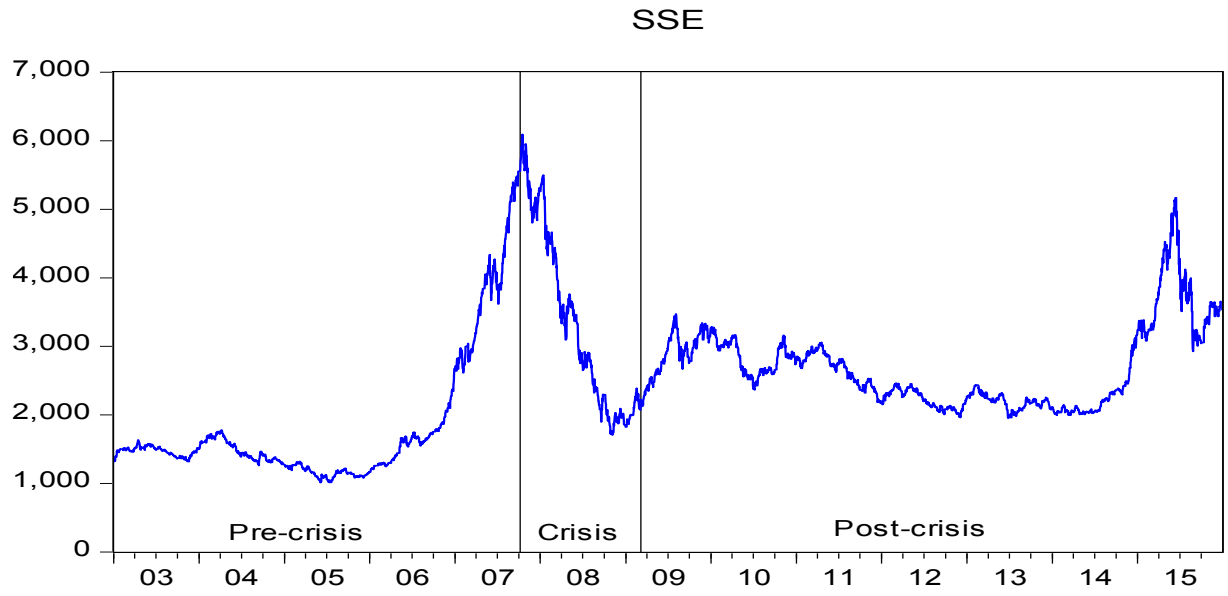
There are two chart will be added in this section. Which are the stock index and logarithmic returns of closing prices of stock indexes. For the modeling of logarithmic return, we can check the formula (3.1). The stock index charts are similar in those seven stock index. As we mention in past chapter, the stock index of pre-crisis period is increasing generally. Shock decreasing during crisis period and slowly increasing during post crisis period. In the charts of logarithmic return of seven stock index. we will see that the fluctuations of index of crisis period are higher than pre-crisis period and post-crisis period.

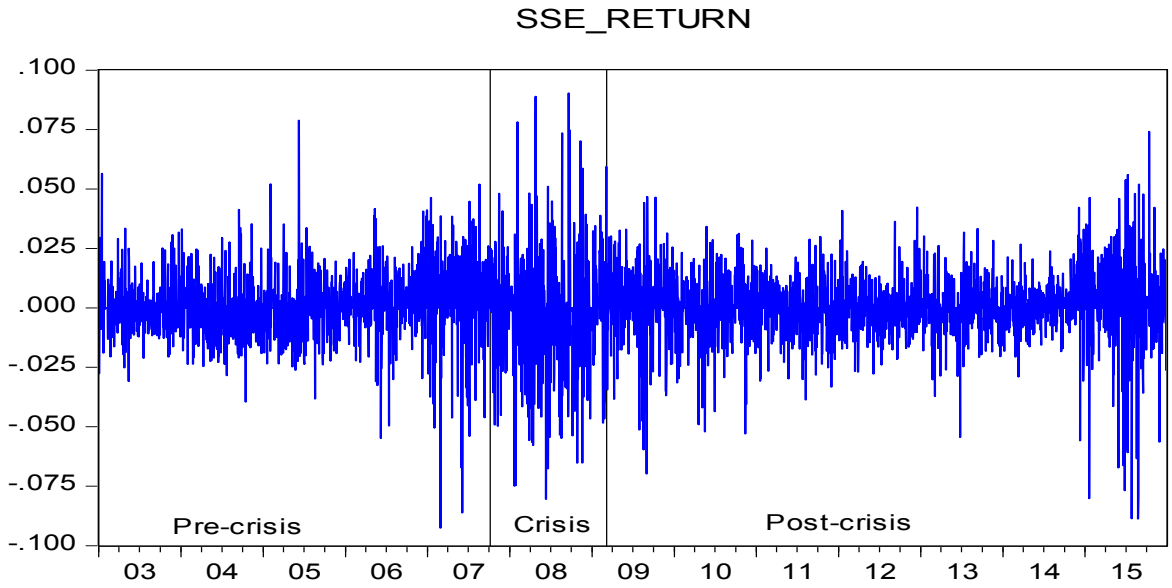
4.2.1 Shanghai Composite Stock Index (SSE)

Stock index is a reference number prepared by a stock exchange or a financial service institution that indicates a change in the stock market. Because of fluctuation of stock price, investors need to take risk of market price. According to stock exchange's own business knowledge and familiarity with the advantages of the market, they ill calculate the stock price index. Investors can test their own investment results and use it to predict the stock market trends.

The Shanghai Composite Stock Index (SSE) which is a listing of all the listed stocks. It includes shares and B shares. SSE reflect the Shanghai Stock Exchange listed stock price movements. It was released on 15th July 1992.

Chart 4.1 The daily data and logarithmic returns of SSE stock index during 2003-2015





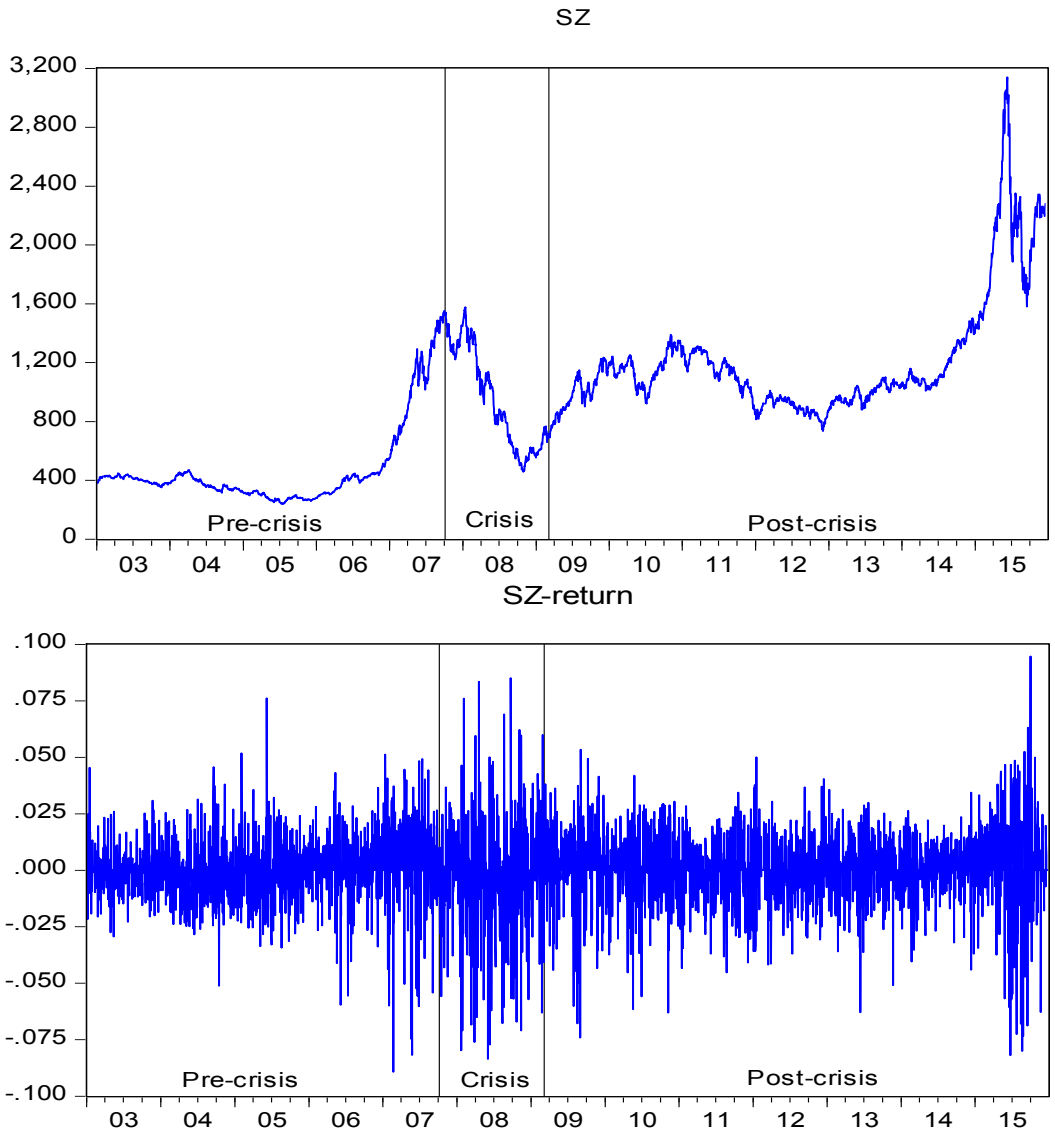
In the chart 4.1, the recession periods were shorter than other stock indexes. As China's balance of payments capital projects have not yet fully opened. The scale of asset securitization is still in the initial stage and China has a large number of foreign exchange reserves. The banking industry is directly affected by the financial crisis, but because of China's financial control more stringent, resulting in relatively small losses, wading is not deep.

4.2.2 Shenzhen SZCOMP Stock Index(SZ)

Shenzhen Composite Index (SZ) was published on 3rd April 1991. It is prepared by the Shenzhen Stock Exchange. The calculation range are all the Shenzhen Stock Exchange listed on the stock market. It calculated by weighted average method: Daily Composite Index = Daily Index Total Market Cap x base index. The base index is set at 1000 since 30th June 2000.

The constituents index of Shenzhen SZCOMP Stock Index: component A-share index, component B-share index, industrial index, business index, financial index, real estate index, utility index, integrated enterprise index.

Chart 4.2 The daily data and logarithmic returns of SZ stock index during 2003-2015



In the post-crisis period. The indexes of SSZ, SZ and HSI were increasing from July 2014 to June 2015. The highest point of SZ was 3100 in this period. It is even higher than the highest point during crisis period. According to the volatilities of chart 4.1 and 4.2, the SSZ and HSI were not so horror but still increase a lot in this period. From a macro perspective, the irrational prosperity of financial markets often means a high degree of shrinking real economy. If the real economy is very profitable, people make money after the more inclined to continue the success of previous experience - the purchase of new equipment, expand the scale of reproduction, rather than putting money into an invisible full of uncertainty of the line. From the system point of view, abnormal

fluctuations in the stock market reflects the basic system of capital market defects and regulatory system defects.

4.2.3 Hang Seng Stock Index (HSI)

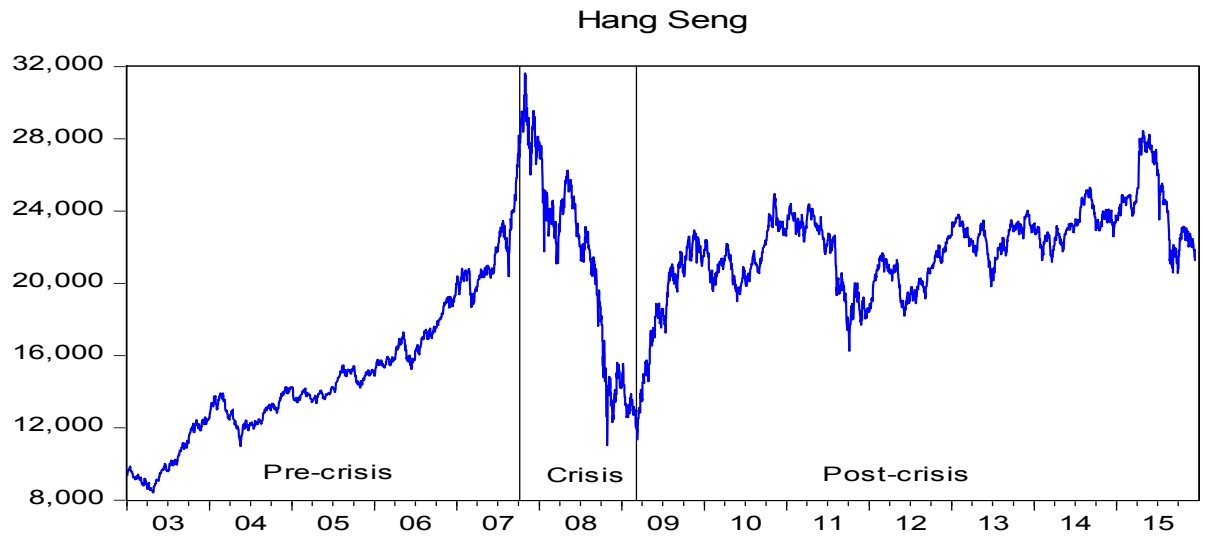
The Hang Seng Index was published on 24th November 1969. It is an important indicator of Hong Kong's stock market. It is calculated from the market value of a number of constituent stocks (blue chips). HSI representing by 63% of the average market cap of 12-month of all listed companies in Hong Kong Stock Exchange. HSI is the most influential stock index in Hong Kong stock market. The selection criteria for the HSI constituent stocks are as follow:

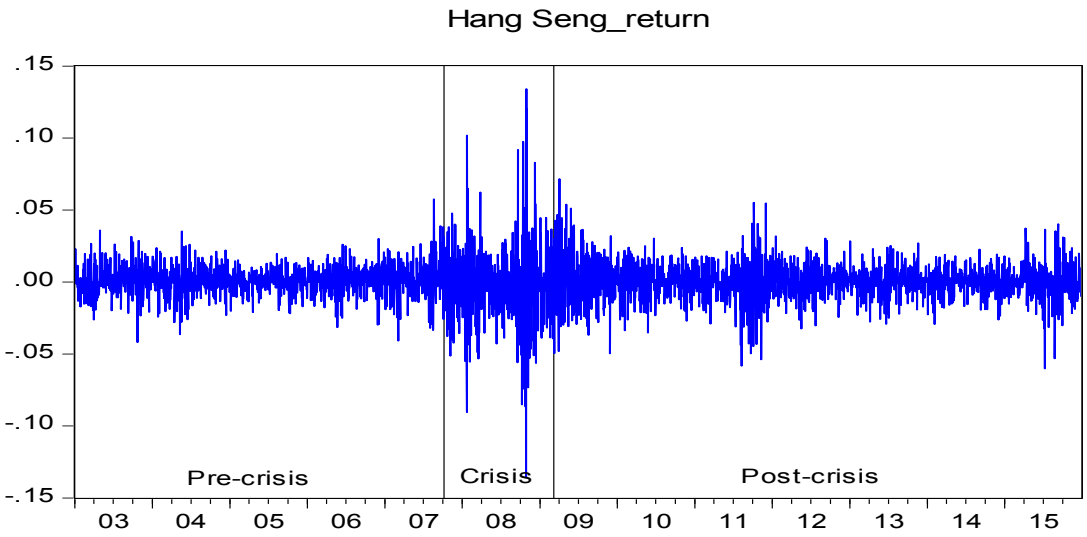
(1) The shares of the market value. The shares must be selected by rank the top 90% of total market capitalisation of all the ordinary shares listed on the Stock Exchange

(2) The shares of transaction. It must fall within 90% of all ordinary shares traded on the Stock Exchange

(3) It must be listed on the Stock Exchange for more than 24 months.

Chart 4.3 The daily data and logarithmic returns of HSI stock index during 2003-2015

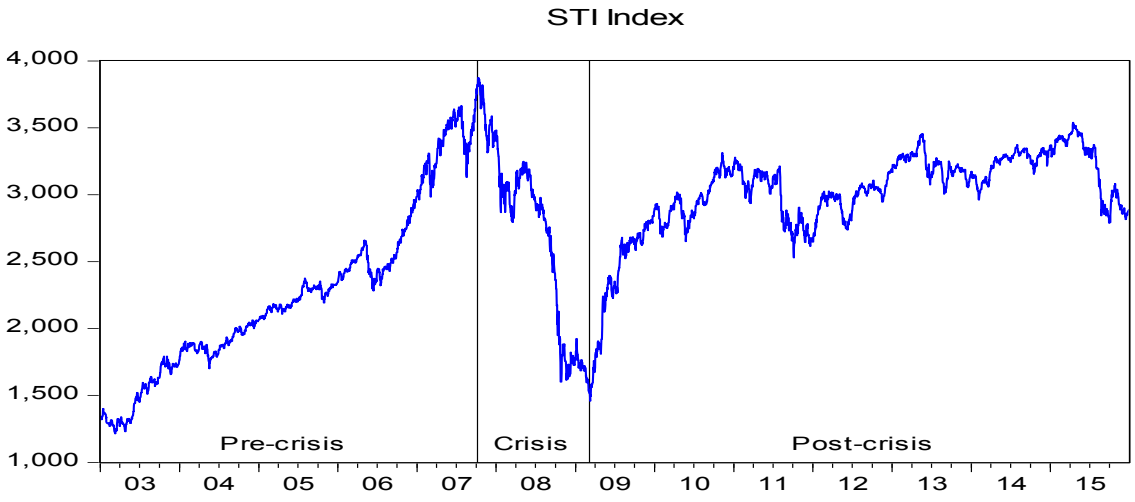


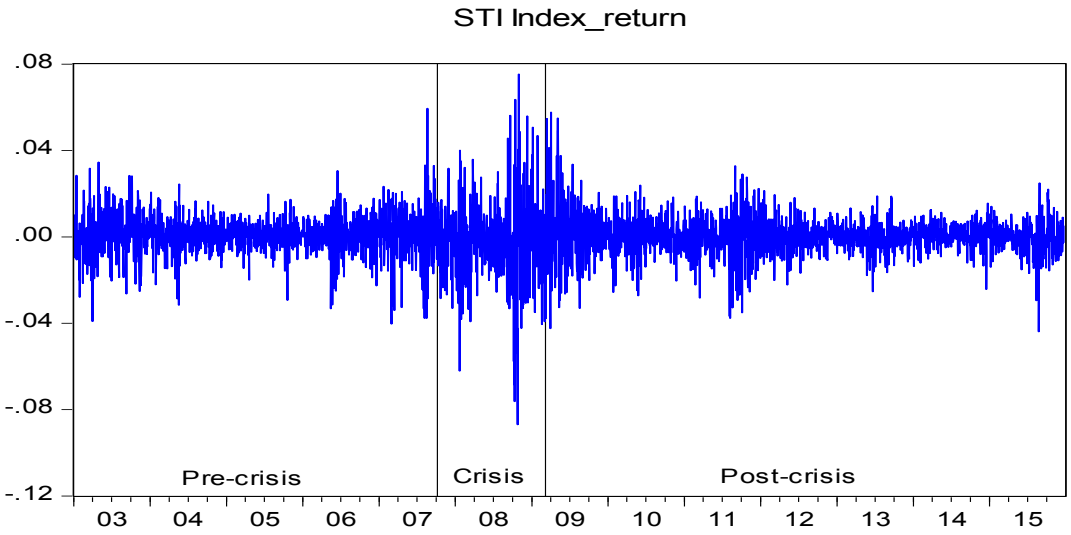


4.2.4 Straits Times Stock Index(STI)

The Singapore Straits Times Index was published on 28th August 1998. It covers the top 40 companies listed on the Singapore Stock Exchange. STI is calculated by weighted average method. The base index is 885.26. It is the best indicator of global investment in Singapore stock market observation.

Chart 4.4 The daily data and logarithmic returns of STI stock index during 2003-2015

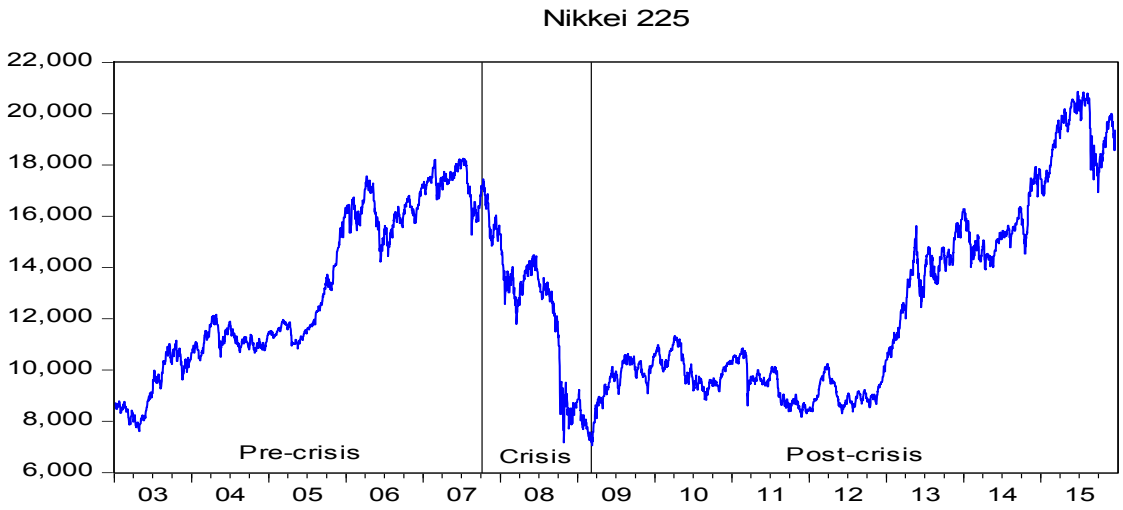


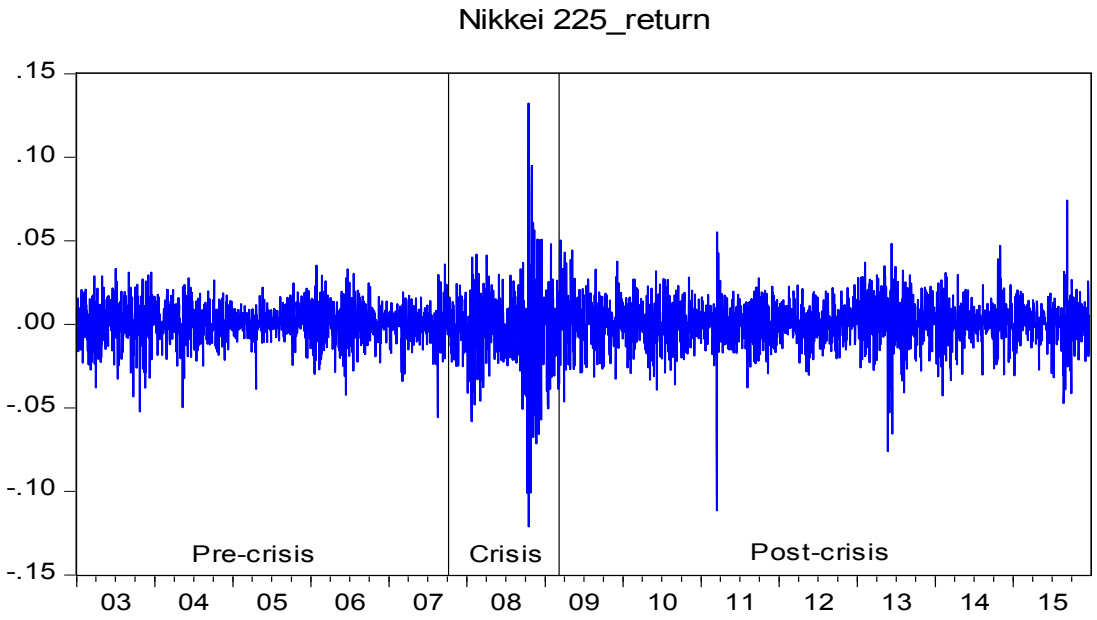


4.2.5 Nikkei 225 Stock Index(Nikkei225)

Nikkei 225 was published on 7th September 1950. It is the Tokyo Stock Exchange's stock market index. It calculated by price weighted method, and components are reviewed once a year. Nowadays, the Nikkei 225 is the most widely quoted in the Japanese stock market.

Chart 4.5 The daily data and logarithmic returns of Nikkei225 stock index during 2003-2015





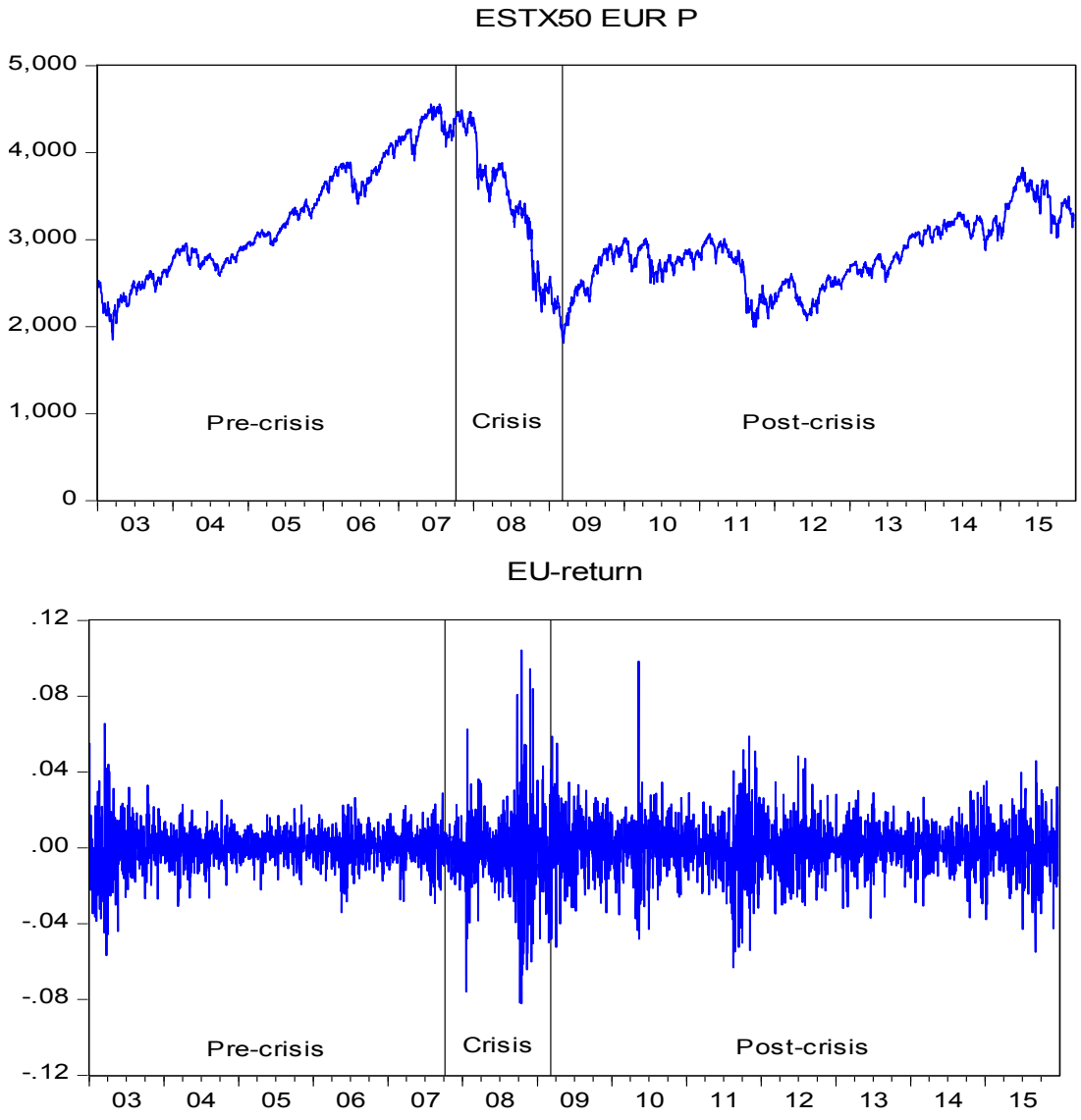
Japan's financial market in 2013 has experienced historical stock prices and the Yen's depreciation. The Nikkei 225 rose about 57% year-on-year. It is the biggest gain in 41 years. The outlook for the higher stock price and the depreciation of the Yen is that the expected to get out of deflation. Due to the large-scale monetary easing proposed by the Bank of Japan president and the economic policy of Japanese Prime Minister Shinzo Abe. the Yen against the dollar hit the biggest decline in 34 years.

4.2.6 EUROSTOCK 50 Stock Index (ESTX50 or EU)

EURO STOXX 50 was published on 26th February 1998. It is a stock index of Eurozone equities designed by STOXX. The goal of this stock is that to provide a blue chip chip representation leader of the Eurozone. It consists of fifty of the largest and most liquid stocks.

The index is calculated by variants of yield: price, net income, total return. The proportion of EURO STOXX 50 of the free float market value of the EURO STOXX total market index is around 60%

Chart 4.6 The daily data and logarithmic returns of ESTX50 stock index during 2003-2015

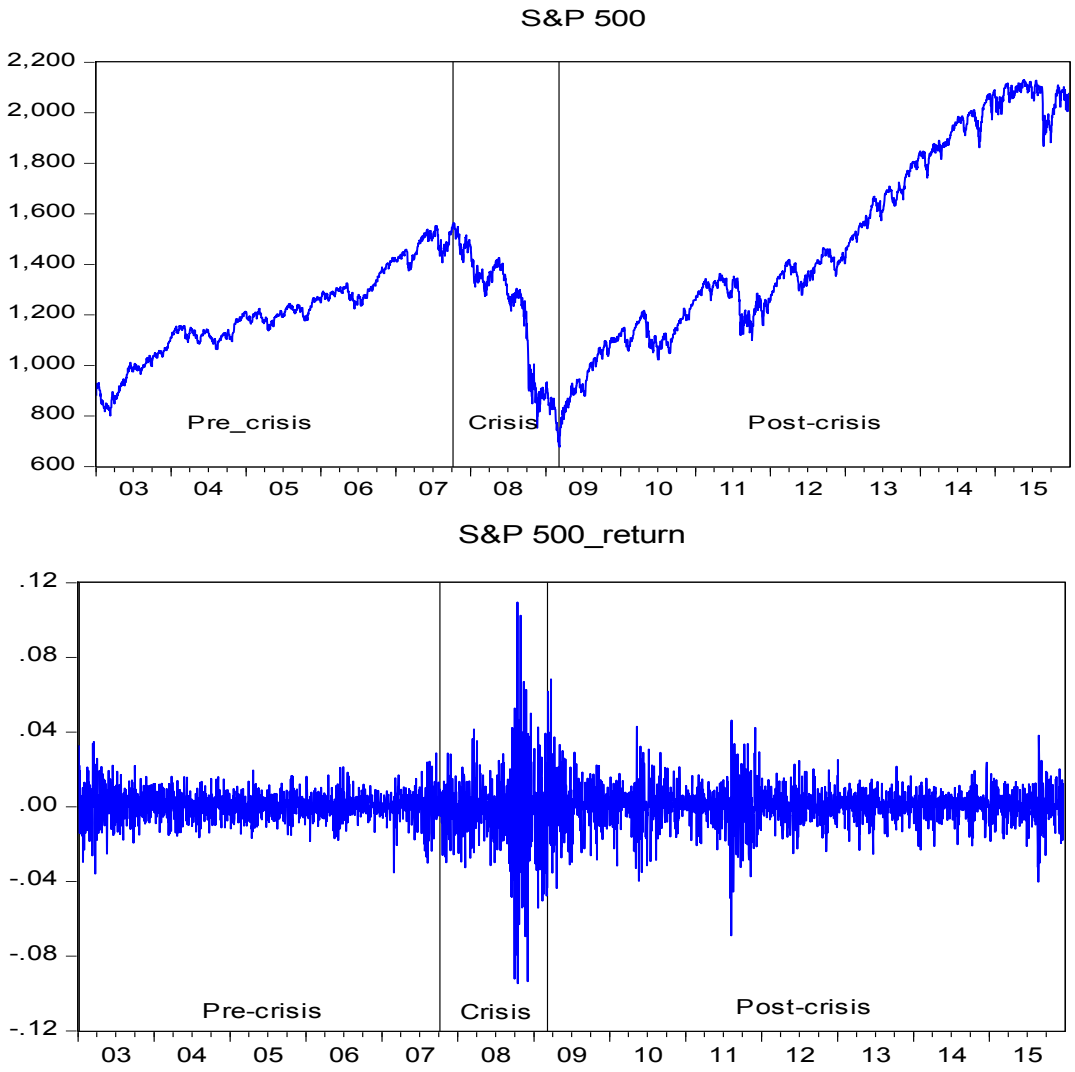


4.2.7 S&P500 Stock Index(S&P500)

The S&P500 Index was published and maintained by Standard & Poor's in 1957. It is a stock index of 500 US listed companies. All companies covered by the S&P500 are listed on the major US exchanges, such as the New York Stock Exchange, Nasdaq. The S&P500 contains more companies

than the Dow Jones. So the risk is more fragmented than Dow Jones. It can reflect broader market changes. It is generally considered an ideal stock index futures contracts.

Chart 4.7 The daily data and logarithmic returns of S&P500 stock index during 2003-2015



Since March 2009, the S&P500 has risen to 200%. The historical level of judgment is not unprecedented. Because of the enterprise balance and the sheet strength, it can promote further merger and acquisition activities, the prospects for US GDP can guarantee steady growth in revenue.

4.3 Descriptive Statistics of Used Time Series

In this section, we will analyze the basic statistics data of pre-crisis, crisis and post-crisis period of seven markets. We assume that the significant level is 0.05. All the data are calculated by EViews.

4.3.1 Descriptive Statistics in Pre-Crisis Period

Table 4.8 shows that basic value of pre-crisis period of logarithmic returns of stock index. The return values were positive during the period. It means that all the stock indexes earn values. The standard deviations were small in this period.

Table 4.8 The Descriptive Statistics in Pre-Crisis Period

	SSE	SZ	HSI	ESTX50	S&P500	STI	Nikkei225
Mean	0.0008	0.0008	0.0006	0.0003	0.0003	0.0005	0.0003
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	0.0789	0.0762	0.0575	0.0655	0.0348	0.0594	0.0360
Minimum	-0,0925	-0,0893	-0,0418	-0,0568	-0,0358	-0,0403	-0,0556
Std.Dev.	0.0122	0.0129	0.0084	0.0091	0.0066	0.0079	0.0097
Skewness	-0,2833	-0,4641	0.0470	0.0047	-0,0426	-0,1990	-0,4723
Kurtosis	10.165	9.1540	7.3196	9.6887	6.9295	8.6882	6.4732
J-B test	3737.3	2801.7	1350.3	3236.1	1117.4	2351.9	937.1
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The Kurtosis were higher than 3, it means that the investigated time series exhibit sharper probability distribution than Gaussian distribution (Tsay, 2010). If we want to test the normality of residuals, the assumption is the regression model which is linear in the parameters and correctly specified; no autocorrelation, no heteroscedasticity, no multicollinearity**;** the variance of residuals is constant. According to the values of J-B test in table 4.8, all the indexes are not normally distributed at significant level 0.05.

4.3.2 Descriptive Statistics in Crisis Period

According to standard deviation values of table 4.9, the volatility is larger than pre-crisis period. It means that the variance of residuals is constant The mean values were negative. The maximum and minimum values are similar with pre-crisis period. All the indexes are not normally distributed at significant level 0.05.

Table 4.9 The Descriptive Statistics in Crisis Period

	SSE	SZ	HSI	ESTX50	S&P500	STI	Nikke225
Mean	-0,0018	-0,0014	-0,0014	-0,0015	-0,0014	-0,001	-0,0015
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	0.0903	0.0851	0.1340	0.1043	0.1095	0.075305	0.132346
Minimum	-0,0804	-0,0835	-0,1358	-0,0820	-0,0946	-0,0869	-0,1211
Std.Dev.	0.0218	0.02323	0.0245	0.0185	0.0196	0.0167	0.0214
Skewness	0.0354	-0,3608	0.2103	0.1692	-0,1723	-0,2042	-0,4031
Kurtosis	5.7606	5.24426	9.3066	10.5461	10.1492	7.6610	11.3088
J-B test	164.59	119.94	862.26	1231.51	1105.70	472.50	1504.08
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

4.3.3 Descriptive Statistics in Post-Crisis Period

In post-crisis period, table 4.10 shows that the standard deviations were back to normal values. The mean values were lower than in pre-crisis period, but the values are positive. Customers did not have enough investment capital after financial crisis.

Table 4.10 The Descriptive Statistics in Post-Crisis Period

	SSE	SZ	HSI	ESTX50	S&P500	STI	Nikkei225
Mean	0.0002	0.0004	0.0002	0.0002	0.0004	0.0002	0.0003
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	0.0741	0.0946	0.0715	0.0984	0.0683	0.0576	0.0742
Minimum	-0,088	-0,0819	-0,0601	-0,06318	-0,0689	-0,0439	-0,1115

Std.Dev.	0.0125	0.0143	0.0108	0.0119	0.0090	0.0077	0.01156
Skewness	-0,827	-0,7282	0.0138	0.00363	-0,1404	0.2756	-0,5324
Kurtosis	11.380	8.3077	8.0536	8.3731	10.868	10.898	10.487
J-B test	7592.2	3151.8	2657.2	3004.3	6449.5	6521.5	5950.7
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

5. Results of Empirical Analysis

In this chapter, all the results of all methods which we described in chapter 3 will be presented. There are five main sections and the summarization will be shown in the last part of this chapter. All the results will be calculated by EViews.

5.1 Results of Correlation Analysis

The correlation is the basic method in this thesis. Due to the high fluctuation of daily close values, we will use logarithmic returns to calculate the correlation. H_0: Indexes are not correlated. H_1: Indexes are correlated. Value* means that the value which we reject null hypothesis at 5% significance level in pre-crisis, crisis and post crisis periods.

Table 5.1 The correlation coefficients of logarithmic returns during pre-crisis period

Pre-crisis	STI	Nikkei225	S&P500	ESTX50	HSI	SZ
SSE	0.1336*	0.1002*	0.0286	0.0194	0.1653*	0.1553*
SZ	0.0174*	0.0116	-0,0061	0.0329	0.0148	
HSI	0.6615*	0.5274*	0.0966*	0.0461		
ESTX50	0.0251	0.0156	0.0214			
S&P500	0.1595*	0.0658*				
Nikkei225	0.4877*					

Mostly, the relationships are positive in those returns. Companies listed on the Shen Zhen Stock Exchange can not trade on the Shang Hai Stock Exchange. Companies listed on the Shang Hai Stock Exchange can not trade on the Shen Zhen Stock Exchange. The two cities of the trading varieties are slightly different, the Shang Hai Stock Exchange focused on large and medium-sized enterprises, while the Shen Zhen Stock Exchange is focused on venture capital and small and medium enterprises. The table 5.1 shows that the correlations are pretty small. It means that the indexes were changed by other effects, but we can see the pairs of SSE with SZ and HSI. Those correlations are lower than 0.2, but the *p*-value are lower than 5% in this period. The connection among SSE, SZ and HSI were not closely linked.

The pairs of HSI with STI and HSI with Nikkei225. Those correlations are higher than 0.5. The higher correlation is, the higher affect between two returns. The open economy is the economic

structure in Hong Kong and Singapore. Hong Kong, Singapore and Japan are the important financial, trade, transportation, tourism, information and communication central in the world. Geographical location let them connect each other. The correlation between Nikkei225 and STI is 0.48 which is near to .5. According to the results of table 5.1, the Asian markets affected each other in pre-crisis period.

Table 5.2 The correlation coefficients of logarithmic returns during crisis period

Crisis	STI	Nikkei225	S&P500	ESTX50	HSI	SZ
SSE	0.3508*	0.3257*	0.0055*	-0,0810	0.5090*	0.1352*
SZ	0.1262*	0.1262*	0.0256*	-0,0061	0.0990*	
HSI	0.7736*	0.6664*	0.2519*	-0,0423		
ESTX50	-0,0274*	-0,0274*	-0,0874*			
S&P500	0.2641*	0.1128*				
Nikkei225	0.6189*					

Obviously, the correlations in crisis period are higher than pre-crisis period. The correlation of SSE and SZ is still small, but the correlation of SSE and HSI was increasing to 0.5. The connection between SSE and HSI was closely linked in crisis period. The pairs of HSI with STI had changed to 0.77 which is the highest result in this period. The financial crisis started from USA, but the effect was limited among European market, USA market and Asian market. The table 5.2 shows that the relationships were actively between Asian markets. Especially in Shang Hai market and Hong Kong market. Due to the depreciation of US dollars, the Hong Kong dollars started to decline. The correlation between HSI and S&P500 was 0.09 only in pre-crisis period, there is 0.15 differences in those two periods. STI and Nikkei225 were strongly connection with HSI. Looking back to the Shang Hai market, the correlations of SSE with STI, Nikkei225 HSI were not so high in crisis period, but it was increasing very much if we compare with pre-crisis period. Generally, we could say that the Asian stock index were effected by each other in this period, but the Europe and America markets were connected by other reasons.

Table 5.3The correlation coefficients of logarithmic returns during post-crisis period

Post-crisis	STI	Nikkei225	S&P500	ESTX50	HSI	SZ
SSE	0.3207*	0.2593*	0.3178*	0.0408*	0.4930*	0.1400*
SZ	0.0183	0.0325	0.0346	-0,0146	0.0770*	
HSI	0.7031*	0.5076*	0.2339*	0.0850*		
ESTX50	0.0989*	0.0637*	0.0712*			
S&P500	0.3178*	0.1376*				
Nikkei225	0.4782*					

In the post-period, the correlations are quite same as pre-crisis period. Asian markets (STI, SSE, Nikkei225 and HSI) connected with each other. The correlation of SSE and HSI was decreasing by 0.016 only if we compare with the correlation of crisis period. The relationship of SZ with SSE and HSI is still quite low. It can be explained in another way which is the Europe and USA markets are not the main reason to influence the Asian markets.

5.2 Results of Cointegration Analysis

Before analyze the cointegration analysis, we have to test wether the time series are stationary or not. It is the ADF test. Table 5.4 shows that the ADF statistics of daily close indexes values of seven market during 2003-2015. In the ADF test: H_0: The series has a unit root, H_1: The series has a no unit root. The value* means that the closing values we can accept alternative hypothesis at significant level 5%, which means the time series are stationary. Otherwise, the time series are non-stationary if we accept null hypothesis. In the pre-crisis period, S&P 500 index is stationary only. There are non-stationary values during crisis period, because of a far cry from the maximum and minimum values during crisis period. After financial crisis, the values started to be stable. There are three values follow a stationary time series which are HSI, S&P 500 and STI during post crisis period.

Table 5.4 The ADF statistics for daily index value

ADF	SSE	SZ	HSI	ESTX50	S&P500	STI	Nikkei225
Pre-crisis	3,22	2,44	0,31	-4,35	-3,61*	-1,64	-2,57
Crisis	-1,48	-1,21	-3,26	-2,87	-2,01	-1,97	-2,26
Post-crisis	-1,55	-1,69	-3,74*	-2,88	-3,54*	-3,70*	-1,83

Table 5.5 The ADF statistics for logarithmic returns.

ADF	SSE	SZ	HSI	ESTX50	S&P500	STI	Nikkei225
Pre-crisis	-44,05*	-40,74*	-41,32*	-42,84*	-44,46*	-42,40*	-43,08*
Crisis	-24,42*	-22,14*	-25,43*	-26,06*	-27,27*	-14,26*	-23,15*
Post-crisis	-49,75*	-45,73*	-50,60*	-50,24*	-52,65*	-49,62*	-52,39*

Table 5.5 shows the ADF statistics for logarithmic returns. They are all stationary at significant level 5% during 2003-2015. So we will use those values to estimate VAR models, Granger causality testing and variance decomposition in this thesis. We will use daily values to test Engle-Granger cointegration. It provides a new approach to the modelling of non-stationary sequences.

Table 5.6The Engle-Ganger cointegration tests results during pre-crisis period

Pre-crisis	STI	Nikkei225	S&P500	ESTX50	HSI	SZ
SSE	1,069	3,396	0,992	2,228	-0,374	-4,579*
SZ	0,347	2,466	0,931	1,755	-0,675	
HSI	-0,802	1,710	-0,873	-1,556		
ESTX50	-2,936	-4,639*	-5,939*			
S&P500	-3,291	-1,542				
Nikkei	-0,766					

There are three pairs of indexes which can be reject the null hypothesis (H_0: The series are not cointegrated, H_1: The series are cointegrated). It means that the Shanghai market is cointegrated with Shenzhen market. The Euro area market are cointegrated with Japanese market and US market at significance level 5%. The HSI with SSE and SZ are not cointegrated in this period. It means

that there are not stable relationship between the HSI with SSE and SZ,In pre-crisis period, the global economy grew strongly. The Japanese economy experienced a wave of export-led growth. The Japanese economy was expanding as the yen depreciates and asset prices rise. The S&P 500 indexes were increasing around 50%. The ESTX50 indexes were increasing around 100% in this period. They are only three pairs cointegration relationship during this period. We can see the table 5.7, the number of pairs were increasing to seven.

Table 5.7 The Engle-Ganger cointegration tests results during crisis period

Crisis	STI	Nikkei225	S&P500	ESTX50	HSI	SZ
SSE	-1,327	-1,453	-1,421	-1,762	-1,943	-3,348*
SZ	-1,496	-1,509	-1,609	-1,533	-2,172	
HSI	-4,069*	-3,561*	-3,997*	-6,311		
ESTX50	-2,987	-2,665	-3,781*			
S&P500	-4,484*	-2,605				
Nikkei	-4,466*					

The subprime mortgage crisis to further strengthen the weak position of the dollar. It accelerated the depreciation of the dollar speed, thereby reducing the advantages of export products. The fourth largest investment bank Lehman Brothers bankruptcy. It triggered financial stocks diving. On 16th September 2008, the SSE Index closed below 2000 points, down 4.47%. ICBC, China Construction Bank, China Merchants Bank, Shanghai Pudong Development, Industrial and Shenzhen Development Bank Shares all limit. On the 29th October 2008, the SZCOMP index was 457 which is the lowest point in crisis period. As same as pre-crisis period, there is cointegration relationship between SSE and SZCOMP indexes.

The Hangseng index (HSI) were cointegrated with STI, S&P 500 and Nikkei225 indexes at 5% significance level. The HSI, STI and Nikkei225 are Asian stock index. The S&P500 index were cointegrated with STI, Nikkei225 and ESTX50(EU) indexes at 5% significance level. There are exist long-term stability of balanced relationships between those pairs. We can assume the hypothesis that in the period of global financial crisis stock markets are rather affected by global evens.

Table 5.8 The Engle-Ganger cointegration tests results during post-crisis period

Post-crisis	STI	Nikkei225	S&P500	ESTX50	HSI	SZ
SSE	-1,366	-1,788	-1,542	-2,248	-1,444	-1,871
SZ	-0,748	-1,947	-1,545	-2,484	-1,373	
HSI	-3,321	-3,915*	-3,771*	-5,238*		
ESTX50	-1,424	-3,881*	-3,408			
S&P500	-0,771	-2,264				
Nikkei	-0,045					

In this period, the null hypothesis of unit root in residuals can be rejected for four pairs of indexes. The HSI is cointegrated with Nikkei 225, S&P500 and ESTX50, and the ESTX50 with Nikkei225 at 5% significance level. It is back to normal level. The SSE is cointegrated with SZCOMP, and ESTX50 with S&P500 in pre-crisis and crisis period. The ESTX50 is cointegrated with Nikkei225 in pre-crisis and post-crisis period.

It means that the local information play more important role for the development of national markets.

According to the result of cointegration test of those three periods, we could say that the residuals of regression of SSE and SZ are stationary in pre-crisis and crisis periods, and there are not any stable relationships between HSI with SSE and SZ in those three periods. It seems that the behaviour of SSE can affect SZ, but the behaviour of Hong Kong stock market can not affect Shang Hai and Shen Zhen stock markets.

5.3 Estimations of VAR Models

The VAR model should be used to determine the hysteresis k in order to satisfy the stationary conditions. If the lag is too small, the autocorrelation of the error term is very serious. It leads to the non-conformance estimation of the parameters. As in the case of the ADF test in table 5.4 and 5.5, the k-value (increasing the number of lagged variables) in the VAR model can eliminate the autocorrelation that exists in the error term. On the other hand, k value should not be too large. The

k value is too large to cause the degree of freedom to decrease, which directly affects the validity of the model parameter estimator.

In this section we will estimate that VAR (10) model for pre-crisis period is shown in Table 5.9., VAR (12) model for crisis period is shown in table 5.10 and VAR (9) model for post-crisis period is shown in table 5.11. the daily closed indexes are not stationary. It has to be used the logarithmic returns of daily closing indexes to calculate the results. For simply, all the results will be shown by the data which we assume reject the null hypothesis at 5% significance level. We have chosen volatility three which are SSE, SZ and HSI indexes to analyse in this section. All the result will be added at the end of thesis (annexes 7-9).

Table 5.9 VAR (10) model for pre-crisis period

	SSE		SZ		HSI
SSE(-4)	-0,0889	SSE(-1)	0,1440	SSE(-6)	0,0521
SSE(-7)	-0,0616	SSE(-2)	0,1111	SSE(-7)	-0,0456
SSE(-8)	-0,1114	SSE(-8)	0,0601	HSI(-1)	-0,0682
SSE(-9)	-0,0770	SSE(-10)	0,0693	ESTX50(-1)	-0,0530
SZ(-1)	0,1124	SZ(-2)	-0,0719	S&P500(-1)	0,4361
SZ(-2)	0,0646	SZ(-5)	0,0574	S&P500(-2)	0,1474
SZ(-3)	0,0787	SZ(-9)	-0,0591	S&P500(-3)	0,2182
SZ(-4)	0,0674	HSI(-6)	-0,1505	S&P500(-5)	0,0925
SZ(-6)	0,0834	S&P500(-9)	0,1282	S&P500(-6)	0,1120
SZ(-8)	0,0998	STI(-6)	0,1254	STI(-2)	-0,0676
STI(-7)	0,1148			STI(-6)	-0,0896
				Nikkei225(-1)	-0,0727
				Nikkei225(-2)	-0,0682
				Nikkei225(-3)	-0,0782
Adj. R-squared	0,0506		0,0379		0,1733
F-statistic	1,8192		1,6052		4,2221

In pre-crisis period, the own lagged values were the important independent variables. No lagged are always statistically significant in this period. In Shang Hai and Shen Zhen market, almost half

days of SSE and SZ returns were integrated with SSE and SZ indexes. Six stock indexes were integrated with HSI, it seems that U.S. market play an important role on Hong Kong market, and Chinese market play a main role by itself. If we check results of the adjusted R^2, the VAR models are not able to explain all the variability in Chinese market. The values of R^2 of Hong Kong was not so high, but the share of variability are higher than the Shang Hai and Shen Zhen markets.

Table 5.10 VAR (12) model for crisis period

	SSE		SZ		HSI
SSE(-2)	-0,207	SSE(-11)	0,129	SSE(-7)	-0,112
SZ(-3)	0,115	SZ(-6)	0,112	SZ(-4)	0,106
SZ(-4)	0,116	HSI(-2)	-0,236	SZ(-8)	0,100
SZ(-6)	0,366	S&P500(-1)	0,171	HSI(-1)	-0,375
SZ(-8)	0,211	S&P500(-8)	-0,264	HSI(-3)	-0,188
SZ(-12)	0,111	STI(-12)	-0,331	ESTX50(-4)	0,204
S&P500(-1)	0,214	Nikkei225(-12)	0,170	ESTX50(-1)	0,435
Nikkei225(-3)	-0,219			S&P500(-2)	0,209
				S&P500(-3)	0,239
				S&P500(-5)	0,177
				S&P500(-11)	-0,211
				Nikkei225(-11)	0,198
Adj. R-squared	0,200		0,023		0,313
F-statistic	2,317		1,126		3,393

In the crisis period, Chinese stock market belongs to significant independent variables in only a few cases. The own lagged values were the important independent variables (except U.S. market) and no lagged are always statistically significant in this period as same as pre-crisis period. The adjusted R^2 in this period were higher than pre crisis generally. Only a small share of variability can be explained by VAR model in Shen Zhen market. Generally, the level of adjusted R^2 increased significantly in financial crisis. It means VAR model is able to explain more share of variability.

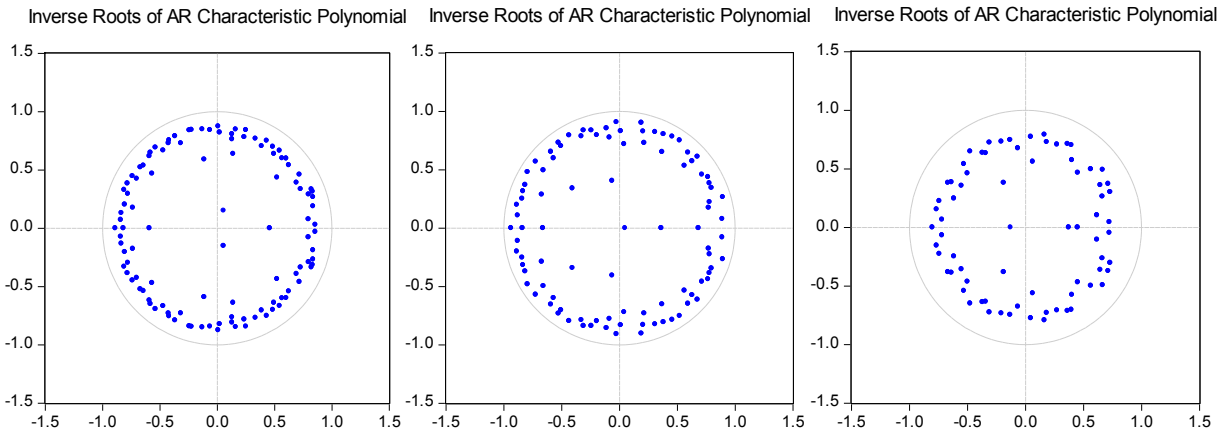
Table 5.11 VAR (9) model for post-crisis period

	SSE		SZ		HSI
SSE(-2)	-0,081	SSE(-2)	0,056	SSE(-1)	-0,053
SSE(-4)	-0,052	SSE(-3)	0,103	SSE(-3)	0,040
SSE(-5)	-0,059	SSE(-4)	0,057	SZ(-2)	0,042
SSE(-8)	-0,104	SSE(-5)	0,080	SZ(-3)	0,032
SZ(-1)	0,047	SZ(-1)	0,066	SZ(-4)	0,033
SZ(-2)	0,112	SZ(-2)	-0,053	SZ(-5)	0,032
SZ(-3)	0,075	SZ(-4)	-0,043	SZ(-7)	0,034
SZ(-4)	0,124	HSI(-1)	-0,088	SZ(-9)	0,031
SZ(-5)	0,079	HSI(-3)	-0,102	HSI(-1)	-0,105
SZ(-9)	0,046	HSI(-9)	-0,108	HSI(-3)	-0,099
HSI(-5)	0,102	ESTX50(-5)	-0,067	ESTX50(-3)	0,037
ESTX50(-5)	0,048	S&P500(-1)	0,079	S&P500(-1)	0,489
S&P500(-1)	0,184	STI(-4)	0,133	S&P500(-2)	0,179
S&P500(-4)	0,078	STI(-9)	0,132	S&P500(-3)	0,135
STI(-7)	0,093			S&P500(-4)	0,077
Nikkei225(-7)	-0,074			S&P500(-5)	0,060
				S&P500(-6)	0,056
				STI(-3)	0,076
				Nikkei225(-1)	-0,080
				Nikkkei225(-2)	-0,054
				Nikkei225(-3)	-0,052
				Nikkei225(-4)	-0,056
Adj. R-squared	0,083		0,047		0,187
F-statistic	4,130		2,700		8,969

According to the results of table 5.11. We can assume that the one day lagged S&P 500 returns are statistically significant at 5% level. It can be explained by this way that after financial crisis, the changes of S&P500 index can affect the behaviour of investors. U.S market play a main role in all the markets except Shang Hai and Shen Zhen markets. This situation is same as pre-crisis and crisis periods. Those two markets are affected by each othesr, it is more important for HSI index. If we

check the correlation between HSI and SSE, SZ, we can know that Hong Kong and the mainland have always had close economic ties. All aspects of the mainland can contribute to Hong Kong's development of stock market. The crisis effected Chinese stock market, but just a small share. The adjusted R^2 back to small size. Generally, the VAR model are able to explain a main part of share of variability during crisis period only.

Table 5.12The AR characteristics for three periods



The condition of the VAR model is that the root of the characteristic equation AR must be inside the unit circle or the root of the opposite characteristic equation AR is outside the unit circle. The table 5.12 shows that all the results are inside the unit circle. So the VAR models are stationary in pre-crisis, crisis and post-crisis period.

5.4 Results of Granger Causality Testing

In this section, we will use EViews to calculate the results of Granger causality test. The value* means that we reject null hypothesis at 5% significance level. We have chosen volatility three which are SSE, SZ and HSI indexes to analyse in this section. All the result will be added at the end of thesis (annexes 1-3).

Table 5.13 The results of Granger causality tests for pre-crisis period

Null Hypothesis:	F-Statistic	Prob.
PRE_SZ_RETURN does not Granger Cause PRE_SSE_RETURN	14,23*	7E-07
PRE_HANG_SENG_RETURN does not Granger Cause PRE_SSE_RETURN	1,951	0,142
PRE_EU_RETURN does not Granger Cause PRE_SSE_RETURN	1,037	0,355
PRE_S_P_500_RETURN does not Granger Cause PRE_SSE_RETURN	1,246	0,288
PRE_STI_INDEX_RETURN does not Granger Cause PRE_SSE_RETURN	1,620	0,198
PRE_NIKKEI_225_RETURN does not Granger Cause PRE_SSE_RETURN	1,859	0,156
PRE_SSE_RETURN does not Granger Cause PRE_SZ_RETURN	16,88*	5E-08
PRE_HANG_SENG_RETURN does not Granger Cause PRE_SZ_RETURN	0,634	0,530
PRE_EU_RETURN does not Granger Cause PRE_SZ_RETURN	0,229	0,796
PRE_S_P_500_RETURN does not Granger Cause PRE_SZ_RETURN	0,430	0,650
PRE_STI_INDEX_RETURN does not Granger Cause PRE_SZ_RETURN	0,380	0,684
PRE_NIKKEI_225_RETURN does not Granger Cause PRE_SZ_RETURN	1,562	0,210
PRE_SSE_RETURN does not Granger Cause PRE_HANG_SENG_RETURN	1,124	0,325
PRE_SZ_RETURN does not Granger Cause PRE_HANG_SENG_RETURN	2,247	0,106
PRE_EU_RETURN does not Granger Cause PRE_HANG_SENG_RETURN	0,137	0,872
PRE_S_P_500_RETURN does not Granger Cause PRE_HANG_SENG_RETURN	116,18*	5E-48
PRE_STI_INDEX_RETURN does not Granger Cause PRE_HANG_SENG_RETURN	9,179*	0,000
PRE_NIKKEI_225_RETURN does not Granger Cause PRE_HANG_SENG_RETURN	2,429	0,088

Table 5.13 shows the results for pre-crisis period. It just SSE and SZ indexes an affect each other by Granger causality test during pre-crisis period. In Hong Kong market, the change of HSI can affect by S&P 500 and STI indexes. The Nikkei 225 is the reason also, if we assume the significance level at 1%. It seems that a change in SSE was the cause of SZ, and a change in SZ was the cause of SSE during pre-crisis period. The changes in S&P 500 and STI were the cause of HSI. Singapore is a small open economy country. It vulnerable to the external economic environment. The financial services sector is an important pillar of the Singapore economy. It accounting for about 12 percent of GDP, and contributing 5 percent of employment to Singapore. The geographical location between Hong Kong and Singapore can explain this result in table 5.13.

Table 5.14 The results of Granger causality tests for crisis period

Null Hypothesis:	F-Statistic	Prob.
CRISIS_SZ_RETURN does not Granger Cause CRISIS_SSE_RETURN	1,537	0,216
CRISIS_HANG_SENG_RETURN does not Granger Cause CRISIS_SSE_RETURN	0,065	0,937
CRISIS_EU_RETURN does not Granger Cause CRISIS_SSE_RETURN	0,005	0,995
CRISIS_S_P_500_RETURN does not Granger Cause CRISIS_SSE_RETURN	7,060*	0,001
CRISIS_STI_INDEX_RETURN does not Granger Cause CRISIS_SSE_RETURN	0,816	0,443
CRISIS_NIKKEI_225_RETURN does not Granger Cause CRISIS_SSE_RETURN	0,762	0,467

CRISIS_SSE_RETURN does not Granger Cause CRISIS_SZ_RETURN	1,467	0,232
CRISIS_HANG_SENG_RETURN does not Granger Cause CRISIS_SZ_RETURN	0,352	0,704
CRISIS_EU_RETURN does not Granger Cause CRISIS_SZ_RETURN	1,364	0,257
CRISIS_S_P_500_RETURN does not Granger Cause CRISIS_SZ_RETURN	2,339	0,098
CRISIS_STI_INDEX_RETURN does not Granger Cause CRISIS_SZ_RETURN	0,090	0,914
CRISIS_NIKKEI_225_RETURN does not Granger Cause CRISIS_SZ_RETURN	0,007	0,993

CRISIS_SSE_RETURN does not Granger Cause CRISIS_HANG_SENG_RETURN	5,349*	0,005
CRISIS_SZ_RETURN does not Granger Cause CRISIS_HANG_SENG_RETURN	0,287	0,751
CRISIS_EU_RETURN does not Granger Cause CRISIS_HANG_SENG_RETURN	0,078	0,925
CRISIS_S_P_500_RETURN does not Granger Cause CRISIS_HANG_SENG_RETURN	39,70*	0,000
CRISIS_STI_INDEX_RETURN does not Granger Cause CRISIS_HANG_SENG_RETURN	21,88*	0,000
CRISIS_NIKKEI_225_RETURN does not Granger Cause CRISIS_HANG_SENG_RETURN	0,094	0,911

The interesting point is that the S&P 500 was effecting all the indexes in crisis period (the SZ index also if we set the significance level at 1%). The crisis started in US, so this tests prove that the results were reasonable. The interesting point is that the S&P 500 was effecting all the indexes in crisis period (the SZ index also if we set the significance level at 1%). The crisis started in US, so this tests prove that the results were reasonable. The Chinese market had little affect from financial crisis if we compare with other markets. China planted to expand domestic demand. It drives domestic consumption and reduce dependence on foreign markets. The changes of STI and SSE were caused by HSI in crisis period. There are three variables caused by HSI, but it was only one variable in SSE and SZ. There is a direct and indirect link between Hong Kong stock market which

is one of the world's most developed stock markets and Chinese mainland stock market. As more and more mainland enterprises choose to be listed in Hong Kong and the mainland at the same time, H-share market, the proportion of mainland Chinese enterprises become growing. It led to the two stock market linkage effect more obvious.

Move to EU market (data was shown in lists of annex2), it extraordinary different with SZ market. Any index can effect EU market in crisis period. After the US New Century Financial Company filed a bankruptcy application. On 9th August 2007, BNP Paribas is the first bank in Europe to claim to be involved in US subprime lending. The media also disclosed that the German IKB Industrial Bank had two such funds in the United States on the verge of bankruptcy. Societe Generale and Raleigh Bank were all involved in the US subordinated debt and suffered losses.

In September 2007, the North Bank of the United Kingdom by the depositors run. It marks the European credit crunch had been upgraded to a credit crisis. On the 21th January 2008, the global stock market rare stock market crash. The European three major stock indexes fell more than 5%. It exacerbated Europe People and investors of the crisis panic. At this time, any type of change of stock indexes in the world can effect the EU stock market. The global economic growth rate was the lowest since World War II. The developed economies have experienced negative growth for the first time since World War II, and a decline of up to 2%. In the middle of 2008, the US economy negative grow by 1.6%, France was 1.9%, Germany was 2.5%, the UK was the strongest 2.8%.

Table 5.15 The results of Granger causality tests for post-crisis period

Null Hypothesis:	F-Statistic	Prob.
AFTER_SZ_RETURN does not Granger Cause AFTER_SSE_RETURN	24,43*	0,000
AFER_HANG_SENG_RETURN does not Granger Cause AFTER_SSE_RETURN	0,463	0,630
AFTER_EU_RETURN does not Granger Cause AFTER_SSE_RETURN	0,820	0,441
AFTER_S_P_500_RETURN does not Granger Cause AFTER_SSE_RETURN	19,73*	0,000
AFTER_STI_INDEX_RETURN does not Granger Cause AFTER_SSE_RETURN	0,049	0,952
AFTER_NIKKEI_225_RETURN does not Granger Cause AFTER_SSE_RETURN	0,723	0,485

AFTER_SSE_RETURN does not Granger Cause AFTER_SZ_RETURN	15,50*	0,000
AFER_HANG_SENG_RETURN does not Granger Cause AFTER_SZ_RETURN	2,031	0,131
AFTER_EU_RETURN does not Granger Cause AFTER_SZ_RETURN	1,845	0,158
AFTER_S_P_500_RETURN does not Granger Cause AFTER_SZ_RETURN	3,789*	0,023

AFTER_STI_INDEX_RETURN does not Granger Cause AFTER_SZ_RETURN	1,473	0,229
AFTER_NIKKEI_225_RETURN does not Granger Cause AFTER_SZ_RETURN	3,840*	0,022

AFTER_SSE_RETURN does not Granger Cause AFER_HANG_SENG_RETURN	2,305	0,100
AFTER_SZ_RETURN does not Granger Cause AFER_HANG_SENG_RETURN	7,315*	0,001
AFTER_EU_RETURN does not Granger Cause AFER_HANG_SENG_RETURN	4,219*	0,015
AFTER_S_P_500_RETURN does not Granger Cause AFER_HANG_SENG_RETURN	223,4*	0,000
AFTER_STI_INDEX_RETURN does not Granger Cause AFER_HANG_SENG_RETURN	9,776*	0,000

In the post-crisis period. There are five markets can effect HSI. The SSE, SZ indexes did granger cause STI index. Singapore stock market is like a microcosm of China's stock market. Although the volatility is not bigger than China's stock market, but the trend is roughly consistent with the Chinese stock market. Singapore stock market also has Chinese investors to invest, their emotions will be affected by the Chinese stock market. There are many Singapore-listed companies operating in China. China's economic situation will affect the performance of these companies, so investors will pay close attention to China's economic data. Singapore is the eighth Big trading partner of China. China is Singapore's second largest trading partner.

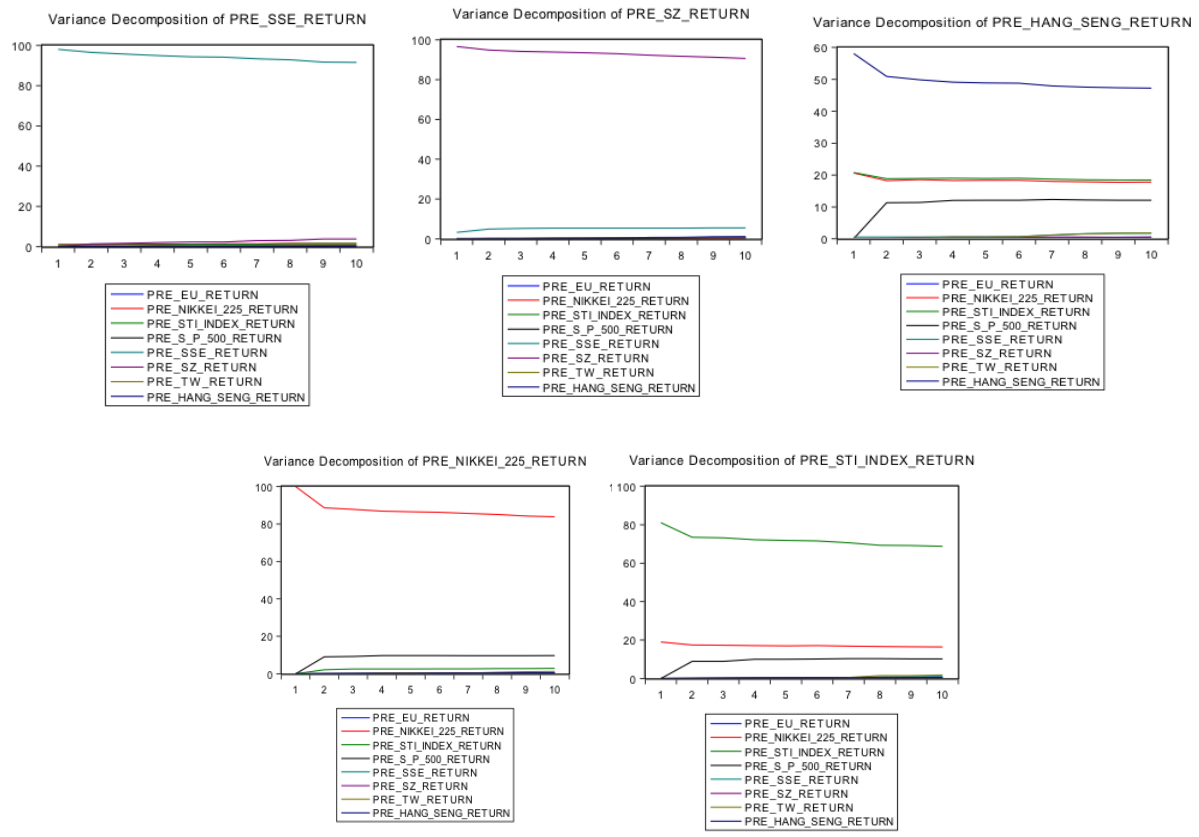
Hong Kong, as one of the international financial central that rely on foreign trade. It can significantly reflect the changes in the international economic situation and international stock markets. The linkage between the Hong Kong stock market, the Shanghai and Shenzhen stock markets are derived from the convergence of capital and the broader penetration of the real economy. Due to the results of crisis and post-crisis period. We can say that the "China factor" is playing an increasingly important role.

5.5 Results of Variance Decomposition

Since the OLS estimator of the VAR model parameter is only consistent, the economic interpretation of the individual parameter estimates is difficult. If we want to analyse a VAR model, it is usually observed that the variance decomposition of the system. In this section, we will use EViews as a tool to analyse the variance decomposition of SSE, SZ, EU, STI, S&P500, HSI and Nikkei225 indexes of logarithmic returns in pre-crisis, crisis and post-crisis periods. Because of he volatility of two results which are STI and Nikkei 225, we have chosen Asian markets which are

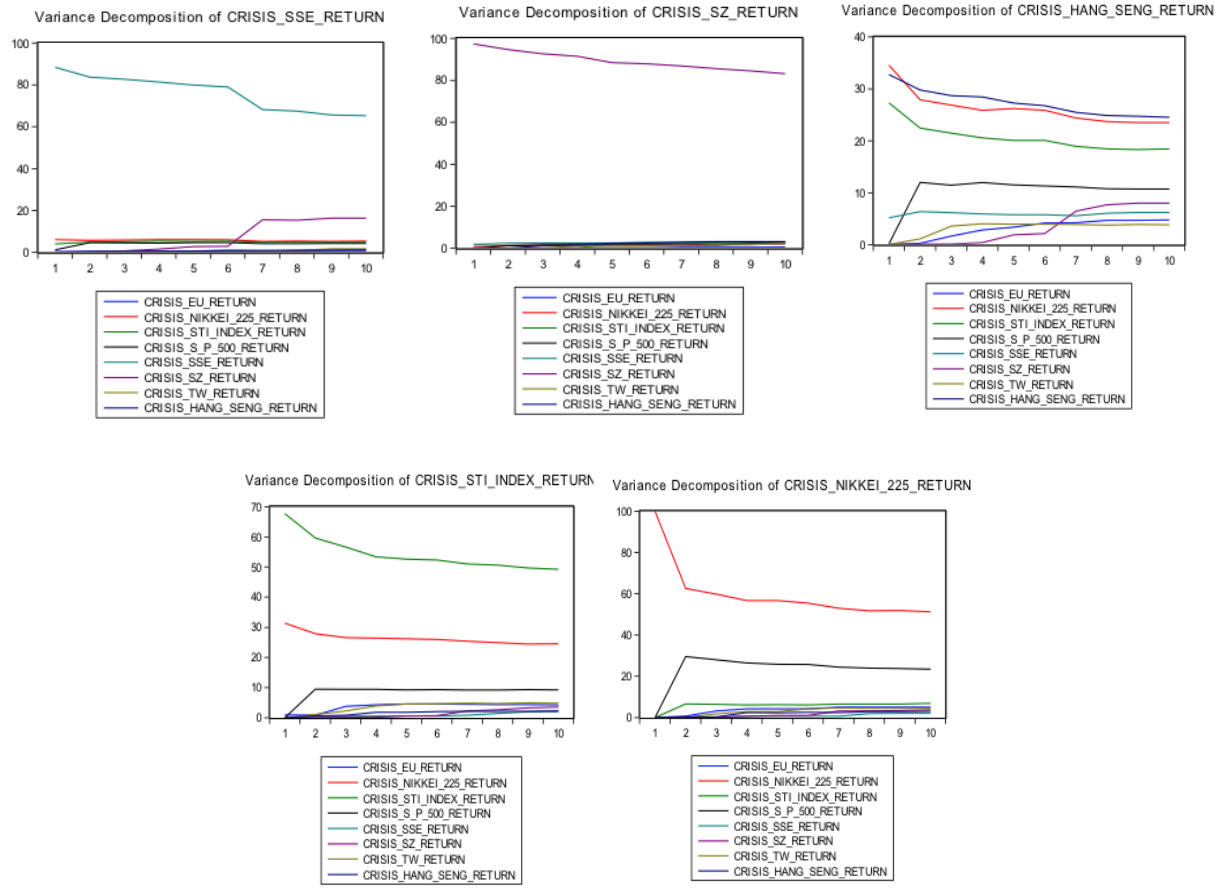
SSE, SZ, HSI, STI and Nikkei225 to analyse in this section. All the result will be added at the end of thesis (annexes 4-6).

Figure 5.16 Variance decomposition of Asian stock markets indexes pre-crisis period



The ordinate in the graph represents the effect of an index on the impact of another index and the abscissa represents the duration of the impact of an index on the other. From figure 5.16 we can see that the highest proportion of variability of those indexes was domestic factor. It is between 45% -100%. In Shang Hai and Shen Zhen markets, this proportion were neatly 100%. The SSZ was the reason for SZ, but just 5% in this period. In Hong Kong market, the proportion variability of Nikkei 225 and STI are similar which is between 16%-20%, the proportion was decreasing after 2 days. It means that change of HSI can affect those two indexes but not for all the time. The proportion of S&P was increasing a lot from 1 day to 2 days in variance decomposition of HSI and STI. Nikkei 225 is one of the factors for STI index also. Generally, their own index was a main role in those three indexes in pre-crisis period.

Figure 5.17 Variance decomposition of Asian stock markets indexes in crisis period

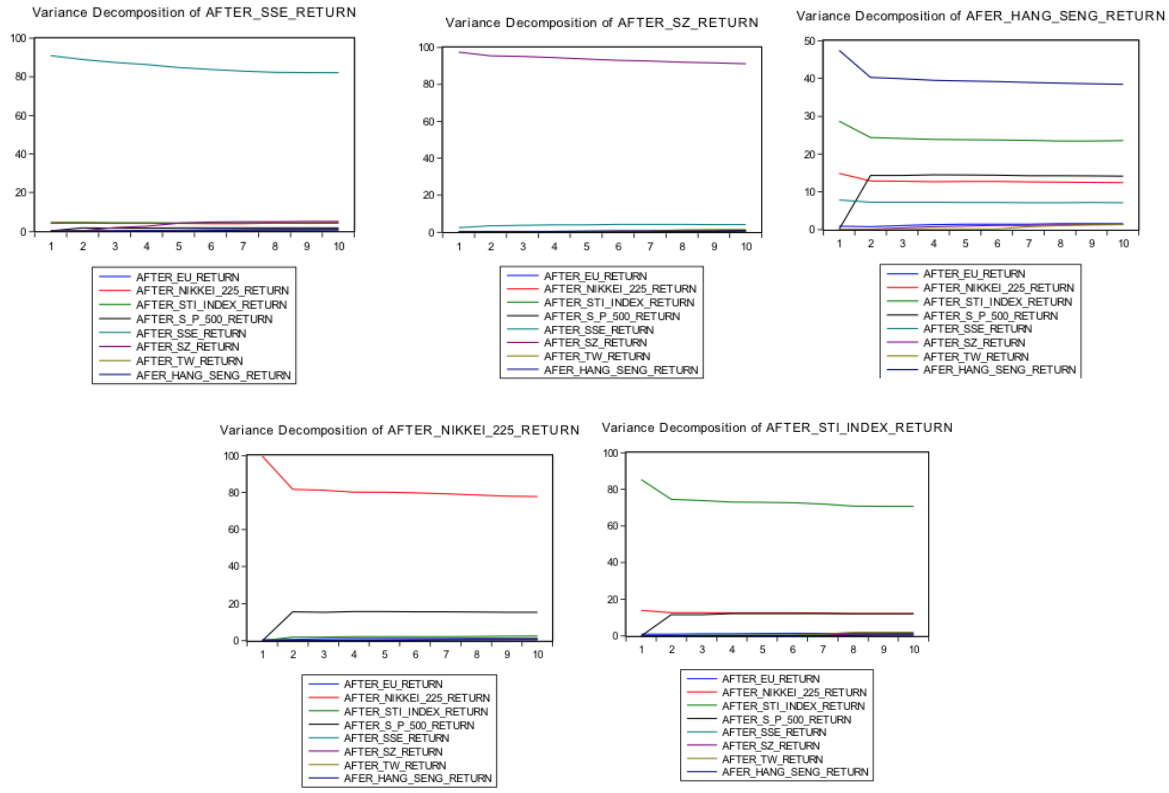


The correlation between S&P 500 and SZ was 0.0256 in crisis period, figure 5.17 proves that just a few were affected in SZ again. The S&P 500 became an important factor in SSZ, we can see that the trend was increasing from 0%(nearly) to 20% in one day, and the trend of SSZ stated decrease from 6 days, China has not suffered severe financial crisis, but the impact of the global financial crisis and the recession has had an impact on China.

The trends are more volatility in crisis period. The HSI is the most changeful one. There are three main indexes which are able to effect HSI, they are the Nikkei 225, STI and HSI (between 18%-35%). In figure 5.17, those three trends were decreasing in 10 days, but the S&P 500 line was increasing after 2 days then invariability (generally) in the period. The same as STI and Nikkei 225. The US market is a key role when decomposition variance. The Shang Hai market and Shen Zhen market effected Hong Kong market, the proportion of SZ index was increasing after 6days.

which means that the SZ impact on HSI to increase during period. The proportion of any indexes is not a great amount, but we can see the proportion is visible in figure 5.17 on HSI. Nikkei 225 index plays a main point in STI (around 26%). As we mentioned that Japan is developed by the U.S. The Japanese stock market has a long-term equilibrium relationship with the United States. So the S&P 500 was the main factors in Japan market during crisis period.

Figure 5.18 Variance decomposition of Asian stock markets indexes in post-crisis period



Due to the change of trends in figure 5.18. The proportions were more stable than crisis period. The trends of SSZ and SZ are similar with pre-crisis period. All the lines are close to straight after 2 days. The structure of proportion of variability is similar in Singapore and Japan market. It is above 70% by domestic factor, and 0% to 20% by US market. In the long run, the impact of the US market on Singapore and Japan can not be ignored. The similar point of Hong Kong market during crisis period and post-crisis period is that all the factors play a role in Hong Kong market. In this period, the proportion of HSI is higher than crisis period. The proportion Nikkei 225 is lower than the proportion in crisis period. The impact on Hong Kong market on Japan market is

decreasing. The Shang Hai market play a role in Hong Kong market, even the proportion variability is not a high value.

5.6 Summary of Achieved Results

In this section, we will make a summary of results during chapters 5.1-5.5. In this chapter, we have described the correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition of Shanghai Composite Stock Index (SSE), Hang Seng Stock Index(HSI), Shenzhen SZCOMP Stock Index (SZ), Straits Times Index(STI), Nikkei 225 Stock Index (Nikkei 225), EUROSTOCK 50 Stock Index (ESTX50 or EU), S&P500 Stock Index (S&P 500).

The period from 2003-2015 was divided into three sub-periods in order to distinguish different behaviour of stock indexes. The three main parts are: Pre-crisis (01/01/2003-01/10/2007), Crisis (01/10/2007-01/03/2009) and Post-crisis (01/03/2009-30/12/2015). Crisis period was defined at the basics of development of US stock market. We have chosen the lowest time and the highest time of S&P stock index for the time tables, because the origin reason of financial crisis 2008 were from USA.

The analysis of correlation has shown that the connection among SSE, SZ and HSI were not closely linked. Because companies listed on the Shen Zhen Stock Exchange can not trade on the Shang Hai Stock Exchange. Companies listed on the Shang Hai Stock Exchange can not trade on the Shen Zhen Stock Exchange. The two cities of the trading varieties are slightly different, the Shang Hai Stock Exchange focused on large and medium-sized enterprises, while the Shen Zhen Stock Exchange is focused on venture capital and small and medium enterprises. The results of pairs of HSI with STI and HSI with Nikkei225 were higher than 0.5 during pre-crisis, crisis and post-crisis period. The open economy is the economic structure in Hong Kong and Singapore. Hong Kong, Singapore and Japan are the important financial, trade, transportation, tourism, information and communication central in the world. Geographical location let them connect with each other. Due to the results of correlation of three periods, the Asian stock index were effected by each other in this period, but the Europe and America markets were connected by other reasons.

The result of ADF statistics for logarithmic returns and daily closed values showed that we have chose the logarithmic returns for VAR models, Granger causality testing and variance decomposition in this thesis. The results cointegration tests showed that the Shanghai market is

cointegrated with Shenzhen market. There are not any stable relationships between HSI with SSE and SZ in those three periods. It seems that the behaviour of SSE can affect SZ, but the behaviour of Hong Kong stock market can not affect Shang Hai and Shen Zhen stock markets. The Euro area market are cointegrated with Japanese market and US market at significance level 5% in pre-crisis period and crisis period. The number of pairs were increasing to seven in crisis period.

The results of VAR model showed that the U.S market play a main role in all the markets except Shang Hai and Shen Zhen markets. Those two markets are effected by each other. The crisis effected Chinese stock market, but just a small share. In EU market, almost all days of EU and S&P500 returns were integrated with ESTX50 index. Generally, the VAR models are not able to explain more share of variability in pre-crisis and post-crisis period.

Due to the results of Granger causality test. The Chinese market had little affect from financial crisis if we compare with other markets. China planted to expand domestic demand. It drives domestic consumption and reduce dependence on foreign markets. The changes of STI and SSE were cause HSI in crisis period. There are three variables were cause HSI, but it was only one variable in SSE and SZ. Changes of other indexes can effect Japan's stock market. The proportion of foreign investors in the Japanese stock market is about 30%. Singapore stock market is like a microcosm of China's stock market. Singapore stock market also has Chinese investors to invest, their emotions will be affected by the Chinese stock market. The "China factor" is playing an increasingly important role. The S&P 500 was effecting all the indexes in crisis period. The crisis started in US, so this tests prove that the results were reasonable. We can assume the hypothesis that in the period of global financial crisis stock markets are rather affected by global evens.

The linkage between the Hong Kong stock market, the Shanghai and Shenzhen stock markets is derived from the convergence of capital and the broader penetration of the real economy. We had the different results of SSZ, SZ and HSI during estimation of chapters 5.1-5.5, because of the different trading rules. The Hong Kong stock market is more exoteric than Shang Hai and Shen Zhen stock markets.

6. Conclusion

The main aim of this thesis was the econometric analysis of interactions of Chinese stock markets with Asian and developed global stock markets during 2003-2015 years. The first sub-goal was to compare the degree of interaction of Hong Kong, Shanghai and Shenzhen stock markets. The second sub-goal was to evaluate an impact of the global financial crisis on interactions of Chinese stock market with Asian and developed global markets.

For the propose of this thesis, we utilized daily closing prices of stock indexes of Shang Hai, Shen Zhen, Hong Kong, Singapore, Japan, European and U.S. stock markets. The methods used in this thesis were correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition.

This thesis was divided into six parts. The first and last one were the introduction and conclusion of the thesis. In the chapter 2, the basic characteristics, classification and main studios of stock markets have been introduced.

The chapter 3 was introduction of methodology of econometrics which we have use in this thesis. We have described the basic information of econometrics and types of data which we estimate in this thesis. The main contents and steps of correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition have stated.

In the chapter 4, the basic information of stock markets of Chinese, Singapore, Japan, United State and European have been introduced. Further more, we have described the data sample and basic characteristics of used time series of stock indexes which we have analysed in this thesis. They are Shanghai Composite Stock Index (SSE), Hang Seng Stock Index(HSI), Shenzhen SZCOMP Stock Index (SZ), Straits Times Index(STI), Nikkei 225 Stock Index (Nikkei 225), EUROSTOCK 50 Stock Index (ESTX50 or EU), S&P500 Stock Index (S&P 500). This sub-period was divided into three main periods in this thesis: Pre-crisis (01/01/2003-01/10/2007), Crisis (01/10/2007-01/03/2009) and Post-crisis (01/03/2009-30/12/2015).

The chapter 5 was the estimations and descriptions of all the data of correlation analysis, cointegration analysis, vector autoregression model, Granger causality and variance decomposition in pre-crisis, crisis and post-crisis periods.

For our main aim of this thesis, the Asian stock indexes were affected by each other. Especially the connections of Chinese and Singapore Stock Markets. The main reason of changes of stock indexes

were national factors, but the Japanese and European markets are rather influenced by the U.S stock market than their own market during the periods.

For the first sub-goal, there are not any stable relationships between HSI with SSE and SZ in those three periods. It seems that the behaviour of SSE can affect SZ, but the behaviour of Hong Kong stock market can not affect Shang Hai and Shen Zhen stock markets. There is a direct and indirect link between Hong Kong stock market which is one of the world's most developed stock markets and Chinese mainland stock market. As more and more mainland enterprises choose to be listed in Hong Kong and the mainland at the same time, H-share market, the proportion of mainland Chinese enterprises become growing. It led to the two stock market linkage effect is more obvious.

For the second sub-goal, the results we calculated present that the financial crisis in 2008 changed the indexes of stock markets which we analysed. U.S. stock market play a main role in crisis period. The crisis did not affected Shang Hai and Shen Zhen stock markets significantly. However, the opposite was true in Hong Kong stock market. U.S stock market was more important also for Japan, EU, Singapore stock markets. The results of all methods were similar in pre-crisis and post-crisis period, but the connections of post-crisis of all stock markets were higher than pre-crisis period in small share. It means that the globalization of financial market is more important in the world. Regarding to the calculation, all the markets were getting closer during crisis period, even nowadays.

In this thesis, the main contents in chapter 2 and chapter 3 were references from books. All the results of charts and tables of chapter 4 and chapter 5 were from the MS Excel and EViews calculated by the author.

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List of Abbreviations

ADF: Dickey-Fuller test

ABS: Asset-Backed Securities

AIC: Akaike Information Criterion

ESTX50 or EU:EUROSTOCK 50 Stock Index

GDP: Gross Domestic Product

LR: Likelihood Ratio

LSE: London Stock Exchange

IPO: Initial Public Offering

NYSE: New York Stock Exchange

Nikkei225: Nikkei 225 Stock Index

OTC: Over-The-Counter

OSL: Ordinary Least Squares

SC: Schwartz Criterion

SSZ: Shang Hai Composite Stock Index

SZ: Shen Zhen SZCOMP Stock Index

STI: Straits Times Index

S&P500: Standard & Poor's 500 Stock Index

TSE: Tokyo Stock Exchange

RSS: Residual Sum of Squares

VAR: Vector Autoregression Model

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