INTERNATIONAL MARKET INTEGRATION AND MARKET INTERDEPENDENCE: EVIDENCE FROM CHINA'S STOCK MARKET IN THE POST-WTO ACCESSION PERIOD

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ABSTRACT

China has implemented a series of financial liberalisation policies in its stock market to meet its accession commitments since China's entry into the WTO in 2001. To a large extent, China has successfully managed the process of transition from a closed market to a partially opened market. China's experience is particularly intriguing because it can further the understanding of financial liberalisation in emerging markets, especially for those without a sound legal and institutional environment. This thesis aims to examine the impacts of China's financial liberalisation on stock market in the post-WTO accession period from two aspects: international market integration and international market interdependence. More specifically, this thesis is going to measure the degrees of market integration and market interdependence between China and the world stock markets respectively, and examine the relationship between these two elements.

The first empirical study of this thesis (Chapter 4) gauges the degree of stock market segmentation (inversely, market integration) between China and the world, and analyses the specific impacts of China's financial liberalisation policies on stock market segmentation. This chapter mainly employs the weak-form measure, which is based on stochastic discount factors (SDF), to gauge the non-normalised degree of stock market segmentation. Meanwhile, this chapter normalises the non-normalised degree of stock market segmentation between China and the world by taking the non-normalised one between the US and the world as a benchmark.

This chapter argues that China's financial liberalisation might have largely decreased the stock market segmentation between China and the world in the period from July 2003 to June 2007, which has been interrupted by the financial crisis in 2008. Meanwhile, this chapter finds that some, but not all, of China's financial liberalisation policies might be regarded as effective, among which are the QFII programme in 2003, the first round of exchange rate reform in 2005 and the QDII programme in 2006,

while others may be ineffective, such as allowing domestic investors to purchase B shares in 2001, and issuing the notice on transfer the state-owned and corporation shares to foreign investors in 2002.

The second empirical study of this thesis (Chapter 5) gauges the degree of stock market interdependence between China and the world, and analyses the specific impacts of China's financial liberalisation policies on stock market interdependence. This chapter primarily utilises the multi-factor R-squared measure on the basis of the principal component analysis (PCA) to measure the non-normalised degree of stock market interdependence. Similar to Chapter 4, this chapter also normalises the non-normalised degree of stock market interdependence between China and the world by taking the non-normalised one between the US and the world as a benchmark.

This chapter finds that the normalised degree of stock market interdependence between China and the world have experienced three stages: 1) the stationary stage at a low level from July 2001 to June 2003; 2) the increasing and steady stage at a moderate level from July 2003 to June 2006, which might be thanks to China's financial liberalisation; as well as 3) an inverted U-shaped pattern during the period from July 2006 to December 2009, which might be attributed to China's economy overheating in the first half year of 2007 and to China's economic stimulus plan in 2008. Meanwhile, this chapter provides strong evidence of the presence of other factors, such as investors' overreaction, rather than financial liberalisation that has highly increased market interdependence in some cases.

On the basis of results obtained from Chapters 4 and 5, the third empirical study of this thesis (Chapter 6) examines the relationship between market integration and market interdependence by a series of tests, namely, the ADF unit root test, the MWALD test for causality analysis, the co-integration tests by the Engle-Granger two-step approach, as well as the event-specific analysis of China's financial

liberalisation. For the sake of caution, this chapter adopts bootstrap procedures for these tests accordingly, due to the small sample size of this study.

This chapter provides supportive evidence of a unidirectional Granger-causality running from market integration to market interdependence. Meanwhile, this chapter finds that there is a cointegration relationship between market integration and market interdependence. Furthermore, this chapter supports the hypothesis that market integration and market interdependence are highly connected but different issues. Market integration is one, but not the only, determinant of market interdependence.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ARCH	Autoregressive Conditional Heteroskedasticity
AREAER	Annual Report on Exchange Arrangements and Exchange Restrictions
CAPM	Capital Asset Pricing Model
CBRC	China Banking Regulatory Commission
CIRC	China Insurance Regulatory Commission
CPC	Communist Party of China
CSRC	China Securities Regulatory Commission
DCC	Dynamic Conditional Correlation
DGP	Data Generating Process
EMU	European Monetary Union
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GATS	General Agreement of Trade in Service
GATT	General Agreement on Tariffs and Trade
GVD	Generalized Variance Decomposition
IMF	International Monetary Fund
IPO	Initial Public Offering
IRF	Impulse Response Function
LOP	Law of One Price
MWALD	Modified Wald
NPC	National People's Congress
OECD	Organisation for Economic Co-operation and Development
OTC	Over-the-Counter
PBC	People's Bank of China
PCA	Principal Component Analysis
P/E	Price-to-earnings
QDII	Qualified Domestic Institutional Investors
QFII	Qualified Foreign Institutional Investors
RMB	Renminbi
SAFE	State Administration of Foreign Exchange
SCSC	State Council Securities Commission
SDF	Stochastic Discount Factors

SEHK	Stock Exchange of Hong Kong
SOE	State Owned Enterprise
SSE	Shanghai Security Exchange
SZSE	Shenzhen Stock Exchange
US	United States
USD	United States Dollar
VAR	Vector Auto-Regression
VD	Variance Decomposition
WTO	World Trade Organisation

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CHAPTER 1: INTRODUCTION

In order to provide an overview of this thesis, this chapter is going to give a brief introduction, including 1) the theme, background and implication of the study, 2) motivation, objectives and methodologies, as well as 3) the structure of this study.

1.1 Theme, background and implications of this study

The last three decades have witnessed a growing financial liberalisation of capital markets across the world, in large part due to the removal or relaxation of foreign ownership restriction and the deregulation of domestic financial market. Not only the OECD countries have reduced their capital control to the lowest point in the past fifty years, but also the developing countries have increased their financial linkages with the worldwide economy. However, not all countries have benefited from financial liberalisation, especially for those that have hastened to liberalize their financial system without a sound legal and institutional framework (Tobin & Sun, 2009). Some developing countries have experienced a slow economic growth, recession, and even financial crisis in the years following their financial liberalisation.

Every coin has two sides, and so does financial liberalisation. On the one hand, financial liberalisation may reduce or remove the trade obstacles between markets, such as foreign ownership restriction, and therefore enhance the integration of financial markets across borders. Theoretically, financial market integration is expected to improve economic growth, welfare and productivity not only from direct channels but also from collateral benefits. The direct channels mainly include risk sharing, the improvement of capital efficiency, as well as the reduction of the cost of capital (Pagano, 1993; Obstfeld, 1994; Kim, Moshirian, & Wu, 2005; Baele, Ferrando, Hordahl, Krylova, & Monnet, 2004; Demyanyk & Volosovych, 2008; Kose, Prasad, & Terrones, 2009; Honig, 2008). The collateral benefits primarily concern the development of financial market and institution, the improvement of corporate

governance, as well as the enhancement of macroeconomic surveillance (Kose M. A., Prasad, Rogoff, & Wei, 2006; Tobin & Sun, 2009).

However, financial market integration *per se* does not possess any positive effect obviously. The effects of financial market integration heavily depend on certain thresholds, such as good institutional quality and the development of domestic financial sector (Masten, Coricelli, & Masten, 2008). Various threshold conditions should be met before countries are able to reap the growth and stability benefits of financial globalisation (Chinn & Ito, 2006). Otherwise, these countries are more likely to experience financial crisis and lower growth rates (Wei, 2006).

On the other hand, financial liberalisation may increase financial market interdependence, such as volatility spillover and market comovement, as it facilitates the free flow of capital and investment across borders by removing impediments to cross-market transactions. Fuelled by financial liberalisation, volatilities can spill over to other countries with greater ease and speed, which may result in financial market comovement and even financial crisis contagion. A spate of international financial crises in the last decades, in particular, the Mexican crisis of 1995, the Asian crisis during 1997 to 1998 and the Russian government default in 1998, as well as the sub-prime mortgage crisis in 2008, has testified that financial crises are more likely to spread across countries as international financial markets are becoming more interdependent.

Meanwhile, financial market interdependence is generally believed to impair the benefits of international diversification because of the increase in the correlation between financial markets. For example, financial markets are inclined to move together during the period of financial downturn, which is the bad time for the benefits of international risk diversification (Solinik, Boucrelle, & Fur, 1996). As pointed out by Ang and Bekaert (2002), however, a high-volatility bear market does not

necessarily negate the benefits of international diversification since regime switches and currency hedging may offer further benefit.

As aforementioned, the issue of financial liberalisation has profound impacts on various aspects of the economy, such as economic growth, capital flow, as well as portfolio and risk management. This issue has received extensive attention from both practitioners and scholars because of its complexity and importance, especially in the era of globalisation. Although there have been intensive studies on the financial liberalisation of emerging markets, the existing literature has not systematically explored the effects of China's financial liberalisation on its stock market. Most of the current studies focus on this subject either at the regional rather than global level, or from the perspective of a single liberalisation policy rather than from a series of policies. In order to fill in the gap in literature, this thesis is going to examine this subject from two aspects: 1) international market integration and 2) international market interdependence. More specifically, this thesis is going to examine international market integration and market interdependence between China and the world stock markets, as well as the relationship between market integration and market interdependence, in the period after China's accession to the World Trade Organisation (WTO) in 2001.

The reason for choosing China's stock market in the post-WTO accession period is not only its rapid development but also its experiences of financial liberalisation in this period. China's stock market has a history of no more than 20 years but has grown to the second largest one in the world in terms of market capitalization. Meanwhile, China's stock market has been liberalised to a large extent, especially after China's accession to the WTO in 2001[1]. A series of financial liberalisation events, such as the Qualified Foreign Institutional Investors (QFII) programme in 2002, the Renminbi (RMB) exchange rate reform in 2005, as well as the Qualified Domestic Institutional

[1] The Chinese government has always been relatively prudent in financial market opening, especially before China's accession into the WTO in 2001.

Investors (QDII) programme in 2006, show that China has carried out an unprecedented opening up of its stock market in the post-WTO accession period. According to the reports of the Office of the United States Trade Representative, China has fully fulfilled its WTO commitments in the securities industry at the end of 2005 and in the financial service at the end of 2006 (Kwon, 2009). Although the event of China's accession to the WTO, *per se*, may not have liberalised China's stock market, it has embarked on a new journey of financial liberalisation on stock market. Against the background of sustainable economic growth, China's progressive financial liberalisation in the post-WTO accession period provides a unique opportunity to observe its impacts on international market integration and market interdependence between China and the world stock market.

This thesis has three main implications. Firstly, it provides empirical support for the theory of financial liberalisation, especially for the developing countries, through the case of China's financial liberalisation. A better understanding of China's financial liberalisation policies on its stock market offers helpful insights for other emerging markets undergoing similar processes. Secondly, to some extent it presents useful information for Chinese policy-makers to assess the impacts of China's financial liberalisation policies on its stock market in the last decade. By looking back at previous financial policies, policy-makers can focus the most challenging issue and make financial regulatory policies correspondingly. Lastly, it sheds some light on international investment in China's stock market for market participants. The degrees of market integration and market interdependence between China and the world stock markets may provide a guide for investment strategies, such as portfolio diversification and arbitrage across countries.

1.2 Motivation, objectives and research questions

In the process of China's financial liberalisation, one of the challenging problems that need to be addressed is how to evaluate the specific impacts of financial liberalisation

policies on stock market in the post-WTO accession period. As *de jure* financial liberalisation policies are not necessarily *de facto* effective, not all financial liberalization policies can certainly affect stock market. Meanwhile, the *de facto* effects of financial liberalisation policies depend on other conditions, such as the willingness of investors, the judgement of investors on regulatory reforms as well as other forms of market imperfections (Bekaert, Harvey, & Lundblad, 2003). Consequently, it is not easy to examine the impacts of financial liberalisation on stock market, though this issue plays an important role in modern financial theory and practice.

If a financial liberalisation policy is *de facto* effective, it is expected to have dual effects. The first one is that international market integration should be enhanced by financial liberalisation, as it removes trade obstacles to cross-border transactions. The second one is that international market interdependence should also be increased by financial liberalisation, because it spurs volatility spillover and market comovement by facilitating capital flow and investment across borders. On the contrary, however, an ineffective can also increase market interdependence in the short term, though it fails to increase market integration fundamentally. In a short time period, the impacts of financial liberalisation policy might be overestimated by domestic investors, due to private or imperfect information (Kaminsky & Schmukler, 2008), even though this policy is *de facto* ineffective. A shock is therefore induced to equity prices in one market and spills over to others. In this way, market interdependence among these markets is increased in a short time period. In the long term, however, this kind of rising market interdependence triggered by ineffective financial liberalisation event is inclined to vanish, as more information is revealed over time. Although an ineffective financial liberalisation policy cannot increase international market integration fundamentally, it might result in an increase of international market interdependence directly through investors' overreaction in a short term period. Consequently, the

effects of financial liberalisation policy on stock market can be examined from two aspects: market integration and market interdependence.

As for examining the effects of financial liberalisation, most of the previous studies treat financial liberalisation as a one-time event by assuming that it occurs at a single point in time (Umutlu, Akdeniz, & Altay-Salih, 2010). The empirical findings are heavily dependent on the liberalisation date selected, as the effects of financial liberalisation event are shown by the difference between the pre- and post- event periods. Different liberalisation dates selected may lead to different inferences in such studies. In recent study, however, financial liberalisation is more recognised as a process with its intensity and speed changing over time (Carrieri, Errunza, & Hogan, 2007). In order to capture the time-varying nature of financial liberalisation, this thesis is going to measure the degrees of market integration and market interdependence by a sliding time window of fixed length. In this way, the time series of degrees of market integration and market interdependence are going to be obtained for analysing the time-varying characteristics of financial liberalisation. Meanwhile, a series of financial liberalisation policies, rather than a single one, can be analysed via the time series of degrees of market integration and market interdependence. Furthermore, the relationship between market integration and market interdependence can be examined via these two time series. Although market integration is intuitively believed to contribute to market interdependence (Geotzmann, Li, & Rouwenhorst, 2005), there is a lack of empirical evidence on their relationship.

In order to achieve these purposes, this thesis is going to gauge the degrees of market integration and market interdependence between China and the world stock markets in the post-WTO accession period respectively, and to examine the relationship between market integration and market interdependence. Correspondingly, this thesis is going to answer three research questions as follows. The first research question is whether and to what degree Chinese financial liberalisation policies have decreased stock market segmentation between China and the world. The second one is whether and to

what degree Chinese financial liberalisation policies have increased stock market interdependence between China and the world. The last one is whether and to what degree market integration has contributed to market interdependence.

The first research question is addressed by gauging the degree of stock market segmentation between China and the world in the post-WTO accession period. Among a variety of determinants, financial liberalisation is regarded as an important one for financial market integration. Spurred by a series of financial liberalisation events, the degree of stock market integration between China and the world is intuitively expected to increase if these events are *de facto* effective. Meanwhile, the degree of market integration is believed to be time-varying, as various events have different impacts on market integration. Consequently, the effectiveness of financial liberalisation events can be determined by the comparison of the degrees of market integration in the pre- and post-event periods, if the degree of market integration has been precisely measured.

This thesis (in Chapter 4) is going to employ the weak-form measure to gauge the degree of market segmentation (inversely, market integration) after comparing several measurement methods. The weak-form measure is proposed by Chen and Kenz (1995) on the basis of stochastic discount factors (SDF). This method has two merits: 1) free of model specification, which can avoid the joint test of model specification *per se* and the hypothesis of market integration; and 2) representing the degree of market segmentation by the minimum pricing differential directly according to the Law of One Price (LOP)[2]. As market integration is usually time-varying, the non-normalised degree, which is produced by the weak-form measure directly, can hardly offer a sensible explanation for the tendency of stock market integration. This thesis is going to normalise the non-normalised degree of stock market segmentation between China and the world by employing the non-normalised one between the US and the world as

[2] According to the LOP, if two asset markets are integrated perfectly, they should follow the same pricing pattern and therefore the pricing differential between them should be exactly equal to zero.

a benchmark of the lowest global stock market segmentation. The reason for so doing is that the US stock market is commonly regarded as the most open one in the world. After both the non-normalised and normalised degrees of market segmentation are obtained, this thesis is going to examine the specific impacts of China's financial liberalisation events on decreasing stock market segmentation between China and the world.

The second research question is addressed by gauging the degree of stock market interdependence between China and the world after China's accession to the WTO in 2001. Financial liberalisation is not the only but an important determinant of stock market interdependence. China's financial liberalisation is generally believed to increase the interdependence between China and the world stock markets, due to the removal of obstacles to cross-border trade by lifting foreign ownership restrictions. Differing from stock market integration, however, stock market interdependence may be influenced by many other factors, such as bilateral trade, investors' overreaction, as well as the similarities of market characteristics. In order to evaluate the impacts of China's financial liberalisation events on market interdependence, this thesis is going to gauge the degree of stock market interdependence between China and the world. If there is a significant difference between the pre- and post-event periods, financial liberalisation event is believed to have influence on stock market interdependence if the compound influence of other factors has been eliminated.

This thesis (in Chapter 5) is going to utilise the multi-factor R-squared measure to gauge the degree of stock market interdependence between China and the world. This method is proposed by Pukthuanthong and Roll (2009; 2011) on the basis of the principal component analysis (PCA). The degree of market interdependence is captured by the adjusted R-squared in a multivariate regression, in which the explanatory variables are a set of main components converted from a matrix of dominant market variables by the PCA. This method avoids both the bias caused by non-stationary variables in the correlation coefficient analysis and the possible

problem of multicollinearity in a multivariate regression model (Gilmore, Lucey, & McManus, 2008). As stock market interdependence is also time-varying, this thesis is going to normalise the non-normalised degree of stock market interdependence between China and the world, which is obtained by the multi-factor R-squared measure directly. The normalised degree between China and the world is obtained by taking the non-normalised one between the US and the world as a benchmark, because the US stock market is generally regarded as the most influential one in the world in terms of its size, power, as well as openness. In so doing, the compound influences of international factors other than China's financial liberalisation are believed to be mitigated to some extent. After the normalised degree of stock market interdependence between China and the world is obtained, this thesis is going to analyse the impacts of China's financial liberalisation events.

The third research question is mainly addressed by examining the relationship between market integration and market interdependence. As market integration and market interdependence are commonly influenced by financial liberalisation, most of the existing literature has focused on their similarities rather than their differences. Actually market integration and market interdependence are highly connected but different issues. Market integration mainly concerns the disparity of trade obstacles of any kind between within- and across markets, while market interdependence primarily reflects the influence of one market on others or the interaction among them. Since the relationship between market integration and market interdependence remains somewhat ambiguous in the current study, this thesis aims to shed some light onto this issue.

This thesis (in Chapter 6) is going to examine the relationship between market integration and market interdependence by time series analysis. On the one hand, this chapter is going to adopt a series of tests, accounting for the possible non-stationarity of time series of market integration and market interdependence degrees. Firstly, this thesis is going to perform the Augmented Dickey-Fuller (ADF) unit root test to

determine whether time series of degrees are stationary. Secondly, this thesis is going to examine the causality relationship between market integration and market interdependence by the Modified Wald (MWALD) test (Toda & Yamamoto, 1995), after the integration orders of time series are determined. Thirdly, this chapter is going to analyse the cointegration relationship between market integration and market interdependence by the Engle-Granger two-step approach (Engle & Granger, 1987). On the other hand, for the sake of prudence, this chapter is going to perform bootstrapping on aforementioned tests correspondingly, due to the small sample size of this study. These bootstrap tests include the residual-based ADF sieve bootstrap test, the leveraged bootstrap simulation on the MWALD test, as well as the bivariate cointegration bootstrap test. In the end, in order to provide further information, this thesis is going to compare the impacts of China's financial liberalisation events on market integration and market interdependence by event analysis correspondingly.

1.3 Contributions of the thesis

This thesis has gauged the degrees of market integration and market interdependence between China and the world stock markets in the post-WTO accession period respectively, and has examined the relationship between market integration and market interdependence. This thesis contributes to the literature on financial liberalisation as follows.

Firstly, this thesis has examined the impacts of financial liberalisation on stock market in a systematic way. This thesis has examined this issue not only from the perspective of international market integration, but also from the perspective of international market interdependence. Meanwhile, this thesis has provided empirical evidence on the relationship between market integration and market interdependence from the case of China's stock market. In so doing, this thesis contributes to financial liberalisation theory that market integration and market interdependence are two highly connected

but different issues. Market integration is one, but not the only, determinant of market interdependence.

Secondly, this thesis has provided two time series of degrees of market integration and market interdependence between China and the world stock markets correspondingly. These two time series can be applied to relevant studies. For example, the time series of degree of market integration can be applied to examine the effectiveness of financial liberalisation policies in this period, while the other is useful for constructing international portfolio. These degrees provide a platform for further studies in this area.

Finally, this thesis has shed some light onto the importance of benchmark degree in measuring the degrees of market integration and market interdependence, as the non-normalised degrees are normally time-varying. This thesis has developed normalised indices by adopting the non-normalised degrees of market segmentation and market interdependence between the US and the world stock markets as benchmarks correspondingly. Compared to the non-normalised indices that are commonly adopted in the existing literature, the normalised indices have provided more valuable information, especially when analysing the impacts of financial liberalisation events.

1.4 Structure of the thesis

The thesis is composed of seven chapters, among which Chapters 4, 5 and 6 are the main chapters. These three main chapters are going to address sequentially the impact of China's financial liberalisation on market integration and market interdependence between China and the world stock markets, as well as the relationship between market integration and market interdependence. The rest of thesis is as follows.

Chapter 2 is devoted to introduce the background of China's stock market, since it is quite different from the developed markets. Providing a better understanding of China's stock market, this chapter facilitates empirical studies in the following chapters. Chapter 2 mainly includes four aspects of China' stock market: 1)

institutional setting, 2) internationalization practices, 3) supervision and legal environment, as well as 4) the recent development of policies and reforms.

Chapter 3 is going to review the existing literature on financial market integration and market interdependence. As most of the existing literature focus on their similarities rather than their differences, this chapter attempts to clarify the ambiguity by reviewing their definitions and determinants, and to find out the differences between them. Accordingly, the criticisms and comments will be given in this chapter. Furthermore, a special section is included in this chapter for the literature review on China's financial liberalisation. In the end, this chapter identifies a gap in the literature.

In Chapter 4, this thesis is going to gauge the degree of stock market integration between China and the world in the post-WTO accession period, and to analyse the effectiveness of China's financial liberalisation policies. This thesis mainly introduces the weak-form measure, and employs it for empirical analysis.

This chapter is organized as follows. Section 1 is a brief introduction. Section 2 provides a brief literature review on measuring market integration. Section 3 primarily introduces the methodology of weak-form measure, which includes the conceptual framework, theoretical framework, as well as the estimation algorithm. Section 4 carries out the empirical analysis, including the descriptions of the data and indices, as well as empirical procedures. Section 5 reports the results of empirical analysis. In Section 6 this chapter reaches its conclusions.

Chapter 5 is to gauge the degree of stock market interdependence between China and the world in the post-WTO accession period, and to analyse the influences of China's financial liberalisation policies on market interdependence. This chapter mainly introduces the methodology of the multi-factor R-squared measure on the basis of the PCA, and employs it to measure the degree of stock market interdependence between China and the world since China's entry into the WTO in 2001.

This chapter is organized as follows. Section 1 is a brief introduction. Section 2 provides a brief literature review on examining market interdependence. Section 3 introduces the methodology of the multi-factor R-squared measure. Section 4 performs the empirical analysis, and reports the results of empirical analysis. Section 5 presents conclusions.

Chapter 6 is going to examine the relationship between market integration and market interdependence on the basis of values obtained from Chapters 4 and 5. This chapter mainly introduces a series of empirical analyses, and uses them to examine the relationship between market integration and market interdependence.

This chapter is organized as follows. Section 1 provides a brief introduction. Section 2 describes the methodologies for empirical analysis. Section 3 is the data description. Section 4 carries out empirical analysis and reports the results. Section 5 concludes this chapter.

Chapter 7 is the conclusion of the whole thesis. This chapter concludes the main findings and presents their implications. Meanwhile, this chapter makes policy proposals. Furthermore, this chapter discusses the limitations of this study and possible further studies.

CHAPTER 2: BACKGROUND OF CHINA'S STOCK MARKET

"Securities, stock markets, are they good or evil? Are they dangerous or safe? Are they unique to capitalism or also applicable to socialism? Let's try and see. Let's try for one or two years; if it goes well, we can relax controls; if it goes badly, we can correct or close it. Even if we have to close it, we may do it quickly, or slowly, or partly. What do we fear? If we keep this in mind, then we will not make big mistakes."

(Deng Xiaoping, 1992)[3]

China's stock market has grown from almost nothing thirty years ago to the second largest in the world in terms of market capitalization, after only the stock market of the United States. In comparison with other markets in transitional economies, China's stock market has performed much better in many aspects, such as market capitalization, liquidity, the number of listed firms, and fundraising capacity (Wong, 2006). However, there is still a long way to go before China develops an equal, fair and transparent stock market. At present, China's stock market also has many defects, such as incomplete corporate-governance structure of the listed firms, inadequate regulatory capacity, ferocious market manipulations, as well as insufficient investor protection (Gao S. , 2002; Wong, 2006; Chen G. , Firth, Gao, & Rui, 2006). For example, as said by the public security ministry, Chinese securities crimes involved more than 200 billion RMB from 2002 to 2010[4].

As China's stock market is a typical emerging market with many specific features, it is worthwhile to give a brief introduction before the literature review so as to avoid any misunderstanding or confusion afterwards. This chapter is going to introduce China's stock market from four aspects: 1) institutional setting, 2) internationalization practice,

[3] Sources are from *China Capital markets Development Report* (2008)

[4] Sources are from the website of Financial Times, *http://www.ft.com/cms/s/0/1c2a765e-24a6-11e1-bfb3-00144feabdc0.html#axzz1vcvutZPU*

3) supervision and legal environment, as well as 4) the recent development of policies and reforms.

2.1 Institutional setting

In the early 1980s, China initiated a series of economic reform policies to restructure its economy from a Soviet-style centrally planned economy to a more market-oriented economy, while staying within the political framework provided by the Communist Party of China (CPC)[5]. Prior to these reforms, all enterprises were virtually either state-owned or collectively-owned while investments were centrally planned, and were funded by government fiscal grants and loans from the state-owned mono-bank system, which were covered by government's central credit plan (Wong, 2006). As part of enterprise reforms, in the first privatization wave of 1984 small state-owned and collectively owned enterprises were allowed tentatively by local government to sell shares to their own employees, or to other companies and state owned enterprises (SOEs)[6]. In 1986 one of the national strategies was to expand SOE restructuring programme[7]. An increasing number of enterprises, including some of the largest SOEs, started experimenting with shareholding reform, and began to issue shares publicly or semi-publicly[8]. As the volume of shares issued increased and the number of investors grew, the curbed trading of enterprise shares soon emerged, which was quickly followed by the over-the-counter (OTC) trading in more organized but still informal exchanges[9]. However, government officials were not willing to hand the absolute

[5] After the Third Plenum of the 11th Communist Party of China (CPC) Central Committee in 1978, China launched a long-term reform and opening-up policy to revitalize national economy.

[6] In October 1984, the direction of reform was identified for urban area and the overall economic system. The state control over small state-owned and collective urban enterprises was relaxed (China Securities Regulatory Commision, 2008)

[7] In December 1986, in the *Provision for Furthering Reform and Revitalizing Enterprises* the State Council claimed that "a few qualified large and medium-sized enterprises owned by the state can be selected to experiment with the shareholding system".

[8] Usually shares were issued at par, which was similar to bonds as dividends were fixed and guaranteed and shares were to be redeemed on maturity. Meanwhile, shares were issued by enterprises themselves without underwriter, and were privately offered to employees and local residents.

[9] In August 1986, Shenyang Trust & Investment Corporation became the first company to provide brokerage service for stock and bond trading. In September 1986, the Jing'an District Branch of the Shanghai Trust & Investment Company, a subsidiary of the Industrial Commercial Bank of China (ICBC) started over-the-counter trading of shares it underwrote for the Feile Audio Equipment Co. and Yanzhong Industrial Co. Ltd., which marked the first occurrence of secondary trading.

control of companies over to shareholders, the initial public offering (IPO) were not quite popular, and there were less than 100 issues before 1990 when China's two stock exchanges were built up[10].

The Shanghai Security Exchange (SSE) was launched on November 26, 1990 and the Shenzhen Stock Exchange (SZSE) on April 11, 1991 respectively. At the end of 1991, there were 8 listed stocks and 25 members for SSE, and 6 listed stocks and 15 members for SZSE respectively[11]. These two exchanges are self-regulated and non-profit legal entities under the supervision of the China Securities Regulatory Commission (CSRC), and do not allow cross-listing[12]. As stated by the Chinese government itself, the main purposes of the establishment of stock market were: 1) to raise capital for enterprises; and 2) to reform the unprofitable, inefficient state-owned enterprises[13].The main statutory obligations of two exchanges included: provision of marketplace, monitoring of trading, supervision of exchange members and listed companies, managing and disseminating market information, accepting and arranging listings[14], as well as examining the listing qualifications and ensuring continuous listing compliance[15] (Javvin, 2008). The establishment of stock exchanges turned a new leaf in the development of Chinese stock market, as they provided a nationwide trading platform for securities[16].

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[10] For more details, please refer to Wong (2006), Kwon (2009), as well as *China Capital markets Development Report* (2008).

[11] Initial members of stock exchanges were mainly trust and investment companies or their securities divisions, and nascent securities firms.

[12] Initially the two stock exchanges were governed by the State Council Securities Commission (SCSC), the People's Bank of China (China's central bank) and the China Security Regulatory Commission (CSRC) jointly in the start-up period. In April 1998, the CSRC was granted the sole regulator status of the two exchanges and the whole security market.

[13] The speeches of Hongru LIU, the first chairman of the CSRC, in the SSE working conferences in January 1994, and of Prime Minister Peng LI in the Fifth Session of the Eighth National People's Congress on March 1, 1997. Sources are from the website:
http://china.findlaw.cn/falvchangshi/gongsishougou/shangshigssg/ssgssgflgd/57377.html

[14] Stock exchanges are the statutory authority to vet listing qualifications of companies. But the authority of approving IPOs is the CSRC rather than stock exchanges themselves.

[15] In accordance with the Securities Law, an issuer shall be suspended from trading or even de-listed if applicable criteria are not met. A listed company shall be suspended from trading if it has posted negative earnings for three consecutive years, and be de-listed if it remains in red at the end of the one-year grace period.

[16] The two exchanges have moved into an electronic trading system, which matches numerous buy and sell orders in a centralized process by prioritizing orders according to price and time. Market

Table 2. 1 The Development of China's Stock Market (1992-2011)

Year	Numbers of Listed Enterprises (A and B shares)	Total Amount of Capital Raised (Billion RMB)	Market Capitalization (Billion RMB)		Market Capitalization to GDP (%)		Annual Trading Volume (100 Billion shares)
			Total Market	Negotiable	Total Market	Negotiable	
1992	53	9.41	104.81	NaN	3.93	NaN	0.038
1993	182	37.55	353.10	86.16	10.22	2.49	0.234
1994	291	32.68	369.06	96.89	7.91	2.08	2.013
1995	323	15.03	347.43	93.82	6.04	1.63	0.705
1996	530	42.51	984.24	286.70	14.72	4.29	2.533
1997	745	129.38	1,752.92	520.44	23.97	7.12	2.561
1998	851	84.15	1,950.56	574.56	25.34	7.46	2.154
1999	949	94.46	2,647.12	821.40	32.85	10.20	2.932
2000	1,088	210.31	4,809.09	1,608.75	54.49	18.23	4.758
2001	1,160	125.23	4,352.22	1,446.32	45.46	15.11	3,152
2002	1,224	96.18	3,838.91	1,248.16	36.94	12.01	3.016
2003	1,287	135.78	4,245.77	1,317.85	36.37	11.29	4.163
2004	1,377	151.10	3,705.56	1,168.86	27.13	8.55	5.828
2005	1,381	188.25	3,243.03	1,063.05	17.71	5.81	6.623
2006	1,434	559.43	8,940.39	2,500.36	42.69	11.94	16.145
2007	1,550	868.02	32,714.09	9,306.44	131.10	37.30	36.403
2008	1,625	385.22	12,136.60	4,521.40	38.65	14.40	24.132
2009	1,718	612.47	24,393.90	15,125.90	71.56	44.37	51.107
2010	2,063	1197.19	26,542.26	19,311.04	66.69	48.52	42.151
2011	2,342	578.6	21,475.81	16,492.13	45.54	34.97	33.957

Notes: In this table the "NaN" indicates the unavailability of data. The data for the period 1992-2010 are taken from China Statistical Yearbook various issues while the data for 2011 are from the statistics data of the CSRC in January 2012[17].

With the establishment of stock exchanges, there has been an apparent growth in many aspects, such as the number of listed enterprises, market capitalization, funds raised from share issuance, as well as trading volume. As shown in Table 2.1, the number of listed enterprises has increased from 53 in 1992 to 2,342 in 2011 while the total amount of capital raised by stock market has risen from 9.41 billion RMB to 750.62 billion RMB during this period. Meanwhile, the total market capitalization of China's stock market has boomed from 104.81 billion RMB in 1992 to 21,475 billion RMB in 2011, which has increased by 204 times in 20 years. More impressively, the highest total market capitalization has even reached 327 trillion RMB, accounting for 131 percent of GDP at the end of 2007. On November 15, 2007 the market capitalization of the Shanghai Stock Exchange hit a high record of 5.09 trillion RMB,

transparency and information disclosure have become much better than the previous off-the-street markets and the regional over-the-counter retail markets.

[17] Sources are from the website:*http://www.csrc.gov.cn/pub/zjhpublic/G00306204/zqscyb/201203/t20120316_207256.htm*

which was equal to 636 billion USD approximately, and increased by 120 percent as compared with that at the end of 2006[18]. Despite the rapid growth, however, China's stock market has been trapped by high speculation, insider trading, insufficient shareholder protection, as well as false financial reporting of the listed company (Kwon, 2009).

Meanwhile, China's stock market was segmented by ownership restrictions in two ways. On the one hand, in order to retain majority ownership in the state owned enterprises[19], the Chinese government divided the shares of the listed companies into tradable and non-tradable shares, according to whether they can be listed and traded on stock exchanges. The non-tradable shares are referred to those that are held by shareholders before IPO and can only be transferred through negotiation among designated parties. The non-tradable shares include state shares[20], legal entity shares[21] as well as employee shares[22]. On the contrary, the tradable shares are those that can be purchased by public investors in IPOs and listed on the exchanges. Tradable shares can be further divided into A shares[23], and the shares denominated in a foreign

[18] Sources are from "Market Capitalization of Shanghai Stock Exchange Hits Record High", *China View* on November 16, 2007 at *http://news.xinhuanet.com/english/2006-11/16/content_5340220.htm.*

[19] Nearly all Chinese listed companies are restructured from the state-owned or state-controlled enterprises by selling shares to its own employees, other SOEs, and legal entities at a price around the book value of equity. After these SOE are restructured into stock companies and satisfy the listing criteria, they can apply for the approval of listing from CSRC and the stock exchange. Upon the approval these firms usually sell about one third of ownership to the general public at the time of IPO, and therefore shares of typical SOEs are split into state, legal entity and tradable shares, with the restriction that state and legal entity shares cannot be traded publicly (Wang C. , 2005)

[20] State shares (sometimes called government shares) are held by the state institutions and government departments, on behalf of the state, in exchange for the capital contribution made by the state. The state institutions can be the central government itself, local government, or wholly government-owned institutions. State shares are not tradable on these two stock exchanges but can be transferred to other domestic institutions upon the approval of the CSRC.

[21] Legal entities shares (sometimes called legal person shares or C-shares) can only be held by other state-owned enterprises and are not listed on these two stock exchanges. Legal entity shares can be transferred to other domestic institutions upon the approval of the CSRC.

[22] Employee shares, which are usually offered to workers and mangers of a listed firm at a substantial discount, are non-tradable until the firm allows their convertibility. After a holding period of 6 to 12 months, the firm may file an application with the CSRC to allow its employees to sell the shares on the open market, but the directors, supervisors and the general managers cannot transfer such shares during their tenure of office. Once sold on the market, they become A shares (Sun, Tong, & Tong, 2002; Tian L. , 2011).

[23] A shares (or called ordinary domestic shares) are mostly purchased and traded by domestic individuals and some by domestic institutions.

currency[24] such as B shares. For tradable shares, originally A shares were available only to Chinese citizens and institutions while B shares were intended exclusively for foreign investors. In so doing, to a large extent the A-share market is deliberately segmented from other kinds of share markets because these shares cannot be freely converted into each other. Although there are some changes during the later stages of development, the main structure and definitions of these shares remain the same[25]. As A shares are the vast majority of Chinese tradable shares, China's domestic stock market usually refers to the A-share market unless otherwise specified.

On the other hand, China's stock market has been segmented from international stock markets for a long time. In order to protect the infant domestic stock market, foreign investors were not allowed to trade A shares until July 2003. Before that, they were only permitted to invest in B shares. Meanwhile, Chinese domestic investors were not allowed to trade B shares until February 2001 and not to hold foreign shares until May 2006. In this way, China's domestic stock market was believed to be segmented from international stock markets due to ownership restrictions. After the removal of ownership restrictions, there are still several other factors hampering the integration between China and the world stock markets, such as trading location, differential tax rates, as well as information endowment (Bhattacharya, Daouk, Jorgenson, & Kehr, 2000; Wang & Iorio, 2007). International segmentation between China and the world stock markets will probably persist as long as the Chinese currency, the RMB, is not a freely convertible currency.

[24] The shares denominated in a foreign currency include B shares in domestic stock exchanges, H shares in the Hong Kong Stock Exchange and N-shares in the New York Stock Exchange. B shares are denominated in the US dollars in the Shanghai Stock Exchange, and in Hong Kong dollars in the Shenzhen Stock Exchange respectively. B shares were initially designated exclusively for foreign investors, but now they have been available to domestic individual investors since February 19, 2001. H and N shares carry the same rights and obligations as A and B shares, but they cannot be traded on domestic stock exchanges.

[25] The B-share market has been opened to domestic investors since February, 2001. The A-share market has also been available to the QFII since December 2002.

2.2 Internationalization practice

In the early 1990s, the Chinese government established the Shanghai Stock Exchange and the Shenzhen Stock Exchange as a part of an effort to develop capital market. A number of stocks, namely A shares, have been listed on these two exchanges. A shares are denominated in the Chinese currency, and can be traded only by domestic individual and institutional investors. The A-share market has become the most important investment playground for China's domestic investors. The firms listed on the A-share market have increased from 14 in 1991 to 1,549 in 2009 while the capital raised on this share market rose from 0.5 billion RMB in 1991 to 389.4 billion RMB in 2009[26]. However, the A-share market is generally regarded as an emerging market with distinct features, such as strong state intervention, low market transparency, high price-to-earnings (P/E) ratio, over-speculation, as well as immature investors.

Meanwhile, in order to attract international capital inflows while avoiding adverse impacts on the domestic market, the Chinese government established the B-share markets on both exchanges in 1992, soon after the establishment of the A-share markets. B shares are denominated in foreign currency[27] and can be purchased by investors from Hong Kong, Macau, Taiwan, and other foreign countries. However, this market was never active and the total market capitalization was tiny. Although B shares traded at huge discounts relative to A shares, B shares proved to be unattractive to foreign investors. Compared to A shares, the average discount rate increased from 25% in 1993 to 86% in 2001. In order to revitalize the B-share markets, the Chinese government resorted to many measures, such as lowering the stamp tax, allowing non-state-owned enterprises to issue B shares, as well as establishing B shares funds (Chen & Lu, 2007). Unfortunately, these efforts proved to be unproductive and the Chinese government finally announced the opening of B-share markets to domestic investors

[26] Information source*: http://www.stats.gov.cn/tjsj/ndsj/2010/indexch.htm*

[27] B shares are denominated in US dollars on the Shanghai Stock Exchange, and in Hong Kong dollars on the Shenzhen Stock Exchange respectively.

on February 21, 2001[28]. However, this policy was ultimately unsuccessful and the B-share markets remained weak with only a few companies having been listed since 2001.

Another important opening approach is listing mainland companies on foreign stock markets, which has also been proved as a useful capital-raising channel for enterprises (Lo & Chan, 2000). The Hong Kong and New York Stock Exchanges are considered to be the most attractive listing destinations for mainland firms[29]. In 1992, Chinese stocks initiated their first listing on the Stock Exchange of New York. In 1993, a number of selected Chinese mainland companies were allowed to list on the Stock Exchange of Hong Kong (SEHK), which traded in Hong Kong dollars and were known as H shares. At the end of 2011, 168 mainland firms have been listed on the SEHK, which have raised 1.123 trillion Hong Kong dollars. At the same time, some other mainland companies were incorporated internationally, and also listed on the SEHK. These companies usually have powerful links with the state-owned companies in mainland, and therefore, their stocks are referred to as Red Chips due to their Red China backgrounds. By the end of 2011, 102 Red Chips have been listed on the Stock Exchange of Hong Kong Main Board, which amounted up to 22.91% of the total market capitalization[30]. These companies are the arms of their mainland parents to raise capital in the Hong Kong market. Red-chip and H-share companies have become an important component of the Hong Kong's capital market.

[28] From February 19, 2001 to June 1, 2001, domestic householders could purchase B shares only by bank deposits of spot exchange and foreign currency in cash. The deposit ought to have been saved in a commercial bank prior to or on the day of February 19, 2001. After June 1, 2001, domestic householders could use bank deposits, which were saved after February 19, 2001. Actually, bank deposits of spot exchange and foreign currency in cash, which were saved before February 19, 2001, were really scarce for householders and therefore the *de facto* opening day of the B-share markets to domestic investors would be no earlier than June 1, 2001 if there was no circumvention.

[29] Other stock markets where Chinese firms have listed include the Stock Exchange of Singaporean and the London Stock Exchange.

[30] Sources are from the website: *http://www.capco.org.cn/zhuanti/cjz/xi_gjsy.html*

Table 2. 2 The A-, B- and H-shares of China's Stock Market (1991-2011)

	The Number of Listed Companies					Raised Capital (100 million RMB)		
Year	Domestic Listed firms	A shares only	A and H shares	A and B shares	B shares only	A shares	H and N shares	B shares
1991	14	14	0	0	0	5	0	0
1992	53	35	0	18	0	50	0	44.09
1993	183	140	3	34	6	276.41	60.93	38.13
1994	291	227	6	54	4	99.78	188.73	38.27
1995	323	242	11	58	12	85.51	31.46	33.35
1996	530	431	14	69	16	294.34	83.56	47.18
1997	745	627	17	76	25	825.92	360	107.9
1998	851	727	18	80	26	778.02	37.95	25.55
1999	949	822	19	82	26	893.6	47.17	3.79
2000	1088	955	19	86	28	1527.03	562.21	13.99
2001	1160	1025	23	88	24	1182.13	70.21	0
2002	1224	1085	28	87	24	779.75	181.99	0
2003	1287	1146	30	87	24	819.56	534.65	3.54
2004	1377	1236	31	86	24	835.71	648.08	27.16
2005	1381	1240	32	86	23	338.13	1544.38	0
2006	1434	1287	38	86	23	2463.7	3130.59	0
2007	1550	1389	52	86	23	7722.99	957.18	0
2008	1625	1459	57	85	23	3457.75	317.26	0
2009	1718	1549	61	85	22	5004.9	1073.18	0
2010	2063	1889	65	86	22	9606.31	2365.62	0
2011	2342	2162	71	86	22	5073.07	713	0

Notes: The data for the period 1992-2010 are taken from China Statistical Yearbook various issues while the data for 2011 are from the statistics data of the CSRC in January 2012.[31]

Furthermore, the Chinese government has dedicated itself to further the liberalisation of its stock market, especially after China's entry to the WTO on December 11, 2001[32]. According to the entry commitments for WTO membership, China needed to open up its capital market and to improve financial regulations step by step. By the end of 2006, China had fulfilled its commitments on opening-up the securities markets [33](Kwon, 2009). A string of liberalisation events show an opening era of China's stock

[31] Sources are from the website:*http://www.csrc.gov.cn/pub/zjhpublic/G00306204/zqscyb/201203/t20120316_207256.htm*

[32] In 1986 the Chinese government applied for membership in the General Agreement on Tariffs and Trade (GATT) but did not have a GATT Contracting Party Status. In the following period, the GATT has been transformed into the WTO under the Uruguay Round in December 1993. In December 1996 China accepted the obligation of *International Monetary Fund's Article VIII* to meet a precondition of admission to the WTO. After 15 years of negotiations, China became a member of the WTO and signed the General Agreement of Trade in Service (GATS) on December 11, 2001(Kwon, 2009).

[33] The commitments related to security industry opening, which were promised by China at the time of its entry into the WTO, includes: (1) foreign securities firms can trade B shares directly; (2) representative offices of foreign securities firms in China can apply for special membership at all

market, among which are allowing eligible foreign companies to purchase state-owned shares and legal person shares of the listed companies in November 2002[34], launching the QFII programme to invest in China's A-share market in December 2002, permitting foreign investors to make strategic investments in the A shares of the listed companies that have completed their non-tradable share reform in February 2006[35], as well as authorizing the QDII to invest in overseas capital market in May 2006. Although the specific impacts of these events have not been systematically examined, they are generally regarded as important liberalisation measures on stock market. For example, Tam, Li, et al (2010) regard the QFII programme as a pilot scheme for relaxing foreign exchange controls over the country's capital account, and find that the QFII programme has enhanced the international integration of China's stock market.

Nevertheless, the Chinese government has sped up the process of opening stock market in the post-WTO accession period, under the pressure of its WTO commitments for financial market liberalisation. China's stock market has become more accessible for foreign investors, mainly thanks to financial liberalisation policies implemented in this period. Despite a variety of harsh restrictions, such as inconvertible currency, non-market-oriented interest rate, as well as inconsistently enforced laws and regulations, China's entry into the WTO is a remarkable milestone towards the opening of its stock market.

2.3 Supervision and legal environment

In the early stage of development of Chinese stock market, shares were issued by enterprises in a variety of ways without regulation and supervision. Special awards

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domestic exchanges; (3) foreign service providers can set up joint ventures for securities trading and fund management, with initial shareholding capped at 33%, and 49% within three years of the WTO accession; and (4) within three years of the WTO accession, foreign securities firms can set up joint ventures with shareholding not exceeding 1/3, and the joint ventures can, without the need to enlist the service of a Chinese intermediary, underwrite A shares, and underwrite and trade B-/H-shares and government/ corporate bonds, as well as launch funds (China Securities Regulatory Commision, 2008).

[34] In November 2002, the *Notice on the Transfer of State-owned Shares and Corporation Share of List Companies to Foreign Investors* was issued.

[35] In February 2006, the *Measure for the Administration of Strategic Investment in Listed Companies by Foreign Investors* was issued.

were offered by some enterprises for their issues, including enrolling subscribers into lottery and offering guaranteed interest payment. On August 10, 1992 a violent protest by potential retail investors in Shenzhen was triggered by a serious shortage of IPO subscription application forms, poor organisation as well as irregular practices. This incident provoked the Chinese government to establish a national regulatory body to supervise the securities market.

In October 1992 the State Council set up the State Council Securities Commission (SCSC) and Chinese Securities Regulatory Commission (CSRC). The SCSC was the highest regulatory body in China while the CSRC was the executive branch of SCSC. Upon the approval of State Council, in 1998 the two-tier structure with the SCSC and CSRC was replaced by a single unified system via consolidating the supervisory function of SCSC and PBC into to the CSRC. The CSRC has become the highest-level regulator of the national securities and future markets, and is subordinated to the State Council directly. Meanwhile, a regional supervision system of the CSRC was also established by absorbing the Provincial Offices of the CSRC. With the establishment of 36 regional offices across the nation[36], a centralized supervisory framework was built up in China.

Since its inception, the CSRC has promulgated a number of laws, rules and regulations. The *Provisional Regulation on Issuing and Trading of Shares* was promulgated in April 1993 to regulate share issuance, trading and the acquisition of listed companies. The *Implementation Rules on Information Disclosures of Companies Issuing Public Shares* was issued in June 1993 to set up standards for required information disclosures of listed companies. The *Provisional Measures on Prohibiting Fraudulent Conducts Relating to Securities* was promulgated in August 1993, and the *Circular on Prohibiting Securities Market Manipulation* was issued in

[36] Regional securities regulatory offices included nine regional offices (Tianjin, Shenyang, Shanghai, Jinan, Wuhan, Guangzhou, Shenzhen, Chengdu and Xi'an), two directly subordinate offices (Beijing and Chongqing), and securities regulatory offices for specially-appointed agents in 25 provinces, autonomous regions, and municipalities.

October 1996 to specify the criteria for defining illegal trading activities and relevant sanctions or penalties. Meanwhile, the CSRC has issued a series of regulations over the operations of securities firms. For example, the *Administrative Procedures for Securities Brokerage Institutions' Equity Underwriting Businesses and the Proprietary Trading Businesses* was issued in October 1996, while the *Provisional Administrative Procedures on Securities Investment Funds* was promulgated in November 1997. These laws, rules and regulations have facilitated the take-off of Chinese stock market significantly and provided a foundation for further improvement in relevant provisions.

Furthermore, the *Securities Law* and the *Company Law* were promulgated to regulate the capital market. The *Securities Law*, which was issued in December 1998, enacted in July 1999 and amended in November 2005, was the first national law to regulate the issuance and trading of securities in China. For the first time, this law confirmed the importance of the capital markets and formalized its legal status in China. Meanwhile, the *Company Law*, which was enacted in July 1994 and amended in 2003, standardized the organisation and operation of companies. This law set out specific provisions for company in several aspects, including the conditions of setting up a company, the organisation of a company, share issuance and transfer, liquidation procedures and legal liabilities (China Securities Regulatory Commision, 2008). The *Company Law* laid a legal foundation for the development of stock companies as it protected the legitimate rights and interests of companies, shareholders and creditors.

In line with the revisions of these two laws, a series of laws and regulations were amended by the National People's Congress (NPC) and the ministries and commissions of the State Council. The *Amendments to the Criminal Law (VI)*[37] was

[37] The *Amendments to the Criminal Law (VI)* defines the disciplinary criterion for a company's violations of its obligations in terms of information disclosure, which harm the interests of shareholders or others. Meanwhile, it specifies that fiduciary duty is violated to the company if a director, supervisor or senior manager of a listed company takes advantage of his office to manipulate the company, which causes heavy losses to the company, and manipulates the market. Furthermore, stricter requirements are set by this law to prevent the crime committed by a director, supervisor or senior manager of a listed company.

passed by the NPC in June 2006 to clarify the responsibilities of the listed companies, securities and futures operating entities for the action related to any specific breach of the law, and to impose heavier punishments for market manipulation. The *Enterprise Bankruptcy Law* [38]was revised in August 2006 to regulate bankruptcy procedures and to protect the interests of all parties involved. Meanwhile, to supplement the amendments to these two laws the CSRC formulated administrative regulations, such as the *Implementing Measures on Freezing and Sealing-up of Corporate Assets,* the *Guidelines on Articles of Association of Listed Companies (2006 Amendments),* the *Rules for the General Meetings of Shareholders of Listed Companies,* the *Administrative Measures for the Qualifications of Directors, Supervisors and Senior Managers of Securities Firms,* the *Rules of Private Placement of Listed Companies,* as well as the *Measures on the Administration of Securities Settlement Risk Funds* (China Securities Regulatory Commision, 2008).

2.4 The recent development of policies and reforms on stock market

Although Chinese stock market has achieved remarkable development, there were several defects, such as incomplete ownership structure of listed companies, lack of institutional investors, unsound corporate governance, as well as a limited supply of blue chip companies. In recognition of these problems, in January 2004 the State Council issued the *Opinions of State Council on Promoting the Reform, Opening and Steady Growth of Capital Markets*. These opinions were high-level guidelines for the further reform and development of China's capital market. According to these opinions, China's capital market was to be developed at a national strategy level. Inspired by this issue, another round of reforms were carried out in Chinese stock market, among which were the non-tradable share reform, enhancing the quality of the

[38] According to the new *Enterprise Bankruptcy Law*, a director, supervisor or senior manager will be liable under civil law if he violates his duties of fiduciary and due care and thus lead an enterprise into bankruptcy. A person is not permitted to assume the post of director, supervisor or senior manager of any enterprise if he has violated his duties with three years as of the day when the procedures for bankruptcy are concluded.

listed companies, reforming the IPO process as well as promoting the development of institutional investors.

2.4.1 Non-tradable share reform

In retrospect of the history of China's stock market, the problematic issue of non-tradable shares mainly stemmed from the early experiment of restructuring of corporate ownership. In order to retain the majority ownership on SOEs, non-tradable shares were segmented from tradable shares of listed companies, and were not allowed to trade on the exchanges. As a result, at the end of 2004 there were 453.3 billion non-tradable shares, which accounted for 64% of the total shares of Chinese listed companies. Among the non-tradable shares, 74% were state-owned. Although both tradable and non-tradable shares provided exactly the same voting and dividend rights for their owners, they differed dramatically in terms of liquidity and ownership. This division created pricing differences between various types of shares, and hampered the development of China's stock market and the management of state-owned assets.

On April 29, 2005, the CSRC launched the non-tradable shares reform under the leadership of the CPC and the State Council, and intended to make non-tradable shares publicly tradable. The purposes were to: 1) raise capital for the pension fund, 2) increase the private ownership of firms, as well as 3) make management more accountable to shareholders and listed firms more efficient (Guo & Keown, 2009). This reform was implemented by the principle of *centralized organizing*[39] and *decentralized decision making*[40], and was based on a pilot programme strategy to test market reaction before rolling it out on the entire market gradually. As the non-tradable shares were originally promised by the listed companies to remain unlisted

[39] For the *centralized organisation*, the CSRC developed rules, procedures and supervisory requirements on investors' protection for listed companies, which were prepared to float their non-tradable shares; the exchanges were to supervise and coordinate the detailed implementation, such as the procedures to list the formerly non-tradable shares on the exchanges.

[40] Regarding the *decentralized decision making*, shareholders' meetings were held by the listed companies to negotiate with all shareholders about the plan of floating the non-tradable shares, which was proposed by the listed companies.

and non-tradable in the post-IPO period, agreements were required, according to the *Contract Law*, to be reached between non-tradable and tradable shareholders on changing the status of shares and on reasonable compensation. In practice, the tradable shareholders were compensated by receiving a portion of shares from non-tradable shareholders at mutually agreed prices. In order to protect the interest of small investors in the negotiation process, the proposal of floating the non-tradable shares could only be passed if at least two-thirds of shareholders voted and at least two-thirds of tradable shareholders endorsed it.

By the end of 2006, 1,301 listed companies have undergone or already completed their non-tradable share reforms, which accounted for 97 percent of the total companies that needed to be reformed. At the end of 2007, the total value of negotiable market capitalization reached 9.3 trillion RMB, which increased by 2.77 times from 2.5 trillion RMB in 2006. This reform helped Chinese stock market to unify equity rights and to reduce price disparities, and therefore, the secondary market started to reflect the values of the listed companies more accurately. To a large degree, this reform was helpful to improve the efficiency of resource allocation in China's capital market and to narrow the gap with international markets in terms of fundamental market mechanism.

2.4.2 Enhancing the quality of listed companies

Listed companies are the foundation of capital markets and driving forces for industrial growth. However, a number of listed companies in Chinese stock market had poor corporate governance and low firm quality due to various systematic and institutional factors. The low quality of listed companies have significantly impaired investors' confidence, and hampered the development of capital market. In recognition of these defects, the CSRC has initiated a series of reforms to enhance the quality of listed companies since 2004, and formulated the *Opinions on Upgrading the Quality of Listed Companies* in 2005.

Since 2006, the CSRC has launched several specific programmes in the purposes of enhancing the compliance of listed companies, strengthening corporate governance and improving the quality of listed companies. These measures mainly include: improving the supervision and regulation[41], strengthening information disclosure[42], improving corporate governance[43], the forced repayment of misappropriated funds of listed companies[44], the establishment of incentive structure[45] as well as pushing forward market-driven merger and acquisition (M&A) and restructuring [46] (China Securities Regulatory Commision, 2008). In so doing, the competitive edge of listed companies has been improved to a large degree, but further efforts are still required, especially in maximizing shareholders' interests.

2.4.3 Issuance system reform

In the period from 1990 to 2000, public offerings of shares in Chinese stock market were subject to administrative approval. In March 2001, the CSRC introduced a new review and approval system for public offering of shares, which required mandatory

[41] The regional offices of CSRC was required to play an active role in supervising listed companies in their respective jurisdictions, and in delegating the supervisory authorities and responsibilities to these regional offices, as well as in encouraging collaboration among them. In this way, a comprehensive supervisory system was fledged in collaboration with many other government departments and local governments.

[42] In February 2007 the CSRC issued the *Administrative Measures for the Information Disclosure of Listed Companies*, which included supporting the stricter requirements on information disclosure of listed companies stated in the new *Securities Law* and the *Company Law*, increasing the transparency of listed companies' operations, adapting to newly increased requirements on the supervision of listed companies after the non-tradable share reform, and improving the quality of information disclosed by listed companies.

[43] After the initiation of non-tradable shares reform, the CSRC amended *the Rules for the General Meetings of Shareholders of Listed Companies*, and the *Guidelines for the Articles of Association of Listed Companies and other relevant rules*. These rules facilitated the formation of the basic framework and principles of corporate governance, as well as the standardization of governance practices.

[44] To tackle the misappropriation of funds, the CSRC performed the pilot project of debt-equity swaps and the repayment of misappropriated funds with the cooperation of local governments and relevant departments. An article on the crime of the misappropriation of the listed company assets was also added to the *Criminal Law of the People's Republic of China*.

[45] In January 2006 the CSRC issued the *Administrative Measures on Stock Incentives by Listed Companies (Provisional)*, which stipulated the rules for implementation procedures and information disclosure of the stock incentive programme.

[46] The *Administrative Measures on the Merger and Acquisition Transactions Involving Listed Companies* was formulated in 2002 and amended in 2006. This rule encouraged the merger and acquisition activities, restructuring of listed companies and listing of industrial groups in the market. Meanwhile, the CSRC set up a review committee to review and approve the mergers and acquisitions of listed companies under a unified set of evaluation standards.

information disclosures and investigations in the pre- and post- issuance phases respectively. Meanwhile, to supervise public offerings the regulatory system was developed with simplified and standardized procedures. As a result, the government-driven pricing system was replaced gradually by a more market-driven pricing system in the offering process. Compared to developed markets, there is still ample space for improving the issuance system in China. In developed markets, the procedures of stock issuance tend to be simple and standardized, which only require registration with supervisory authorities for public offering while the price is determined by market directly.

The CSRC has taken a number of measures to improve the issuance system from the following aspects: improving the transparency of share issuance approval system[47], strengthening market discipline on securities issuance[48], as well as adopting market-driven pricing mechanism[49]. These measures have facilitated the transform of stock market from being government-driven to market-driven gradually, and have improved market discipline and transparency, as well as the power of market pricing mechanism. To some extent, the reform of issuance process has not only made the pricing being more market-driven, but also motivated securities firms to improve their management capacities and core competitiveness (China Securities Regulatory Commision, 2008).

[47] In 2004 the CSRC implemented the *Provisional Measures on the Sponsorship System for Issuing and Listing of Securities*, and replaced the leading underwriter recommendation system by a sponsorship system for issuing and listing of securities. At the end of 2004 the CSRC performed the *Provisional Measures for Public Offering Review Committee*, which abolished the secrecy rule of keeping the identity of committee members confidential, and adopted the real-name voting by committee members as well as defined the accountability and supervision mechanism for committee members.

[48] In 2006 the CSRC stipulated the *Administrative Measures on the Securities Issuance for Listed Companies*, the *Administrative Measures on IPO*, and the *Administrative Measures on Securities Issuance and Underwriting* and other related regulations. These new policies improved market discipline by increasing the sponsor's responsibilities and introducing regulations related to road shows and book-building process, share allotment, simultaneous issuance and listing in domestic and overseas markets, over-allotment options, as well as non-public issuance and equity warrants.

[49] At the end of 2004, the CSRC enacted the *Circular on Several Issues concerning the Book-building Procedures for IPOs*, which removed the government approval of share issuance price and replaced it by a book-building process.

2.4.4 Developing institutional investors

In the early stages of development, Chinese stock market was dominated by individual investors, which resulted in unfavourable conditions for the long-term development. As pointed out by Kumar (2009), for example, individual investors prefer stocks with lottery features. Meanwhile, the fund management industry suffered from low efficiency in operation, high speculation as well as irregular trading, which led to a number of fund scandals. In order to improve the investor structure, the CSRC started to put forward the strategy to develop institutional investors in 2000.

The CSRC employed two major measures: liberalisation of the fund management industry, and promoting market opening and market competition. On the one hand, the CSRC initiated a gradual liberalisation of the funds approval system in 2002[50]. Approval procedures were simplified to converge with internationally-accepted registration systems by introducing an expert review system. This system made the approval process more systematic, transparent, professional and standardized. The average approval time for individual funds application decreased from 122 working days in 2000 to 16 working days in 2006. On the other hand, the promoting of market opening and market competition led to a significant increase in innovation capabilities and service quality of fund management companies. For example, almost all varieties of fund products in mature markets have already been developed in the period from 2001 to 2006[51]. Benefiting from these measures, institutional investors have become an important role in China's stock market. The net value of funds increased from 10

[50] In November 2002, the CSRC stipulated the *Notification on Relevant Issues Concerning the Examination and Approval of Securities Investment Funds*, which to a large degree simplified the approval process and reduced the control on mutual fund industry. Subsequently, the CSRC issued the *Administrative Measures of Expert Review System for Securities Investment Fund* in 2003 and the *Circular on Relevant Issues Concerning the Further Improvement of Procedure* for *the Application and Examination of Raising Securities Investment Funds* in 2005, which introduced simplified procedures for the internal review of the existing fund products. In 2007, the CSRC reduced further the approval time for fund applications.

[51] The Chinese fund management industry launched the open-end fund in 2001, the bond fund and the index fund in 2002, the umbrella fund, the principal-guaranteed fund and the money market fund in 2003, the convertible bond fund, the listed open-end fund, and the exchange traded fund in 2004, the mid/short-term bond fund in 2005, as well as the QDII in 2006.

billion USD in 2002 to 57 billion USD in 2005. In 2007, funds under management reached 448.5 billion USD.

In summary, the recent round of reforms has become an important part of the development strategies of China's stock market, and may have collateral effects on market integration and market interdependence. These reforms are believed to contribute the development of China's stock market by enhancing pricing efficiency, increasing competition capability, as well as improving market transparency. Financial market development can reduce the differential between China's and international stock markets in terms of pricing mechanism, and therefore, increases market integration between them. Meanwhile, financial market development can also contribute to market interdependence, as market integration is an important determinant of market interdependence (Geotzmann, Li, & Rouwenhorst, 2005). As pointed out by Carrieri, Errunza and Hogan (2007), for example, financial market development and financial liberalisation play important roles in integrating emerging markets. More specifically, Hou and Lee (2012) find that the non-tradable share reform of China's stock market contributes to reduce market segmentation (represented by the price discount) between A- and B-shares.

However, this study is not going to examine the collateral effects of financial liberalisation policies on international market integration and market interdependence, via the development of financial market. As financial market development is a gradual process, the collateral effects might take a long time to be detectable. Meanwhile, it is hardly to distinguish the collateral effects of financial liberalisation policies from those brought about by other financial reforms, as all these factors contribute to financial market development jointly. Furthermore, the collateral effects are more subtle than the direct impacts of financial liberalisation policies on international market integration and market interdependence. For the simplicity of analysis, this study mainly focuses the direct impacts of financial liberalisation policies, while ignoring their collateral effects on international market integration and market

interdependence. Admittedly, the impacts of financial market development deserve further study, which is beyond the scope of this thesis.

2.5 Conclusions

This chapter briefly introduces the background of Chinese stock market in terms of institutional setting, internationalization practices, supervision and legal environment, as well as the recent development of policies and reforms. As may be seen from this introduction, China's stock market has developed greatly since its inception. Meanwhile, the Chinese government has implemented a series of reform on stock market, especially after China's entry into the WTO in 2001. These reforms include the opening up of stock market to foreign investors, the non-tradable share reform, as well as the issuance system reform. However, there are still some defects in Chinese stock market, such as immature investors, excessive speculation, rampant insider manipulations, as well as incomplete law and regulations.

In the post-WTO environment, the Chinese government has revised its regulatory and supervision policies to better conform to internationally-accepted standards, and to improve the international competitive capacity of Chinese financial institutions and the soundness of financial market. To a large extent, financial liberalisation has played a catalytic role in the development of Chinese stock market (Kwon, 2009). But it remains unclear whether, and to what degree, China's financial liberalisation has influenced its stock market. Consequently, this thesis is going to examine the impacts of China's financial liberalisation policies on stock market from the perspectives of international market integration and market interdependence.

CHAPTER 3: LITERATURE REVIEW

3.1Introduction

Recent decades have witnessed an unprecedented liberalisation of financial markets across the world[52]. Financial liberalisation allows foreign investors to invest in domestic financial market, and gives domestic investors the opportunity to trade in foreign financial market. Although financial liberalisation is thought to have a large potential impact on economic growth, welfare improvement, as well as risk sharing, there is no general consensus on the net benefits of financial liberalisation (Laeven, 2003; Gehringer, 2013). In the field of macroeconomics, some researchers find strong support for the growth enhancing effects of financial liberalisation (Bekaert, Harvey, & Lundblad, 2005; Quinn & Toyoda, 2008), while others find only weak or mixed evidence of positive growth (Kose, Prasad, & Terrones, 2009). In particular, some researchers document the negative impact of financial liberalisation on several aspects, such as increasing financial instability (Neumann, Penl, & Tanku, 2009), magnifying industrial production volatility (Levchenko, Ranciere, & Thoenig, 2009), as well as inducing financial crisis (Amess & Demetriades, 2010).

As for examining the impacts of financial liberalisation on financial market, market integration and market interdependence are two widely used concepts. On the one hand, an effective financial liberalisation can reduce or remove the trade obstacles between markets, and therefore enhance the integration of financial markets across borders. The effectiveness of financial liberalisation can be reflected by market integration to a large degree, because financial liberalisation leads to market integration if it is effective. As pointed out by Bekaert, Harvey and Lundblad (2003), for example, it is necessary to distinguish between the concepts of liberalisation and integration in examining the impacts of financial liberalisation. Not all regulatory liberalisation is necessarily the *de facto* effective liberalisation that results in market

[52] Financial liberalisation is a broad concept, which may include financial deregulation or even privations. In this study, it mainly refers to allowing inward and outward foreign investment.

integration. The *de jure* liberalisation might have little or no effect because of investors' judgement, market imperfections, as well as regulatory circumvention. Consequently, the concept of market integration has been commonly employed to examine the effectiveness of financial liberalisation.

On the other hand, financial liberalisation to some degree can foster an increase in the extent and the speed of spillover of volatilities across markets in different countries, and therefore, can enhance the degree of market comovement among them[53]. Market interdependence is therefore expected to increase if financial liberalisation is effective. However, an ineffective liberalisation can also increase market integration temporarily, due to private or imperfect information in the markets. The effectiveness of a regulatory liberalisation might be overestimated by domestic investors, even if it is ineffective (Kaminsky & Schmukler, 2008). A shock in asset prices is therefore induced in one market, and spills over to others. During the process of transmission, the volatility might be magnified and causes greater price changes in other markets. Hence, an increase of market independence might be caused by ineffective liberalisation in a short term period. But this increase is inclined to vanish in a long term period as more information is revealed over time. As market interdependence is highly related to market movement, this concept has been widely adopted to examine the impacts of financial liberalisation on financial market from the perspective of cross-market movement.

As both market integration and market interdependence are affected by financial liberalisation, the existing literature generally focuses on their similarities rather than their differences. The relationship between market integration and market interdependence remains somewhat ambiguous in the current literature, though there have been extensive studies on each of them respectively. As there is no well established theoretical framework, this chapter is going to shed some light on this

[53] Market comovements can be aroused either by the global shocks or by the spillover of country-specific shocks through various economic linkages (Walti, 2011).

issue in general by reviewing their definitions and determinants. The specific reviews on measuring market integration and market interdependence will be provided in the main chapters respectively. The criticisms and comments will also be given in this chapter. Although this general issue is relevant for understanding China's financial liberalisation on stock market, this chapter is going to provide a special section for the literature review on China's financial liberalisation.

The rest of this chapter is as follows. Section 2 reviews the existing literature generally from the perspectives of definition and determinant, and finds out the differences between market integration and market interdependence. Section 3 provides a specific literature review on China's stock market. Section 4 presents the gap of the literature review.

3.2 Literature review in general

By and large, some of the existing literature fails to distinguish market integration from market interdependence properly, due to their high similarities. On the one hand, some researchers regard market integration as the same as market interdependence, among which are Roca and Brimble (2005), Bellotti and Williams (2005) as well as Singh and Singh (2010). For example, Campbell and Hamao (1992) argue that the common movement in expected excess returns across two countries is suggestive of capital market integration in the long term. Bracker, Docking and Koch (1999) employ the degree of market comovement to reflect stock market integration. On the other hand, many researchers fail to distinguish the measurement methods of market integration from those of market interdependence properly, though they realize that market integration and market interdependence are different issues. A large body of empirical studies examine market integration through volatility spillover or market comovement, which in fact represents market interdependence. These studies include Maghyereh and Al-zuobi (2005), Carverhill and Chan (2006), Berben and Jansen

(2009), Choi and Dupont (2007), Hatemi-J (2008), Bley (2009), Cheng and Glascock (2006), Maneschiold (2006), as well as Tian (2007).

In fact market integration and market interdependence are highly connected but different issues. In order to reconcile the ambiguity in the current study, this part of study is going to observe the differences and connections between market integration and market interdependence from two aspects: definitions and determinants.

3.2.1 Literature review on financial market integration

This subsection is going to introduce financial market integration from the perspectives of definition and determinants.

3.2.1.1 Definition of financial market integration

As far as financial market integration is concerned, this concept has been developed for a long time, even though none of those definitions can be generally accepted or considered as a benchmark. The existing definitions of financial market integration are defined in terms of one or more of the following aspects: the mechanism that equalizes the price of risk (Kiranand, 2004), the mobility of capital flow, as well as the completeness of international financial market (Kearney & Lucey, 2004).

From the perspective of equalizing the price of risk, Stulz (1981) considers that asset markets are perfectly integrated internationally if two assets, which have perfectly correlated returns in a given currency but belong to different countries, have identical expected returns in that currency. Bekaert and Harvey (1995) regard that markets are completely integrated if assets with the same risk have identical expected returns irrespective of their domicile. Similarly, Levine and Zervos (1998) regard that capital in integrated financial markets should flow across international borders to equate the price of risk. From the perspective of mobility of capital flow, Riedel (1997) claims that a country is integrated into the world capital markets if capital is free to move into and out of the country, and if its assets can substitute for those of other countries.

Much more intensively, from the aspect of the completeness of financial market, Stockman (1988a) argues that perfect financial market integration exists when economic and financial market participants can insure against the full set of anticipated states of nature via a complete set of international financial markets.

In general terms, *international financial market integration refers to the growing openness and unification of financial markets across the world so that the potential participants in initial-segmented markets enjoy the same unimpeded access* [54] (Brouwer, 1999; Obadan, 2006). This study is going to adopt this definition because it combines three aspects of market integration aforementioned very well.

Firstly, perfect cross-market integration can be generally understood as a situation in which there is no obstacle of any kind to cross-border financial transactions, such as tariffs, taxes, restrictions on trading of foreign assets, and information costs or any other cost that makes it more difficult to trade across countries than within them (Ayuso & Blanco, 2001). Secondly, without extra obstacle to international transactions, international capital can flow across borders freely so that it makes the cross-market arbitrage opportunity vanish if market segmentation is the only distortion. The law of one price (LOP), i.e., portfolio with the same payoff should have the same price irrespective of transaction locations, holds therefore in perfectly integrated markets. Lastly, cross-market integration enhances market completeness essentially because the removal of obstacles to cross-market transactions reduces the frictions between relevant markets. Householders and firms in the domestic market can therefore achieve some degree of self-insurance (against risks due to nature or uncertainty about future government policies) via purchasing assets in international financial markets, instead of changing the composition of production, the level of consumption and savings, the levels of investment labour supply, capital utilization (Stockman, 1988a; Stockman, 1988b).

[54] Essentially, international financial market integration is identical to financial globalization (Obadan, 2006) but comparatively focuses on the process and state of events among markets in the micro-level.

3.2.1.2 Determinants of financial market integration

As there is no well developed theory on the determinants of financial market integration, this study has summarised the literature on this topic and categorised the determinants into four groups. These groups are: 1) advancement in information and computer technologies, 2) the globalisation of national economies, 3) the liberalisation of national financial markets (Hausler, 2002), as well as 4) the development of financial market (Carrieri, Errunza, & Hogan, 2007).

Firstly, advancement in information and computer technologies has facilitated cross-border transactions. Information technology advancement makes it easier to collect and process information in managing financial risk, and to price and trade the complex financial derivatives across international financial centres (Hausler, 2002; Obadan, 2006).

Secondly, the globalisation of national economies has lowered obstacles to international trade, and has spurred cross-border flows in goods and services greatly. Coupled with financial liberalisation, the spatial dispersion of real economic activities over different countries or regions has stimulated cross-border finance and fostered the formation of an internationally mobile pool of capital and liquidity (Obadan, 2006).

Thirdly, the development of financial market may not only increase the degree of pricing efficiency, but also provide a better regulatory and institutional environment[55]. These improvements are generally believed to reduce obstacles to cross-border transactions to some extent. On the one hand, the improvement of asset pricing efficiency is helpful for capital allocation across countries by sending appropriate price signals. On the other hand, the advancement in regulatory and institutional environment can reduce irrational behaviours of investors. For example, Morck,

[55]Financial market development is a complex and multi-faceted conception, which mainly includes: (a) market size, liquidity and volatility, (b) market concentration, (c) asset pricing efficiency, as well as (d) regulatory and institutional development (Demirgüç-Kunt & Levine, 1996).

Yeung and Yu (2000) note that inadequate property right protection might hamper risk arbitrage and create noise traders.

Lastly, financial market liberalisation plays a crucial role in international market integration. Financial liberalisation has not only relaxed restrictions on international financial transactions, but also to some degree removed regulations constraining foreign participation in domestic capital markets. As noted by Hausler (2002), for example, financial liberalisation has catalyzed financial innovation and has stimulated the growth of capital flow across borders.

All these factors have together contributed to financial market integration, but financial liberalisation has been the most important factor and has received extensive attention (Chuppe, Haworth, & Watkins, 1989; Akdogan, 1996; Obadan, 2006).

3.2.2 Literature review on financial market interdependence

In parallel with the previous subsection, this subsection is going to introduce the financial market interdependence from the perspectives of definition and determinants.

3.2.2.1 Definition of financial market interdependence

Compared to financial market integration, there is a broad consensus on the definition of financial market interdependence. Gallo and Otranto (2008) regard market interdependence as a situation in which a regime shift in one market results in a change of that in the others. Forbes and Rigobon (2002) define financial market interdependence as a situation in which there is no significant change in the cross-market linkage between the pre- and post-shock periods[56]. Both definitions of market interdependence refer primarily to the cross-market linkage in terms of market comovement, which is influenced by an endogenous or exogenous shock. According to these definitions, not surprisingly, many studies gauge market interdependence by

[56] This definition is proposed as opposed to that of contagion, which is defined as a significant increase in cross-market linkages after the shock. This study modifies the definition of market interdependence in analysing market integration and market interdependence.

examining volatility spillover or market comovement. Taking into account the common characteristics of definitions aforementioned, *this study defines market interdependence as a sturdy cross-market linkage, in which national markets display substantial comovement across borders.* By this definition, market interdependence includes many aspects, including volatility spillover, market comovement and convergence, as well as market linkage.

3.2.2.2 Determinants of financial market interdependence

Compared to financial market integration, there are more factors driving financial market interdependence. For example, Campbell and Hamao (1992) argue that fundamental economic variables, such as interest rates and dividend-price ratio, drive the comovement between the United States and Japan markets. Heston and Rouwenhorst (1994) regard that country-specific effects rather than industrial effects dominate the correlation between countries. Bracker, Docking and Koch (1999) regard that international stock market comovement has been caused by bilateral import dependence, the geographic distance between markets, the size differential across markets, as well as the overlap of trading hours. Baele (2005) argues that the intensity of volatility spillover in European has been increased by trade integration, the development of equity market, as well as low inflation. Kim, Moshirian and Wu, (2005) note that both regional and global comovements of stock markets in the area of the European Monetary Union (EMU) have been significantly driven by macroeconomic convergence, which are related to the introduction of the EMU and financial development. In general, these determinants can be categorized into four groups: 1) "contagion" effect, 2) macroeconomic interdependence, 3) the similarities of market characteristics, as well as 4) financial market integration (Pretorius, 2002).

3.2.2.2.1 "Contagion" effect

"Contagion" effect refers to the propagation of shock across markets in excess of that determined by the underlying fundamentals (Pretorius, 2002; Billio & Caporin, 2010).

"Contagion" effect can be induced by investor irrationality, forced redemption and a two-stage investment strategy.

Firstly, investor irrationality, for example, the herding behaviour, can result in a widespread uprising or decline in prices across markets irrespective of economic fundamentals. For example, Morck, Yeung and Yu (2000) argue that in emerging economies the comovement of stock price, which are unrelated to changes in economic fundamentals, are mainly created by noise traders as there is lack of property right protection.

Secondly, the forced redemption of open-ended mutual funds can also create a "contagion" effect. These global mutual funds will have to sell off their assets in the most liquid markets when they face redemption pressure, such as large-scale withdrawals and a reduction in inflows (Pretorius, 2002). The forced redemption can lead to a simultaneous decline in several markets without recognised change in economic fundamentals. Similarly, the same phenomenon occurs when global mutual funds try to exploit the perceived mispricing in specific markets by selling equities in those less-related markets.

Lastly, by applying a two-stage strategy investors may use a linear combination of asset payoffs in the first stage as a private signal to update information about all assets in the second stage. When this private signal is adopted, changes in one asset may influence all asset prices in an international portfolio, and then lead to asset price comovement (Mondria, 2010). The first-stage decision motivated by country-specific factors can also influence other markets, even though those factors are of little importance to other countries.

In a word, "contagion" effect can lead to a widespread volatility spillover across markets and market comovement, which are irrespective of fundamental changes.

3.2.2.2.2 Macroeconomic interdependence

Macroeconomic interdependence is referred as to the interdependence of macroeconomic variables across borders, which mainly includes the interdependence of real economic activities, the coordination of monetary policy as well as the synchronicity of national business cycle fluctuations.

Firstly, the degree to which two economies are interdependent can influence the degree to which their stock markets depend on each other. That is to say, the stronger the interdependence of real economic activities, such as bilateral trade and foreign direct investment, the higher the degree of interdependence should be expected between their stock markets (Pretorius, 2002; Walti, 2011). As noted by Johnson and Soenen (2002), for example, not only the increased export share of Asian economies to Japan but also the greater foreign direct investment from Japan to other Asian economies contribute to greater market comovement between Japan and other Asia countries . Similarly, Tavares (2009) finds that the intensity of bilateral trade increases the correlation of stock returns while the asymmetry of output growth and export dissimilarity decrease it.

Secondly, the coordination of monetary policy in two countries can lead to a comovement between their stock markets (Elyasiani & Zhao, 2008). According to the cash flow model, any factor influencing the stream of cash flows or the risk-adjusted discount rates can influence stock prices systematically, among which are interest rates, inflation as well as exchange rates. The coordination of monetary policy implies a convergence of the real interest rates or the inflation expectations in two countries. Meanwhile, a lower volatility of exchange rate can lead to a higher comovement of stock market (Walti, 2011; Beine, Cosma, & Vermeulen, 2010). Furthermore, the announcement of monetary policy decision may also convey information relevant to future economic activities, and therefore result in changes in equity prices across markets via portfolio adjustments in multiple markets (Hussain, 2011). For example,

Kodres and Pritsker (2002) argue that portfolio adjustments serve as the main channel for shocks transmission. Harvey and Huang (1991) regard that macroeconomic news announcement, including policy announcement, can lead to market comovement across markets.

Lastly, the synchronicity of national business cycle fluctuations may offer a common shock to highly integrated economies (Walti, 2011). Originating from the same source, changes in equity prices are expected to occur in relevant markets, which result in the phenomenon of market comovement or volatility spillover. As noted by Brockman, Liebenberg and Schutte (2010), for example, the relation between stock market comovement and business cycle fluctuation is strong in the poor countries, and in those countries with less developed financial markets and weak accounting and transparency standards.

3.2.2.2.3 Similarities of market characteristics

The similarities of market characteristics, such as market size, volatility, and the dominated industry, can influence the extent to which equity markets are interdependent potentially (Pretorius, 2002). The more similarities two equity markets possess, the more interdependent they should be. The dissimilarities in market characteristics may indicate the difference between two markets in the aspects of information acquisition, transaction cost, investor risk aversion, as well as risk source.

The size of equity market may indicate the stage of market development, the cost of information acquisition, as well as transaction cost. Meanwhile, market volatility may reflects the average risk aversion of the investors in this market to some degree, as investors should be less risk averse for the high volatility stocks they hold. The basic principle is that the higher the volatility of equity market, the higher the risk the market should be. Furthermore, the dominant industry may determine what kind of risk the investors take on. For example, an equity market, which is mainly dominated by petroleum industry, may often suffer from the risk of decreasing demand for oil in

the world. The similarity of dominant industry will influence the extent of equity market comovement when the performance of equity market is determined by that industry. Generally, equity markets with greater industrial similarities tend to experience more substantive comovement (Bracker, Docking, & Koch, 1999).

3.2.2.2.4 Financial market integration

Financial market integration is expected to enhance the degree of financial market interdependence (Geotzmann, Li, & Rouwenhorst, 2005). Market integration can merge the initially segmented markets into an integrated one by removing or reducing obstacles to cross-border trade. If there is no any difference in trade obstacles between within- and across markets, the idiosyncratic volatility of an initially segmented market can instantly spread out to other markets without time delay. These markets should move together synchronously as there is no more market-specific volatility in these markets.

Financial market integration implies that the market-specific volatility can transmit to other markets with greater ease and speed, which results in the phenomena of market comovement and volatility spillover across markets. In some cases, the magnitude of volatility can be exacerbated during the process of propagation to a certain level, which is far in excess of that determined by underlying fundamentals. By the aforementioned definition, contagion is expected to occur as another adverse consequence of closer financial integration. As argued by Bekaert and Harvey (1995; 2000), for example, financial market integration can influence the interdependence between stock returns in emerging markets and the global market factors. Similarly, Walti (2011) finds that financial (market) integration contributes to greater comovement in stock market returns.

It is worth noting, however, that financial market integration and market interdependence share some common determinants. These driving forces of financial market integration can also lead to financial market interdependence. As

aforementioned, these determinants include the advancement in information and computer technologies, the globalisation of national economies, as well as the liberalisation of national financial and capital markets. For example, Beine, Cosma, and Vermeulen (2010) find that financial liberalisation significantly increases the left tail comovement of stock return while the introduction of the euro increases the comovement across the entire return distribution. Similarly, Chen, Buckland, and Williams (2011) find that the conditional correlation between equity markets increases significantly over the post deregulation period.

3.2. 3 Differences between market integration and market interdependence

Comparing the definitions and determinants of market integration and market interdependence correspondingly, it is easy to reach the conclusion that market integration and market interdependence are two highly connected but different issues.

Firstly, market integration and market interdependence reflect different aspects of financial market, though they are highly connected. Market integration mainly concerns the removal of trade obstacles of any kind to cross-border transactions in the process of openness and unification among financial markets, such as financial liberalisation. On the contrary, market interdependence basically focuses on disturbances of any kind to cross-market linkage, such as volatility spillover and market comovement. More specifically, *market integration reflects the disparity of trade obstacles of any kind between within- and across markets while market interdependence represents the influences of one market on others or the interaction among them.*

Secondly, financial market integration and financial market interdependence are quite different from the aspect of determinants, though they share some common factors. As shown in Table 3.1 below, there are many determinants, other than market integration, that influence market interdependence. In some cases, those determinants may overwhelm the effect of financial market integration, and result in an anomaly of

market interdependence. For example, financial crisis contagion can give rise to an increase in market correlation, which is irrelevant to market integration. Savva and Aslanidis (2010) argue that the increase in the correlation among European markets is not driven by financial market integration but by the development of the European Union. Although market comovement or volatility spillover is suitable for measuring market interdependence, it is not the proper way to gauge market integration because many factors, other than market integration, contribute to market comovement or volatility spillover.

Table 3. 1 The Determinants of Market Integration and Market Interdependence

Panel A: Financial Market Integration	
Driving Factors	Advancement in information and computer technologies; Globalisation of national economies; Development of financial market; Liberalisation of national financial and capital markets
Panel B: Financial Market Interdependence	
Determinants Categories	**Driving Factors**
"Contagion" Effect	Investors' irrationality; Forced redemption; Two-stage investment strategy
Macroeconomic Interdependence	Interdependence of real economic activities; Coordination of monetary policy ; Synchronicity of national business cycle fluctuations
Similarities of Market Characteristics	Market size, volatility, and dominant industry
Financial Market Integration	Advancement in information and computer technologies; Globalisation of national economies; Development of financial market; Liberalisation of national financial and capital markets

Lastly, there is a significant difference between market integration and market interdependence in terms of the influence mechanism of financial liberalisation. As mentioned in the introduction of this chapter, financial liberalisation leads to an increase of market integration only if this liberalisation is effective. However, market interdependence can increase, irrespective of the effectiveness of financial liberalisation. An ineffective liberalisation can also increase market interdependence, due to private or imperfection information. Although financial liberalisation is common to both financial market integration and financial market interdependence, it has different influence mechanisms on them. Market integration, rather than market

interdependence, is a more appropriate measure for the effectiveness of financial liberalisation.

In summary, market integration and market interdependence are two highly connected but different issues. Market integration is one, but not the only, determinant of market interdependence. Financial liberalisation can affect both market integration and market interdependence, but has different influence mechanisms on them. Market integration can be increased by financial liberalisation only if it is an effective liberalisation, while market interdependence can increase by financial liberalisation, irrespective of its effectiveness. Compared to market interdependence, market integration is more suitable to examine the effectiveness of financial liberalisation.

3.3 Literature review on China's financial liberalisation

In the existing literature, there are very few studies focusing on China's financial liberalisation in terms of market integration and interdependence, but also suffer from the aforementioned limitations. Most of these studies are also confounded by the differences between financial market integration and financial market interdependence, among which are Yang (2003), Chelley-Steeley and Qian (2005), Tian (2007), Giraradin and Liu, (2007), as well as Yao, Luo and Morgan (2010). Meanwhile, these studies have mostly focused on the subject at the regional rather than global level. Most of these studies have focused on either the relationship among A-, B- and H-share markets or the one among the Greater China area stock markets, including mainland China, Hong Kong and Taiwan. Only a few studies, for example, Wang and Iorio(2007), have examined this issue from the global perspective. Furthermore, most of these studies have concentrated on the policy of opening the B-share markets to domestic investors, while largely neglecting other important policies, such as the QFII programme, the QDII programme, as well as the exchange rate reform. Consequently, this thesis seeks to fulfil this gap in the literature by examining international market

integration and market interdependence between China and the world stock markets in the post-WTO accession period.

Regarding market integration, the empirical findings are mixed and the degree to which Chinese stock market is globally or regionally segmented (or integrated) remains controversial, though there has been a general belief that Chinese stock market is largely segmented (Wang & Iorio, 2007; Lean, 2010). Similar to many other countries, China has divided its stock market into a domestic board (A shares) and foreign boards (B and H shares), resulting in different prices for the same underlying shares. Contrary to what has been observed in other markets with a similar segmented structure, such as Thailand, Singapore, Finland and Mexico, the prices of foreign boards (B and H shares) trade at a discount relative to domestic board counterparts (A shares) in China's stock market(Sun & Tong, 2000; Yeh, Lee, & Pen, 2002). There have been several explanations for this phenomenon, such as asymmetric information (Chakravarty, Sarkar, & Wu, 1998; Chui & Kwok, 1998; Gao & Tse, 2004; Yang, 2003), different demand (Sun & Tong, 2000), liquidity differential (Chen, Lee, & Rui, 2001) as well as different risk aversion (Ma, 1996; Zhang & Zhao, 2004). Generally, the pricing differential between A- and B-share markets has been found to be significantly reduced by the policy of opening the B-share markets to domestic investors (Lu, Wang, Chen, & Chong, 2007). From the international perspective, however, as pointed out by Jacobsen and Liu (2008), for example, Chinese stock market are still segmented from international markets partially. Meanwhile, Wang and Iorio (2007) find no supportive evidence on the increasing integration of B- and H-share markets with the world stock markets.

As for market interdependence, the empirical findings generally support the view of significant interdependences between the A-share market and B-, and H-share markets. The lead-lag and cointegration relationships between these markets have been generally observed, among which are Kim and Shin (2000), Tian and Wan (2004), as well as Shen, Chen and Chen (2007). As pointed out by Qiao, Li and Wong (2008a),

for example, that the A-share markets are inclined to lead their B-share counterparts on the same stock exchange since the opening of the B-share markets to domestic investors in 2001, while the B-share markets continue with the tradition of leading the H-share market. Meanwhile, Qiao, Chiang and Wong (2008b) find that the policy of allowing domestic investor to purchase B shares has increased market interdependence between A- and B-share markets, and Hong Kong market. Furthermore, Su, Chong and Yan (2007) find that China's financial openness has played an important role in the increase of market comovement between mainland China and Hong Kong. Li (2007) finds supportive evidence of unidirectional volatility spillovers from the Hong Kong stock exchange to those in Shanghai and Shenzhen in the period of 2000-2005, but not any direct linkage between the stock exchanges in mainland China and the US market correspondingly. Johansson (2009) finds significant interdependencies among mainland China, Hong Kong and Taiwan stock markets. Cheng and Glascock (2005) regards that the US stock market exerts more impacts on the Greater China Economic Area stock markets than Japanese market, while the Hong Kong stock market is the most influential one among the three Greater China Area markets.

3.4 The gap in the literature review

The study of the impacts of financial liberalisation on stock market can be approached from different perspectives, including international market integration and international market interdependence. Although there has been an extensive study investigating this issue, little attention has been paid to the differences among financial liberalisation, market integration as well as market interdependence. Most of the existing literature has focused on their similarities rather than differences. The relationship among them remains somewhat ambiguous. Some researchers regard market interdependence as the same concept of market integration, or use the concept of market interdependence to examine the effectiveness of financial liberalisation. The misuse of concepts might lead to false research findings. As there is no well developed

theory for this issue, it deserves a systematic study to clarify their relationships with each other.

Although there have been intensive studies on the financial liberalisation of emerging markets, the existing literature has not systematically explored the impacts of China's financial liberalisation on stock market. As a series of financial liberalisation policies has been implemented by China's government on its stock market, its stock market is thought to be more integrated into and interdependent with the world stock markets in the post-WTO accession period. However, most of the current studies focus on this topic either at the regional rather than the global level, or from the perspective of a single liberalisation policy rather than a series of policies. Little study has examined the impacts of China's financial liberalisation on stock market as a series of polices at the global level.

In order to fill in the gap in literature, this study is going to examine the impacts of China's financial liberalisation on its stock market in the post-WTO accession period. More specifically, this thesis is going to gauge the degrees of market integration and market interdependence between China and the world stock markets in the post-WTO accession period respectively, and to examine the relationship between market integration and market interdependence. In so doing, the time series of degrees of market integration and market interdependence are going to be obtained respectively by a sliding time window of fixed length. The time series of degrees can be applied to analyse the impacts of a series of China's financial liberalisation policies on stock market at the global level, and can be adopted to provide empirical evidence for the relationship between market integration and market interdependence.

Admittedly, the research findings might be related to measurement methods and indicators chosen in this study. However, the limitation is not unique to this study, and is a common problem in the literature that seeks to explore the impacts of financial liberalisation. By combining market integration and market interdependence together,

the aim of this study is twofold: 1) to give a systematic evaluation of the impacts China's financial liberalisation on stock market; and 2) to provide empirical evidence for the relationship among financial liberalisation, market integration, as well as market interdependence from the case of China's financial liberalisation. More detailed analysis will be covered in Chapters 4, 5 and 6, while other limitations of this study are to be found in the final chapter.

CHAPTER 4: MEASURING MARKET INTEGRATION BETWEEN CHINA AND THE WORLD STOCK MARKETS THROUGH STOCHASTIC DISCOUNT FACTORS: THEORY AND EMPRICAL ANALYSIS

4.1 Introduction

This chapter is going to examine international market integration between China and the world stock markets in the post-WTO accession period. The main purpose of this chapter is twofold. On the one hand, it aims to provide empirical evidence on whether China's financial liberalisation has increased international market integration between China and the world stock markets since China's entry into the WTO in 2001. On the other hand, it attempts to generate a time series of integration degree between China and the world stock markets, which is useful for examining the relationship between market integration and market interdependence in further study.

To achieve this purpose, this chapter is going to gauge the non-normalised degree of market segmentation (inversely, market integration) between China and the world stock market by the weak-form measure after comparing several methods. The weak-form measure is proposed by Chen and Kenz (1995) on the basis of stochastic discount factors (SDF). This measure has two merits. Firstly, this method is free of model assumption, and therefore avoids the pre-biases due to model misspecification. Secondly, this method is based on the Law of One Price (LOP), and represents the degree of market segmentation by the minimum pricing differential across asset markets directly[57]. As the non-normalised degree of market segmentation is shown to be time-varying, this chapter is going to propose a normalised index of market segmentation between China and the world stock market by taking the non-normalised degree between the US and the world as a benchmark. The reason for so doing is that the US stock market is generally regarded as the most open and influential one in the

[57] According to the LOP, if two asset markets are integrated perfectly, they should follow the same pricing pattern, and therefore the pricing differential between them should be exactly equal to zero. The weak form measure provides an estimated value of market segmentation by pricing differential directly, as two asset markets in reality cannot be perfectly integrated.

world, which provides a benchmark of the lowest stock market segmentation in the world. Compared to the non-normalised degree, the normalised degree of market segmentation provides more useful information, especially when analysing the tendency of market integration and the impacts of China's financial liberalisation policies.

The rest of this chapter is as follows. Section 2 provides a brief literature review on the subject. Section 3 offers the main theoretical framework of SDF and the estimation methodology. Section 4 presents empirical analysis, including the descriptions of the indices and data, the empirical procedures, as well as empirical results. In Section 5 this chapter reaches its conclusion.

4.2 Previous literature on measuring financial market integration

In the majority of the existing studies, financial market integration is measured either by *de jure* or by *de facto* measures (Vo & Daly, 2007). *De jure* measures are the proxies of the prerequisites that lead to financial market integration, while *de facto* measures represent financial market integration from its consequences or results. Although both the *de jure* and *de facto* measures have important information for financial market integration, different types of measures chosen may lead to various results, especially on the impacts of financial market integration (Kose M. A., Prasad, Rogoff, & Wei, 2006; Bekaert, Harvey, & Lundblad, 2006). However, as pointed out by Kose and Prasad (2006), *de facto* measures are generally more suitable for many applications.

4.2.1 *De jure* measures

De jure measures mainly concern the rule-based indicators of restrictions on capital flow, which are related to the mobility of cross-border capital flows in legal restrictions, such as controls on inflows and outflows, and restrictions on foreign equity holdings (Kose M. A., Prasad, Rogoff, & Wei, 2006). Various *de jure* measures

have been proposed, but most of them are based on the information of the *Annual Report on Exchange Arrangements and Exchange Restrictions* (*AREAER)*, which is published by the International Monetary Fund (*IMF*). The IMF has established the AREAER to measure over sixty different categories of controls, mostly on current account restrictions since 1950[58].

Based on the disaggregated *AREAER*, several researchers, for example, Vittorio and Milesi-Ferretti (1995), and Klein and Oliver (2008), construct the "S*hare*" measure to reflect the proportion of years within the sample period that the capital account is judged free of restrictions. Similarly, the *OECD-Share* has been put forward for the Organisation for Economic Cooperation and Development (*OECD)* member countries [59] , and the *M-R Share* has been developed for emerging markets respectively[60]. In contrast to the binary IMF indicators, Quinn (1997) creates a finer openness measure from the information provided by the *AREAER* to capture the intensity of controls on the capital account and the current account[61]. Moreover, Chinn and Ito (2002; 2006) and Ito (2006) develop a capital account openness index, namely *KAOPEN*, by the principal components extracted from disaggregated *AREAER*. Mody and Murshid (2005) construct an index of financial integration, which has been firstly introduced by Grilli and Milesi-Ferretti (1995) in a systematic dataset, as the sum of four government-restrictions measures[62]. Edwards (2005) constructs a new index of capital mobility by combining information from Quinn (2003) and Mody and Murshid

[58] In the *AREAER*, the dummy variable indicating capital openness takes on a value of zero if the country has at least one restriction in the "restrictions on payments for capital account transaction" category. Starting with the 1996 edition, the *AREAER* provides dummy variables with several subcategories of transactions rather than one of that in the older versions. For details, see Bekaert, Harvey and Lundblad (2005), M. A. Kose, E. Prasad, et al(2006), Miniane (2004) as well as Klein, et al(2008).

[59] The *OECD-share (Code of liberalization of Capital Movements)* reflects the fraction of 11 categories free of restrictions averaged over the relevant period. This measure potentially ranges from 0 to 1 with increments of 1/11 for any one country in any year.

[60] The *M-R Share* ranges from 0 to 1, wherein bigger values represent stronger capital account restrictions. The *M-R Share* is different from those measures mentioned previously (Montiel & Reinhart,1999).

[61] The *Quinn* index scores from 0 to 4, wherein a value of 4 represents a fully open economy and a value of zero *vice versa*.

[62] This index takes values between 0 and 4, wherein a zero indicates the closed capital and current accounts, and a value of four indicates an open regime.

(2005) with that from country-specific sources[63]. There have also been some refinements of the earlier measures after the expansion of disaggregated categories of the *AREAER*[64] to reflect the existence of capital control (Miniane, 2004).

However, it is worth nothing that the range of *de jure* measures aforementioned is not as broad as it may seem. Essentially, most of them just summarise the information from the *AREAER* of *IMF* in one way or another (Kose M. A., Prasad, Rogoff, & Wei, 2006). Meanwhile, most of them are qualitative on/off indicators of the existence rather than the intensity of rules or restrictions on capital flows (Edison & Warnock, 2003), and therefore fail to capture the magnitude of real-world capital controls fully (Chinn & Ito, 2006; Edison, Levine, Ricci, & Slok, 2002).

In parallel with those *AREAER*-based measures, some other *de jure* measures related to equity market have also well developed but focus on much narrow issues: holding restrictions on foreign participation on domestic equity markets(Edison, Levine, Ricci, & Slok, 2002) and the official date of equity market liberalisation[65] (Naceur, Ghazouani, & Omran, 2008).

As for the perspective of ownership restrictions on foreign participation, the most important *de jure* measures are the International Finance Corporation Global (*IFCG*) index and the International Finance Corporation Investable (*IFCI*) index for emerging market countries. The indices of *IFCG* and *IFCI* , which are designed by the International Finance Corporation/ Standard and Poor's (*IFC/SP*)[66], represent the overall capital market for each country and the partial market that are available to foreign investors respectively (Edison & Warnock, 2003; Henry, 2000a; Bekaert,

[63] This index has a scale from 0 to 100, wherein a bigger value indicates a higher degree of capital mobility. A value of 0 denotes the absolutely restricted capital mobility, and *vice versa* for the value of 100.
[64] Several researchers, for example, Johnston and Tamirisa (1998), are regarded as trendsetters in the area of disaggregated categories (Kose M. A., Prasad, Rogoff, & Wei, 2006).
[65] In most cases, the official policy decree dates are regarded as the official date of financial liberalization.
[66] The Standard and Poor's company took over the maintenance and ownership of International Finance Corporation price indices in 1999.

Harvey, & Lundblad, 2005). The ratio of IFCI to IFCG measures the availability of the country's equities to foreign investors, and therefore one minus this ratio is a measure of capital control *vice versa*. Based on *IFCG* and *IFCI* indices, other novel indices are constructed by Edison and Warnock (2003) to explore the evolution of restriction degree on foreign ownership of equities over time. Chari and Henry (2001) use the firm-level *IFC* data to study the cross-sectional repricing of systematic risk when barriers to capital movements are removed. Bekaert, Harvey and Lundblad (2005) employ the *IFCG* and other indices to measure financial liberalisation.

Regarding the perspective of official liberalisation dates, Henry (2000a; 2000b) points out that the date of a country's first stock market liberalisation is identified with the occurrence of any of the following three events: the promulgation of financial liberalisation policy, the establishment of the first country fund, or an increase in the invetstability index of at least 10 percent[67]. Bekaert, Harvey and Lundblad (2005) regard the first sign of American Depositary Receipt (*ADR*) as a complementary indicator of equitity market liberalisation. They provide the most comprehensive dates of equity market liberalisation for developing countries[68], on the basis of *"A Chronology of Important Financial, Economic and Political Events in Emerging Markets"* (Bekaert & Harvey, 2002), and of information provided by Bekaert and Harvey (2000) and Henry (2000a).

Despite their increasing sophistication and fineness, all aforementioned *de jure* meausures suffer from similar drawbacks. Firstly, they cannot accurately reflect financial market integration, because market integration does not arise instantly as soon as legal barriers are lifted (Vo & Daly, 2007). Financial market integration is a possible end result of official liberalisation, and requires many formal and practical elements of institutionalization as well as a system of rules. These factors should

[67] For each of 12 contries in his sample, Henry lists the first liberation date of its stock market as well as the means by which it liberalised.
[68] Dating financial liberalization in these papers concerns *de facto* measures partially, which will be discussed in details.

allow financial market to function competively and securely (Von Furstenberg, 1998). Secondly, they do not capture the intensity of capital controls (or the enforcement effectiveness of legal restircitons), which can change over time even if there is no regulatory change on capital controls (Kose M. A., Prasad, Rogoff, & Wei, 2006). As pointed out by Edwards (1999), the private sector can circumvent capital control restrictions to invalidate the regulatory effects. Lastly, despite the extensive coverage of the *de jure* measures on capital controls, there possibly exist other omitted regulations. These regulations act as capital controls effectively in fact, such as the investment willingness of investors, the judgement of investors on regulatory reforms, as well as other forms of market imperfection.

4.2.2 *De facto* measures

Paralleling with *de jure* measures aforementioned, *de facto* measures have developed with greater complexity and sophistication. *De facto* measures are generally divided into three groups: 1) measuring market integration by pricing differentials, 2) gauging the co-movement of equity market, as well as 3) quantity measures on capital flow mobility.

4.2.2 .1 Measuring market integration by pricing differentials

As for measuring market integration by pricing differentials, this approach is based on the rationale that unrestricted capital flow should result in the equalisation of rates of return by seeking the best available return across countries. This approach invokes the law of one price or arbitrage mechanism, whereby financial assets with similar risk (or maturity) require the equalised return across integrated markets. In a set of perfectly integrated markets, pricing differentials are zero if the law of one price holds across markets[69] , and therefore arbitrage opportunities vanish intuitively[70].

[69] In perfectly integrated markets, pricing differential is zero if market segmentation is the only distortion. But in reality, some other market frictions, such as the cross-market transaction costs and information asymmetry, may hamper pricing differential from zero.

Regarding the measurement of pricing differentials, the most popular models are the Capital Asset Pricing Model (CAPM) and its derivatives. The CAPM family play an important role in measuring pricing differentials as they provide a specific relationship between the risk of an asset and its expected return. According to the CAPM theory, if a portfolio is constructed in one market, which is completely segmented from the rest of the world, its expected return can hardly be explained by its covariance with the common world factor. Meanwhile, its reward to risk is also different from others because the sources of risk are different (Bekaert & Harvey, 1995). Consequently, the deviations of expected return or the ratio of reward-to-risk from the theoretical one, which is derived from a CAPM model with perfect international integration, reflects the deviations from the complete market integration. Alternatively, market integration can be measured by the contribution of a given market to the world systematic risk relative to its contribution to the world market value (Akdogan, 1995).

After the birth of CAPM (Sharpe, 1964; Lintner, 1965), the CAPM model has well developed in the field of measuring market integration though there remains controversy. Generally, this strand of studies can be further classified in three broad categories by their assumptions: segmented markets, integrated markets, or partially segmented markets (Bekaert & Harvey, 1995). Firstly, the standard CAPM can be applied to a single country with absolute country-segmentation. The implicit assumption is that the market is either completely segmented from the world market or it is the proxy of a broader world market return (Bekaert & Harvey, 1995). Secondly, another set of studies assume that financial markets are completely integrated in a global level and risks are totally exposed to the common world factor. These studies measure market integration in the framework of CAPM, such as the international CAPM (Jorion & Schwartz, 1986; Baele, Pungulescu, & Horst, 2007), the world consumption-based model (Wheatley, 1988), the world arbitrage pricing theory

[70] Even in perfectly integrated markets, cross-market arbitrage opportunities may still exist if portfolios, which are constructed from both markets, offer positive payoffs in the future but have negative prices. For details, please refer to Chen (1995).

(Solnik B. , 1983; Korajczyk & Viallet, 1989; Mittoo, 1992), the world multi-beta models (Ferson & Harvey, 1993; 1994) as well as the world latent factor models (Bekaert & Hodrick, 1992; Campbell & Hamao, 1992). Lastly, more realistic methods suppose that financial markets are neither completely segmented nor integrated. For example, Errunza and Losq (1985) and Errunza, Losq and Padmanabhan (1992) derive an international CAPM with mild market segmentation, in which financial markets are supposed to be partially segmented. But the degree of market segmentation in this model is assumed to remain fixed over time, which is somewhat against the intuition that some markets have becoming more integrated through time. Allowing the degree of market segmentation to vary over time, further models have been developed by Bekaert and Harvey (1995) with a smooth change, by Santis and Imrohoroglu (1997) with a regime change, and by Kiranand (2004) with a switching probability that follows a Markov process.

However, the aforementioned studies rely heavily on the CAPM and its derivatives to test market integration via pricing differential. As pointed out by Wheatley (1988), Chen and Kenz (1995) as well as Ayuso and Blanco (2001), however, measuring market integration via the CAPM are joint tests of the asset pricing model *per se* and the hypothesis of market integration. The rejection may be due to model misspecification or the rejection of the market integration hypothesis.

4.2.2.2 Measuring market integration by market comovement

A significant number of studies have measured international financial market integration from the perspective of market comovement over time. This strand of measures is based on the intuition that the integrated markets should move together in terms of their returns or variances. Sharing a common economic fundamental and information set with each other, integrated markets are expected to move towards the same direction and to react to each other instantly. Focusing on the comovement of financial markets, three econometric methods are the most common measurements of

financial market integration, among which are the cross-market correlation analysis, cointegration analysis as well as Granger causality analysis.

4.2.2.2.1 Cross-market correlation analysis

As for the cross-market correlation analysis, the rationale here is that if the correlation structure demonstrates instability over time, then, given that the trend is towards increased correlation, a greater cross-market correlation coefficient indicates higher market integration (Kearney & Lucey, 2004). For example, Maghyereh and Al-zuobi (2005) measure equity market integration by an asymmetric version of the Dynamic Conditional Correlation (*DCC*) model. Carverhill and Chan (2006) use a multivariate GARCH model, which presents the correlation dynamically, and find evidence in favour of international market segmentation. Similarly, Berben and Jansen (2009) employ a GARCH model with a smoothly time-varying correlation, and find that stock market integration is a more gradual process than that of bond market in Europe.

Nonetheless, there are fundamental flaws in measuring the degree of market integration by correlation analysis. Firstly, the correlation analysis is subject to several technical limitations. The substantial autocorrelation of return may understate the true correlation between the markets, and thus leads to inappropriate conclusions. For example, Dumas, Harvey and Ruiz (2003) argue that under the hypothesis of market segmentation the estimated values of correlation coefficients are much smaller than the true correlations. Carrieri, Errunza and Hogan (2007) regard that it is improper to use the correlations of market-wide index returns as measurements of market integration because such correlations consistently underestimate the degree of integration. To make things worse, the non-stationarity of time series can also lead to a biased estimation (Kiranand, 2004). Secondly, as pointed out by Pukthuanthong and Roll (2009), the cross-market correlation coefficient is a poor measure for market integration because even perfectly integrated markets can exhibit weak correlations. This phenomenon may occur whenever there are multiple global sources of return

volatility and markets do not share the same sensitivities to all of them. Lastly, the increase of correlation coefficient is a necessary, but not sufficient condition for market integration. Market correlation tends to increase temporarily in financial distress period, but it does not indicate a temporal increase in market integration (Forbes & Rigobon, 2002). Hence, cross-market correlation analysis is not suitable for measuring market integration.

4.2.2.2.2 Cointegration analysis

Compared to the correlation analysis, co-integration analysis is more appealing to researchers in measuring market integration. Cointegration analysis is an attractive technique, because it allows researchers to analyse the long-term equilibrium relationship while accounting for the non-stationarity of time series.

Using cointegration analysis, Kasa (1992) finds a single common trend driving the major equity markets over the period 1974—1990. Corhay, Rad and Urbain (1993) find a common stochastic trend among five important stock markets over the period 1975-1991. Chung and Liu (1994) examine the US and five East Asian equity markets over the period 1985-1992 and find two co-integration relationships among them. Click and Plummer (2005) find that five stock markets in the original Association of Southeast Asian Nations countries are co-integrated, and thus argue that these markets are not completely segmented by national borders. Bley (2009) finds that the European stock markets have become more integrated between 1998 and 2006. However, empirical findings have not been unanimous. Chan, Gup and Pan (1992) find no supportive evidence of market integration among the US, Hong Kong, South Korea, Singapore, Taiwan, Japan over the period 1983-1987. Chan, Gup and Pan (1997) expand their previous study to eighteen national equity markets and find a decrease in market integration in the 1980s. Kanas (1998) finds that the US market is not pair wise co-integrated with any of the six largest European equity markets. More fundamentally, it is worth noting that, however, the presence of cointegration does not

necessarily imply market integration, which has been discussed in Chapter 3. Consequently, it is inappropriate to measure market integration by cointegration analysis.

4.2.2.2.3 Granger causality analysis

If equity markets are integrated, there should not be a lagged price adjustment, which is long enough to induce arbitrage across markets. Based on this intuition, Granger causality analysis has often been adopted as a measure of market integration, which gauges market integration by the lagged market response to others.

Numerous researchers have applied the Granger causality test to address the issue of equity market integration. For example, Cheng and Glascock (2006) find supportive evidence that the US, China, Hong Kong and Taiwan stock markets have become more interrelated after the 1997 Asian financial ciris. Similarly,Tian (2007) finds that the Shanghai A-share market has a unidirectional Granger causality effect on other markets in the Greater China region and on the US market during the post-Asian crisis period. As for other regions, Maneschiold (2006) finds evidence of causality running from the European markets to the Baltic markets, and the causality relationships among the Baltic States, excepting for the short-term effects of Latvian and Lithuanian on the Estonian markets. As aforementioned in Chapter 3, however, Granger causality indicates market interdependence rather than market integration essentially.

As discussed in Chapter 3, the notion of measuring market integration from the perspective of market comovement is problematic, no matter what kind of methods it employs. As pointed out by Adler and Dumas (1983), Chen and Kenz (1995) and Pukthuanthong and Roll (2009), the notion is improper that integrated markets should move together though it seems reasonable intuitively. Generally, market comovement is only a necessary, but not sufficient, condition of market integration. In some cases, market comovement is even unrelated to market integration, because of the

compounding effects of other factors. Fundamentally, market comovement reflects market interdependence rather than market integration.

4.2.2.2.3 Numerical measures on key economic aggregates and market behaviours

Other ways of measuring market integration are numerical measures s on key economic aggregates and market behaviours, particularly on their changes in magnitude (Riedel, 1997) and structural breaks (Bekaert & Harvey, 2002). The key market behaviours mainly refer to asset returns and volatilities while economic aggregates are primarily related to capital flows. As for market behaviour, for example, a sharp drop in dividend yields may capture the permanent price effects, which are entailed by the market integration, if dividend yields are associated with expected returns. Meanwhile, sharp changes of capital flow and foreign asset-liability ratios can also be seen as evidences of market integration (Lane & Milesi-Ferretti, 2001; 2007).

Furthermore, Bekaert, Harvey and Lumsdaine (2002a) trace the liberalisation of emerging equity markets by endogenous break points in capital flows, returns, and dividend yields as well as the world interest rates. Bekaert, Harvey and Lumsdaine(2002b) find that endogenous break dates of marekt integration are usually later than official dates. However, the major drawback of this approach is measuring the *ex ante* market integration by the *ex post* magnitude changes of economic aggregates and market behaviours. For example, when both two markets are subject to the same exogenous shocks, the changes in capital flow across borders may occur without any actual progress in market integration.

To sum up, the measurement methods aforementioned have some drawbacks more or less in measuring market integration. Generally, *de jure* measures are inappropriate for measuring market integration, because *de jure* financial liberalisation policies do not necessarily lead to *de facto* increases in market integration. Compared to *de jure* measures, *de facto* measures seem to be more suitable, though some of their

measurement methods are problematic. For example, it is improper to measure market integration from the perspective of market comovement.

After comparing several measurement methods, this chapter is going to adopt the weak-form measure to gauge market integration between China and the world stock market. The weak-form measure is proposed by Chen and Kenz (1995) on the basis of stochastic discount factors. This measurement method involves the law of one price, and gauges the degree of market integration by the pricing differentials across markets directly. Differing from the CAPM framework, the weak-form measure is free of model specification and therefore avoids the problem of joint rejection on model specification and the market integration hypothesis. In the following section, this study is going to introduce the methodology in detail.

4.3 Methodology

This section is going to introduce the weak-form measure on the basis of stochastic discount factors, which includes the conceptual framework, theoretical background as well as estimation methodology. The theoretical background is largely drawn from the work of Chen and Kenz (1995). For more details, please refer to the original paper.

4.3.1 Conceptual framework

International financial integration is generally understood as a process of growing openness and unification of financial markets across the world so that the potential participants in initial-segmented markets enjoy the same unimpeded access[71] (Brouwer, 1999; Obadan, 2006). That is to say, in perfect cross-market integration there is no obstacle of any kind to cross-border financial transactions, such as tariffs, restrictions on trading of foreign assets, information costs or any other costs that make it more difficult to trade across countries than within them (Ayuso & Blanco, 2001). Without extra obstacle to international transactions, capital can flow freely across borders. The

[71] Essentially, international financial market integration is identical to financial globalization (Obadan, 2006) but comparatively focuses on the process and state of events among markets in the micro-level.

free flow of capital makes the cross-market arbitrage opportunity vanish if market segmentation is the only distortion. The law of one price, i.e., portfolio with the same payoff should have the same price irrespective of transaction locations, holds therefore in perfect cross-market integration. In a set of perfectly integrated markets, pricing differentials tend to zero[72] and arbitrage opportunity is absent across markets[73].

As regards measuring market integration by pricing differentials, the most popular models are the Capital Asset Pricing Model (CAPM) and its derivatives. However, the CAPM framework suffers from a joint test of model specification and the hypothesis of market integration. Alternatively, Chen and Kenz (1995) follow the seminal works of Hansen and Jagannathan (1991) and develop the weak-form measure for market integration[74]. The weak-form measure involves the law of one price directly, and utilises the differentials in the implied pricing kernel between two markets to represent the degree of market integration. More specifically, the weak-form measure regards the degree of market integration as a minimum distance (in a Hilbert Space sense) between the implied pricing kernel sets correspondingly.

As far as the law of one price is concerned, perfectly integrated markets should assign payoffs to prices similarly. That is to say, the degree of integration is ultimately reflected by the pricing differentials to payoffs even though markets may have different price-forming microstructures. As each pricing functional can be uniquely represented by a stochastic discount factor, an equivalent way to define perfect market integration is to require that there is at least one stochastic discount factor in common between two integrated markets. Consequently, the minimum distance between two

[72] In perfectly integrated markets, pricing differential is zero if market segmentation is the only distortion. But in reality, some other market frictions, such as transaction cost cross-market and information asymmetry, may hamper pricing differential from zero.

[73] Even in perfectly integrated markets, cross-market arbitrage opportunities may still exist if portfolios, which are constructed from both markets, offer positive payoffs in the future but have negative prices. For details, see in Chen (1995).

[74] Apart from the weak-form measure, Chen and Kenz (1995) also propose the strong-form measure for market integration. The weak-form measure directly relies on the concept of the law of one price while the strong-form measure is based on the absence of arbitrage opportunity. This thesis only discusses the weak-form measure while the strong-form measure is left for further study. Actually the strong-form measure can be easily extended from the weak one.

sets of stochastic discount factors can be utilised to measure the degree of market integration. More details are going to be described in a quantitative way in the following section.

4.3.2 Theoretical framework

In financial theories, the method of SDF plays a very important role in the fundamental theorem of asset pricing, especially when diagnosing asset pricing models. Many researchers, for example, Jagannathan and Wang (1996; 2002), Hansen and Jagannathan (1997), Hodrick and Zhang (2001), Jagannathan and Wang (2007), Kan & Robotti (2008), Li, Xu, and Zhang (2010), employ the SDF to test model misspecification and to compare the performance of different asset pricing models. Meanwhile, inspired by the seminal works of Hansen and Jagannathan (1991; 1997), an important connection has been established between the existence of stochastic discount factor and the law of one price as follows [75](Chen & Kenz, 1995; Hansen & Renault, 2009).

This SDF methodology is based on the intuition that current price of a future payoff on any traded security should equal the expected product of the payoff and the intertemporal marginal rates of substitution, which can be expressed by the so called Euler equation as follows:

$$E(p_i) = E(x_i d) \qquad \forall\, i \epsilon N \tag{4-1}$$

where $E(\cdot)$ is the expectation operator, p_i is the price of asset i, x_i is the future payoff of the asset i, d is the discount factor, N is the number of trading assets in market. In more generality, this method can be discussed in Hilbert space.

Assume a frictionless market endowed with a probability space (Ω, F, P_r), on which the linear space of square-integrable random variables, which is denoted by $\mathcal{L}^2$, is defined. $\mathcal{L}^2$ is known to be a Hilbert space if it is equipped with the mean-square

[75] Below is a brief discussion of the theory behind this method. For a very comprehensive knowledge of this subject, please refer to Chen and Kenz (1995) and Hansen and Jagannathan (1991; 1997).

inner product $\langle x|y\rangle \equiv E(xy)$ for any $x, y \in \mathcal{L}^2$. The norm related to Hilbert space is defined by $\|x\| \equiv \sqrt{E(x^2)}$.

In this economy, the market has N traded assets $\{\gamma_i\}$, indexed by the set N, where each $\gamma_i \in \mathcal{L}^2$ is the total return per dollar invested in the i^{th} asset. For a portfolio $\omega \in \Re^N$, $R = \sum_{i=1}^{N} \omega_i \gamma_i$ is its total payoff, and $\sum_{i=1}^{N} \omega_i$ is its current price. Given this set-up, the set of all obtainable asset payoffs in the economy is

$$M \equiv \{R \in \mathcal{L}^2 : \exists \omega \in \Re^N \; s.t. \; \sum_{i=1}^{N} \omega_i \cdot \gamma_i = R\}, \tag{4-2}$$

which is a (mean-square) closed subspace of $\mathcal{L}^2$. Define a pricing correspondence $\pi(\cdot)$ on M by

$$\pi(R) \equiv \{\sum_{i=1}^{N} \omega_i : \; \omega_i \in \Re \; and \; \sum_{i=1}^{N} \omega_i \cdot \gamma_i = R\} \qquad \forall R \in M \tag{4-3}$$

Since many portfolios in this market may bring about the same payoff R, $\pi(R)$ can be a set of each $R \in M$.

***Definition 1*:** The market (M, π) is said to satisfy the law of one price if $\pi(R)$ is a singleton for every marketed payoff R (Chen & Kenz, 1995).

That is to say, the LOP is the property that π assigns a unique price to every $R \in M$. Consequently, π forms a continuous linear functional over M under the LOP, and thus satisfies the conditions of the Riesz Representation Theorem[76]. By this theorem, an important lemma can be obtained as follows.

Lemma 1: The law of one price holds on the market (M, π) if and only if there exists a unique marketed payoff $d^* \in M$ such that[77]

$$E(\gamma_i \cdot d^*) = \pi(\gamma_i) = 1 \quad \forall i \in N \tag{4-4}$$

[76] Since π is extended to a continuous linear functional on all of $\mathcal{L}^2$, there is always possible when π is a linear functional over the closed, linear space M.
[77] Proof, see Chen and Kenz (1995).

Each $d \in \mathcal{L}^2$ satisfying Equation (4-4) are referred as an admissible stochastic discount factor for the market(M, π), and let D be the set of all admissible stochastic discount factors for(M, π). The set D is closed, convex as well as nonempty when the LOP holds.

In order to define the weak-form measure of market integration proposed by Chen and Kenz (1995), which is based on the SDF and involves the LOP, the payoff span and pricing functional, i.e., (M_A, π_A) and (M_B, π_B), are defined for markets A , B respectively.

***Assumption 1*:** The LOP holds separately on markets A and B. Furthermore, there exist $R_A \in M_A$ and $R_B \in M_B$ such that $\pi_A \neq 0$ and $\pi_B \neq 0$.

Under ***Assumption 1***, both D_A and D_B, the sets of admissible stochastic discount factor for markets A and B, are nonempty. By ***Lemma 1***, particularly, there is a unique stochastic discount factor $d_A^* \in D_A$ in M_A for market A. Similarly, a unique $d_B^* \in D_B$ is in M_B for market B. Intuitively, two perfectly integrated markets should assign the same price to the same payoff at least. This intuition leads to the following definition.

Definition 2: Markets A and B are said to be perfectly integrated in the weak form if $D_A \cap D_B \neq \emptyset$, where $\emptyset$ denotes the empty set (Chen & Kenz, 1995).

In other words, two markets are perfectly integrated in weak form if and only if the LOP holds across them. Consider the two markets A and B are combined into a market C, the combined market C therefore has its set of admissible discount factors given by $D_c = D_A \cap D_B$ and its payoff span by $M_c = M_A + M_B$. Then, $D_c \neq \emptyset$ if and only if $D_A \cap D_B \neq \emptyset$. This measure is based on the rationale that two "closely" integrated markets should assign a given payoff to prices that are "close". Consequently, the degree of market can be measured by the magnitude of pricing differentials.

Definition 3: For any two markets A and B satisfying *Assumption 1*, the weak form integration measure is a real-valued function $g(\cdot,\cdot)$ (Chen & Kenz, 1995):

$$g(A,B) = \min_{d_A \in D_A, d_B \in D_B} \|d_A - d_B\|^2 \tag{4-5}$$

Geometrically, $g(A,B)$ measures the minimum squared distance between the two sets D_A and D_B. Since D_A and D_B are convex, closed and nonempty, the set of $(D_A - D_B)$ is so by ***Assumption 1***. As every nonempty, convex, and closed set in a Hilbert space has a unique minimum norm element, there exists a solution to the problem in Equation (4-5).

Theorem 1: Any two markets A and B satisfying *Assumption 1* are perfectly integrated in the weak sense if and only if $g(A,B) = 0$ (Chen & Kenz, 1995).

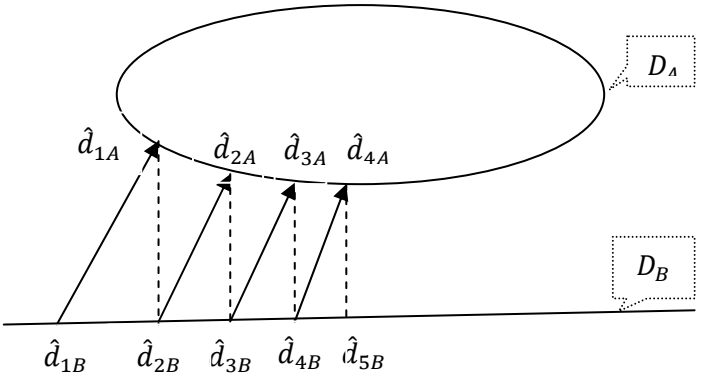
Perfect weak-form integration is thus made tractable by estimating $g(A,B)$ directly since $g(A,B) = 0$ provides a benchmark cross-market relation from a theoretical perspective. The major virtue of such a test is independent of any particular asset pricing model and therefore avoids the spurious results due to the misspecification of parametric models.

It is worth noting that $g(A,B) \leq \|d_A^* - d_B^*\|^2$ generally, where d_A^* and d_B^* is the unique minimum-norm stochastic discount factors in D_A and D_B respectively. Even though $d_A^* \neq d_B^*$, one may still obtain $g(A,B) = 0$ and perfect weak-form integration. Consequently, such an integration measure should gauge the minimum distance between two sets D_A and D_B rather than compare d_A^* and d_B^* alone. However, it is not simple to solve the minimum distance problem between two sets, which are closed and convex, as there may exists more than one solution, even though the minimum distance between them is unique. In the following subsection, this chapter is going to describe the general estimation algorithm.

4.3.3 Estimation algorithm

The algorithm proposed by Chen and Kenz (1995) involves the finding by Hansen and Jagannathan (1991), that the expressions to estimate the least square distances and the least square projections are sample counterparts. This algorithm is based on the logic depicted in Figure 4.1, involving two iterative steps. In the first step, the least square projection of a randomly selected point, say $\widehat{d}_{1B}$, in the set D_B onto the set D_A is computed. The corresponding projection point $\widehat{d}_{1A}$ in D_A and the minimum distance between two points, which is denoted by $g(\widehat{d}_{1B}, D_A)$, are also recorded. In the second step, projecting the point $\widehat{d}_{1A}$ back onto D_B, the corresponding projection point of $\widehat{d}_{2B}$ in D_B is found. The minimum distance between two points $g(\widehat{d}_{1A}, D_B)$, is also recorded. These iterative steps are repeated back and forth until the distance convergences to the minimum distance or when certain stopping criteria are satisfied.

Figure4. 1 Illustration of the Algorithm



Notes: D_A and D_B are the sets of stochastic discount factor for markets *A* and *B* respectively. $\widehat{d}_{1B}$ is a randomly selected point in set D_B for the initial iteration while $\widehat{d}_{1A}$ is its least square projection onto D_A. Correspondingly, $\widehat{d}_{2A}$, $\widehat{d}_{3A}$ and $\widehat{d}_{4A}$ are the stochastic discount factors in set D_A for iteration 2,3 and 4 respectively, while $\widehat{d}_{2B}$, $\widehat{d}_{3B}$, $\widehat{d}_{4B}$ and $\widehat{d}_{5B}$ in set D_B are for iteration 2,3,4 and 5 respectively .

In empirical computation, this algorithm uses data on prices and payoffs for a sample of securities in two markets as well as the approximate population moments with sample moments. Formally, for example, there exists the set D_j of admissible discount

factor d in market j, which is made of vectors of dimension T(T is the number of time series observations). The set D_j satisfies the following N_j restrictions[78]:

$$IP_j = dX_j \tag{4-6}$$

where I is a vector of ones with dimension T, P_j is the vector of the prices of the N_j securities traded in market j, and X_j is the matrix of the payoffs of the same securities.

Given the setting above, this algorithm can be expressed more specifically as follows.

Step 0. Let K be the number of iterations. For the initial iteration, set $K = 0$ and find the stochastic discount factor vector $\hat{d}_{KA}$ in D_A .

$$\hat{d}_{KA} = \hat{d}_{0A} = X_A' \left(\frac{1}{T}(X_A X_A')\right)^{-1} P_A \tag{4-7}$$

Step 1. Compute the least square distance between a vector $\hat{d}_{KA}$ and the set D_B

$$g(\hat{d}_{KA}, D_B) = \left[\left(\frac{1}{T}(X_B\,\hat{d}_{KA}) - P_B\right)' \left(\frac{1}{T}(X_B X_B')\right)^{-1} \left(\frac{1}{T}(X_B\,\hat{d}_{KA}) - P_B\right)\right]^{\frac{1}{2}} \tag{4-8}$$

Step 2. Compute the stochastic discount factor vector $\hat{d}_{KB}$ in the set D_B for iteration K by taking the least square projection of $\hat{d}_{KA}$ onto the set D_B.

$$\hat{d}_{KB} = \hat{d}_{KA} - X_B' \left(\frac{1}{T}(X_B X_B')\right)^{-1} \left(\frac{1}{T}(X_B\,\hat{d}_{KA}) - P_B\right) \tag{4-9}$$

Correspondingly, compute the least square distance between a vector $\widehat{d}_{KB}$ and the set D_A.

$$g(\hat{d}_{KB}, D_A) = \left[\left(\frac{1}{T}(X_A\,\hat{d}_{KB}) - P_A\right)' \left(\frac{1}{T}(X_A X_A')\right)^{-1} \left(\frac{1}{T}(X_A\,\hat{d}_{KB}) - P_A\right)\right]^{\frac{1}{2}} \tag{4-10}$$

[78] These restrictions are the sample counterparts of the population restrictions of Equation (4-1).

Step 3. Compute the stochastic discount factor vector $\hat{d}_{KA}$ in the set D_A for iteration K by taking the least square projection of $\hat{d}_{KB}$ onto the set D_A.

$$\hat{d}_{KA} = \hat{d}_{KB} - X_A' \left(\frac{1}{T}(X_A X_A')\right)^{-1} \left(\frac{1}{T}\left(X_A\, \hat{d}_{KB}\right) - P_A\right) \tag{4-11}$$

Step 4. Let $K = K + 1$. Repeat ***steps 1*** to ***3*** for a preset number of iterations or stops by applying some other stopping criteria. The stopping criteria are: 1) the iterative process stops once it converges to the specified convergence tolerance; Otherwise, 2) the iteration will be stopped compulsorily when it reaches the specified maximum number of iterations and the estimated value will be discarded.

It is worth noting that the value of the estimated integration measure is dependent upon the combination of the values selected for T and $N_A + N_B$. As shown by Ayuso and Blanco (2001), the integration measure is uninformative if T is larger than $N_A + N_B$ and the rank of $\mathrm{X_{AB}}$ equals $N_A + N_B$, wherein $\mathrm{X_{AB}}$ is the payoff matrix of assets from market A and B. In this case, the intersection between D_A and D_B is non-empty since the system does have a solution by jointly considering Equation (4-6) in both markets. And therefore, the estimated value of market segmentation is always zero. Under this circumstance, however, the value of zero does not mean that markets are perfectly integrated, because two portfolios with the same payoffs cannot be constructed in both markets rather than both portfolios are priced equally. In other words, in this case the estimated value is a trivial measure because it is uninformative for measuring market segmentation. Consequently, attention should be paid to the selection of T and $N_A + N_B$ in empirical study.

4.4 Empirical analysis

This section is going to gauge the degree of market segmentation (inversely, market integration) between China and the world stock markets. The degree of market segmentation is expected to decrease intuitively since a series of financial liberalisation policies have been implemented after China's entry into the WTO in

2001. As few of studies provide empirical evidence, this section is going to shed some light on this issue by the weak-form measure described above.

Since the existing literature provides no sensible interpretation of the non-normalised degree of market segmentation, which is represented by the pricing differential directly, this thesis is going to normalise the non-normalised degree of market segmentation. In this study, the stock market of US is employed as a benchmark market for comparison. The US stock market is commonly regarded as the most opening and influential one in the world, the degree of stock market segmentation between the US and the world provides a benchmark of the lowest global segmentation in the world. The normalised degree is obtained by comparing the pricing differential of two pairs of markets, i.e., China-World, US-World, in the same period. In so doing, the compounding influence of international factors other than China's financial liberalisation is believed to be mitigated to some extent. The normalised measure is specified as follows:

$$S(C,W) = 1 - \frac{mg(U,W)}{mg(C,W)} \tag{4-12}$$

where $S(C,W)$ is the normalised measure of market segmentation between China and the world stock markets, $mg(C,W)$ is the non-normalised degree, between China and the world stock markets while $mg(U,W)$ is the non-normalised one between the US and the world stock markets[79]. Both $mg(C,W)$ and $mg(U,W)$ are represented by the pricing differentials of China-World and US-World correspondingly, which are obtained by the weak-form measure directly.

By Equation (4-12) the normalised measure $S(C,W)$ is in direct proportion to $mg(C,W)$ and in inverse ratio to $mg(U,W)$. $S(C,W)$ equals zero if $mg(C,W)$ is equal to $mg(C,W)$. In this case, China's stock market is regarded to be perfectly integrated into the world since the degree of market segmentation between China and

[79] Hereafter, without specific definition this chapter adopts the letter C to denote China, U to represent the US and W to stand for the world.

the world is the same as the one between the US and the world. On the contrary, $S(C,W)$ takes the value of 1 if $mg(C,W)$ is much larger than $mg(U,W)$, standing for a complete segmentation from the world. The normalised measure $S(C,W)$ is a monotonically decreasing function of the multiple of $mg(U,W)$ to $mg(C,W)$. Normally, $S(C,W)$ ranges from zero to 1, as the value of $mg(C,W)$ is usually bigger than that of $mg(U,W)$. A higher value of $S(C,W)$ represents China's stock market is more segmented from the world market.

For the purpose of generality, both the non-normalised and normalised degrees will be reported. In the following subsections, this thesis is going to introduce the data, empirical procedures, and reports the empirical results.

4.4.1 Data description

After comparing several alternative data sources, this study chooses sector indices of equity market in level 3, which are defined by the Datastream database, to estimate the degree of market segmentation between markets. Each of these sector indices represents a certain industrial sector, such as oil and gas production. These sector indices, instead of individual stocks, appear to possess the broadest coverage and the most availability within the objective markets. In level 3 the Datastream database provides 35 sector indices for China, 40 for the US as well as 39 for the world stock markets respectively. The world sector indices are produced by aggregating the sector indices of 53 countries. For each market, the sector indices are calculated by allocating stocks to industrial sectors using the Industry Classification Benchmark (ICB) jointly created by FTSE and Dow Jones[80]. As the Datastream database does not provide a total *Return Index* for sector indices, this chapter has to employ that in the form of *Price Index*, though the former is more preferable[81]. The basic information about sector indices of three markets are reported in the Table I in the Appendices, which

[80] For more details, please refer to the Datastream Global Equity Indices User Guide (Issue 5).
[81] *Return Index* includes reinvested dividends, while *Price Index* does not.

includes index identification, Datastream mnemonic, the period of availability, the number of "usable" daily and weekly returns, as well as the mean and variance values.

These data sets are daily and range from January 3, 2000 to May 31, 2011[82] for the US, China and the world stock markets. These data sets provide almost two years in the pre-WTO accession period as a benchmark, and cover the post-WTO accession period since December 11, 2001. Although the base period might not be long enough, it is the second-best choice due to the limited data availability and the sample size requirement of the weak-form measure[83]. For those sector indices appearing later than January 3, 2000, this study does not employ them until they are available[84]. As the daily price provided by the Datastream database is not truly market determined[85] , this chapter discards these prices unless both the US and China stock markets have traded on the same calendar day[86]. Given the large number of observations, this is a simple and safe way to obtain "usable" daily prices, which are paired with each other. The retained "usable" values are normalised to the same base[87], and are calculated to form weekly returns[88]. Meanwhile, all sector indices in local currency are converted into the US dollars to alleviate exchange rate noise. As for indices for the US stock market, the currency is already in the US dollars so that this conversion is unnecessary.

4.4.2 Empirical procedures

This subsection mainly concerns two issues on carrying out empirical analysis: 1) parameter presetting and 2) random sampling procedure.

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[82] The end date is set to be the date of data collection for this study.
[83] The sample size requirement is going to be discussed in the following subsection.
[84] In the initial period, there are only 29 section indices available for China's stock market.
[85] The DataStream database provides daily price in the format of five-day-a-week and posts a value anyway, which is identical to the previous value for holidays, such as, Christmas for the US, and the Chinese New Year for China.
[86] The trading dates for China and US stock markets can be obtained from the website *http://finance.yahoo.com/*
[87] The base date is selected to be January 3, 2000. All section indices are normalised by dividing by their prices on the base date correspondingly.
[88] In order to eliminate the impact of holidays and events, discontinuous trading is excluded from the calculation of weekly returns. In order to satisfy the restriction on data selection, more rigorously, all discontinuous trading less than 3 days are excluded.

4.4.2.1 Parameter presetting

As pointed by Chen and Kenz (1995), the pricing differential is a non-decreasing function of the number of assets observed[89]. That is to say, sample size may influence the non-normalised degree of market segmentation, as it is represented by the pricing differential directly. In order to control the size distortion, sector indices in the same observation period are randomly drawn from each market to produce two pairs of subsets in the same sample size.

$$N_C = N_U = N_W = N \tag{4-13}$$

where N is a constant, N_C ,N_U and N_W are the number of sector indices drawn from China, the US and the world stock markets respectively. In a subset the number of sector indices, N, is determined by the product of T and $Ratio$, i.e.,

$$N = T \times Ratio \tag{4-14}$$

where T is referred to the length of observation interval and $Ratio$ is pre-specified to determine the group size of sample in empirical study. In so doing, the size distortion is believed to be mitigated to a large content, as all subsets have the same sample size.

In order to avoid the trivial measure aforementioned, T should be less than the sum of $N_C\ (or\ N_U)$ and N_W . As $N_C = N_U = N_W$ in this case, therefore, $Ratio \geq 0.5$. Meanwhile, in order to obtain an efficient solution from Equation (4-10), $Ratio$ should be no bigger than 1 as there is a full rank of matrix required[90]. Consequently, $Ratio$ should be a constant, ranging from 0.5 to 1.

Admittedly, the estimated values vary somewhat with $Ratio$ and T. As found by this study[91], however, the estimated values almost follow the same trend under different

[89] Intuitively, pricing consistency across assets is more demanding to maintain in large markets with more assets traded. Proof, see Chen and Kenz (1995).

[90] Go back to Equation (4-10), this equation is solvable only if there exists a invertible matrix $(X_A X_A')$, which requires that the number of assets N_A should be less than the length of observation interval T. Consequently, $Ratio$ should be no bigger than 1.

[91] For the sake of prudence, this study has also examined the performance of the weak-form measure under different sample sizes.

parameters of $Ratio$ and T. Particularly, the normalised degrees are found to be steady, which will be shown in the following sections. For the simplicity of expression, this thesis will only reports the representative results, wherein $Ratio$ is set to be $0.50, 0.55$ and 0.60 while T takes the value of 6 and 12 months respectively. These settings are believed to balance well the trade-off between including more indices horizontally to make markets truly subject to market segmentation test (Chen & Kenz, 1995) and adopting more observations vertically to capture the impact of financial liberalisation on the degree of market segmentation dynamically. For example, if $Ratio$ were set to be 0.75 when T were selected to 12 months (i.e., 48 weeks/observations), then there would be 36 sector indices required for each market. Obviously, this value is in excess of that provided by China's stock market. There are only 19 and 29 sector indices available in 1994 and 2000 respectively.

4.4.2.2 Random sampling procedure

For the given $Ratio$ and T, it becomes somewhat random when N indices out of 35 (China), 40 (the US) and 39 (the world) sector indices are picked up from each market. Undoubtedly, the estimated degree of market segmentation can vary greatly by single sampling. In order to control such biases, a randomization procedure is adopted as follows:

Step I: For a subset the number of sector index N is determined if $Ratio$ and T are specified. Randomly select N indices from Chinese stock market, N indices from US stock market and N indices from the world stock market respectively, which gives two pairs of subsets with $N\ to\ N$ indices. For instance, for an observation interval of 6 months if $Ratio$ takes the value of 0.6 and if T is 25 (weeks), there would be 15 indices that can be randomly taken from each market respectively. Two pairs of index subsets, i.e., China-World and US-World, are formed to estimate the degrees of market segmentation within each of them respectively.

Step II: Following the estimation algorithm provided by Section 4.3.3, gauge the non-normalised degrees of segmentation $g(C,W)$ (between China and the world) and $g(U,W)$ (between US and the world) among each pair of subsets, which are obtained from *Step I.* The iterative process stops once when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations, i.e., the convergence tolerance is *1‰*. Otherwise, the iteration will be stopped compulsorily when it reaches the maximum number of iterations and the estimated values of $g(C,W)$ and $g(U,W)$ will be discarded in this case. In this study, the maximum number is set to be 2000 times[92].

Step III: Repeat *Steps I, II* for M times, for example, 5,000 or even bigger 10,000 [93] times, and compute the mean value of $g(C,W)$ and $g(U,W)$ respectively, which are denoted as $mg(C,W)$ and $mg(U,W)$, and calculate the normalised market segmentation $S(C,W)$ by Equation (4-12). Meanwhile, the mean numbers of iterations is also collected when iterative process reaches the stopping criteria.

By the random sampling in large numbers, the sampling bias is expected to be alleviated to a large extent. Meanwhile, the mean value of estimated degree is regarded to represent the full sample through random sampling. After checking the performances of parameter presetting and random sampling, the results of empirical analysis are going to be reported in the following section.

4.5 Empirical results

This section is going to report the main findings of empirical analysis, which include: 1) the performance of stopping criteria for iterative process and random sampling, 2) measuring the degrees of market segmentation of two pairs of markets, as well as 3) the impacts of China's financial liberalisation policies on stock market segmentation.

[92] The stopping criteria are quite satisfactory, which is going to be shown by the figure of convergent paths of iterative process as well as the mean of iterations in empirical results.
[93] In empirical analysis the random sampling up to 5000 times is big enough to represent the full sample, as the sampling up to 10000 times does not improve the performance too much.

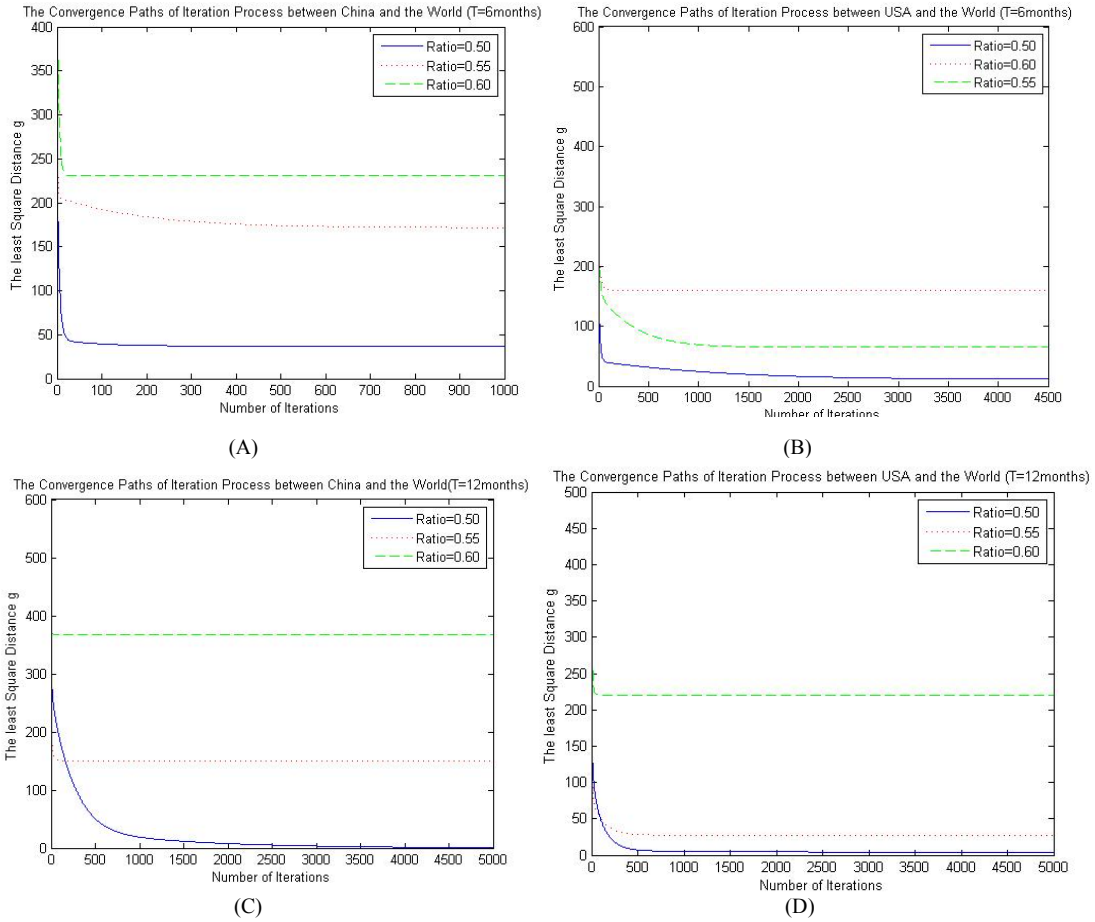
4.5.1 Performance of presetting

As it is necessary to examine the performance of presetting, this subsection is going to report the relevant results before measuring market segmentation. The performance checking mainly concerns two issues: 1) the stopping criteria for iterative process and 2) the random sampling.

4.5.1.1 Performance of the stopping criteria for iterative process

This subsection is going to examine whether the performance of stopping criteria for iterative process is satisfactory. As aforementioned, the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when it reaches the maximum number of iterations, i.e., 2000. In other words, the maximum number of iterations is specified to be 2,000 and the convergence tolerance is to be *1‰*. To verify the efficiency of stopping criteria, the sample convergent paths without applying stopping criteria and the mean numbers of iterations are provided for the given $Ratio$ and T. The sample convergent paths are reported in Figure 4.2 while the mean numbers of iterations are listed in Table 4.1.

Figure4. 2 The Sample Convergent Paths for Iterative Process



Notes: For each observation interval *T* (*T*=6, 12months) and each pair of markets (China-World, US-World), there is one sample convergent path of iterative process reported below. In each sub-figure, there are three lines standing for three *Ratios*, i.e., 0.50, 0.55 and 0.60 respectively. All iterations are allowed to continue until they reach 5,000 times.

Figure 4.2 shows that the speed of convergence is normally higher for *Ratios* with larger values and most of iterations converge to the optimal value before they reach 2,000 times. To optimize the computational resources, this study is going to apply some stopping criteria for iterative process. The stopping criteria are that an iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2000. The estimated value will be discarded if the number of iterations reaches 2000. Actually the stopping criteria are very rigorous because the mean number of iterations is far less than 2000 times when iterative processes converge to the default tolerance level. The mean number of iterations is shown in Table 4.1 as follows.

Table 4. 1 The Mean Numbers of Iterations

Time (Year)	**Ratio=0.50 T=12 months**		**Ratio=0.55 T=12 months**		**Ratio=0.60 T=12 months**	
	China-World	US-World	China-World	US-World	China-World	US-World
2000	478.35	814.00	78.90	312.17	35.11	124.06
2001	402.57	1020.33	102.76	482.09	40.11	168.69
2002	445.48	839.24	68.61	297.12	32.27	113.42
2003	457.17	784.83	71.75	236.73	32.13	90.45
2004	488.84	797.94	79.62	267.58	35.68	113.38
2005	483.13	782.84	78.45	254.20	35.60	104.52
2006	479.89	726.75	80.86	195.60	36.44	74.96
2007	482.14	735.81	77.04	199.93	34.58	80.07
2008	508.28	816.35	84.41	241.67	36.90	93.33
2009	510.01	932.00	127.98	336.26	34.14	78.23
2010	521.20	768.00	88.37	228.49	37.65	92.38
Mean Numbers	**477.92**	**819.83**	**85.34**	**277.44**	**35.51**	**103.04**
Time (Quarters/Year)	**Ratio=0.50 T=6 months**		**Ratio=0.55 T=6 months**		**Ratio=0.60 T=6 months**	
	China-World	US-World	China-World	US-World	China-World	US-World
Q1,2/2000	283.36	537.31	67.27	173.01	32.43	67.96
Q3,4/2000	301.88	551.60	76.03	194.03	36.50	83.42
Q1,2/2001	265.83	576.89	63.84	197.66	31.72	77.42
Q3,4/2001	301.79	638.29	73.74	246.59	35.52	96.37
Q1,2/2002	251.91	540.79	60.81	175.64	30.11	73.00
Q3,4/2002	311.48	640.02	75.43	262.42	36.60	110.34
Q1,2/2003	441.35	594.16	127.86	343.13	48.65	110.56
Q3,4/2003	330.70	574.41	86.53	203.96	40.84	86.06
Q1,2/2004	281.95	532.65	69.23	169.81	33.15	72.97
Q3,4/2004	500.67	575.24	124.91	334.45	27.04	63.20
Q1,2/2005	243.03	510.04	58.05	158.57	28.88	66.21
Q3,4/2005	482.78	500.57	121.43	290.44	26.12	55.62
Q1,2/2006	443.86	469.03	128.93	253.93	47.66	87.15
Q3,4/2006	284.61	494.89	70.32	149.35	35.53	64.64
Q1,2/2007	452.22	526.25	128.55	283.51	46.97	96.22
Q3,4/2007	369.80	478.79	150.40	269.54	30.82	48.09
Q1,2/2008	396.28	529.91	149.25	301.83	31.06	55.23
Q3,4/2008	337.42	726.08	172.24	410.41	33.95	69.46
Q1,2/2009	418.42	469.27	135.05	259.93	47.84	89.76
Q3,4/2009	381.33	484.05	143.37	272.31	29.36	47.09
Q1,2/2010	331.92	503.08	160.34	270.37	54.75	89.85
Q3,4/2010	380.79	524.53	148.21	296.98	30.09	51.45
Mean Numbers	**354.24**	**544.45**	**108.72**	**250.81**	**36.16**	**75.55**

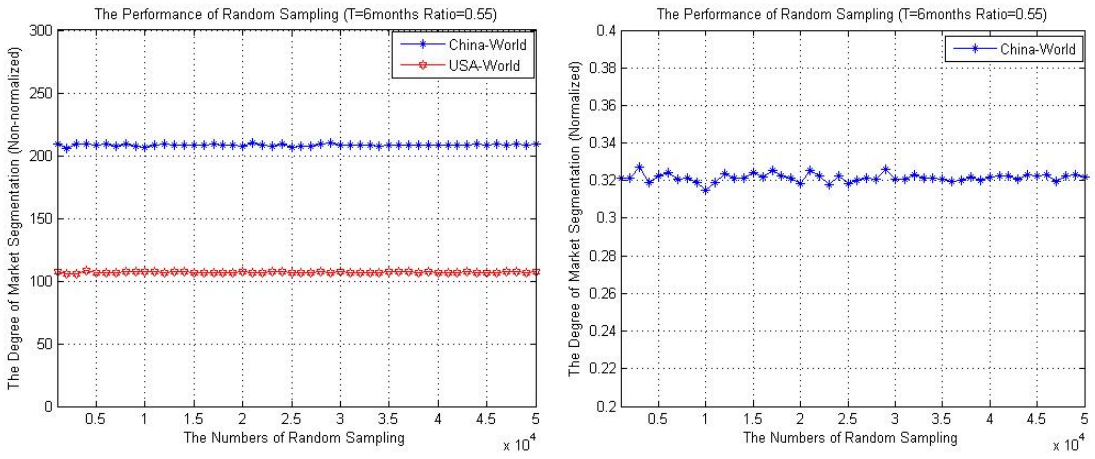
Notes: For each year (quarters/year) and each pair of markets, the numbers of iterations are reported when stopping criteria are applied. The stopping criteria are that an iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when iterations reaches 2000. The number of random sampling is specified to be 10,000 times.

Table 4.1 shows that the largest iteration number is 1020.33 , which belongs to the pair of market, US-World, in the year of 2001 when *T* is adopted to be 12 months and *Ratio* to be 0.50. Meanwhile, this table displays that the number of iterations decreases with increasing *Ratio*, which supports the findings of convergent paths. As the mean number of iterations ranges from 35.51 to 819.83, Table 4.1 confirms that 2,000 is an employable number for the maximum iterations as it is nearly twice of the largest iteration number in fact.

4.5.1.2 Performance of the random sampling

This subsection is going to test the performance of random sampling. More specifically, this part is going to explore whether the random sampling up to 10,000 times is large enough to represent the full sample. The performance of random sampling is examined by whether the estimated degree of market segmentation converges to an optimal value with the increasing number of random sampling, which is up to 50,000. For the simplicity of expression, this study only takes one case for example[94], wherein the observation interval *T* is 6 months and *Ratio* equals 0.55. Both the non-normalised and normalised degrees of market segmentation, which are dependent variables on the number of random sampling, are reported in Figure 4.3 for two pairs of sample markets, i.e., China-World and US-World.

Figure4. 3 The Performance of Random Sampling (T=6 months Ratio=0.55)



Notes: For an observation interval *T* of 6 months and a Ratio of 0.55, the non-normalised degrees of market segmentation are reported in the left figure for two pairs of sample markets, China-World and US-World, while the normalised degree of market segmentation between China and the world is displayed in the right figure. The number of random sampling increases from 1,000 to 50,000 with an interval of 1,000 for each sampling. The stopping criteria applied here are that an iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2000.

[94] As for the observation interval *T* of 12 months, the computation resource required is out of the memory of computer when the number of random sampling reaches 14,000. However, the verified performance of random sampling follows the same rules that for the observation interval *T* of 6 months.

Figure 4.3 shows that both the non-normalised and normalised degrees of market segmentation vary very slightly with the increasing number of random sampling. As the number of random sampling does not change the estimated values of market segmentation too much, the procedure of random sampling can be regarded as an effective one. For prudence, this study also checks the performance of random sampling in other cases when *Ratio* adopts the values of 0.50 and 0.60 respectively, and reports the results in Table 4.2. To make comparison easier, the results when *Ratio* is 0.55 also listed in this table.

Table 4. 2 The Performance of Random Sampling (T=6 months)

	Ratio=0.50 T=6months			**Ratio=0.55 T=6months**			**Ratio=0.60 T=6months**		
M	*mg(C,W)*	*mg(U,W)*	*S(C,W)*	*mg(C,W)*	*mg(U,W)*	*S(C,W)*	*mg(C,W)*	*mg(U,W)*	*S(C,W)*
1000	107.252	48.378	0.378	209.247	107.473	0.321	286.87	169.607	0.257
2000	105.485	49.294	0.363	206.035	105.858	0.321	281.86	168.121	0.253
5000	106.894	47.723	0.383	208.317	106.695	0.323	284.09	167.335	0.259
8000	108.148	48.379	0.382	209.401	107.577	0.321	283.80	167.781	0.257
10000	106.797	48.642	0.374	206.878	107.749	0.315	283.25	168.805	0.253
20000	107.061	48.263	0.379	207.609	107.388	0.318	283.56	168.294	0.255
50000	107.299	48.417	0.378	208.782	107.064	0.322	283.35	167.714	0.256

Notes: For each *Ratio* and each pair of sample markets with an observation interval *T* of 6 months, the non-normalised and normalised degrees of market segmentation are reported as the number of random sampling increases from 1,000 to 50,000. In this table, *mg(C,W)* stands for the non-normalised degree of market segmentation between China and the world, and *mg(U,W)* is the one between US and the world while *S(C,W))* represents the normalised degree of market segmentation between China and the world. The stopping criteria applied here are that an iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2000.

Table 4.2 shows that for each *Ratio* both the non-normalised and normalised degrees of market segmentation vary very slightly when different numbers of random sampling are adopted, which confirms the findings above. By the performance checking, this study finds that the random sampling procedure applied here is effective as the estimated degrees of market segmentation do not vary with the number of sampling too much. In the following empirical analysis, the number of random sampling *M* is set to be 10,000, as it is big enough to represent the full sample by the random sampling procedure.

Another finding is that the estimated values are independent of the selection of sector indices, even though the number of random sampling is adopted to be a small value.

That is to say, the sector indices may be regarded as homogeneous portfolios because their industrial characteristics are relative small. This finding supports the rationality of data collection.

After checking the performance of presetting, this study is going to gauge the degree of market segmentation between China and the world in the following subsection.

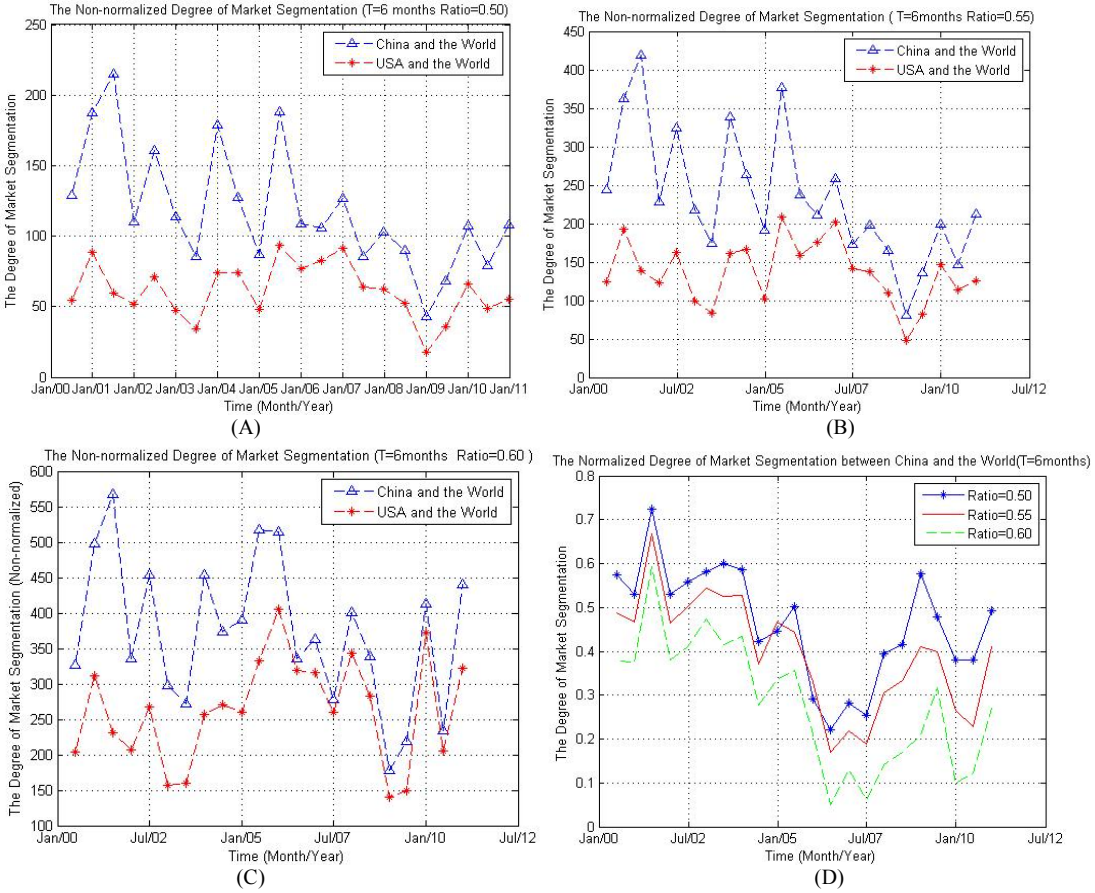
4.5.2 Measuring the degrees of stock market segmentation

This section is going to measure the degrees of market segmentation between China and the world stock markets since China's accession to the WTO in 2001. As the Chinese government has implemented a series of financial liberalisation policies after 2001, the degrees of market segmentation are expected to decrease in the post-WTO accession period. However, the degrees of market segmentation are not anticipated to change gradually, because these financial liberalisation policies may have various impacts. Their impacts might be delayed, overlapped, as well as invalid[95]. Meanwhile, the degrees of market segmentation might be affected by the global financial crisis in 2008, due to foreign capital withdrawal in this period.

The degrees of market segmentation are going to be gauged by the weak-form measure. As discussed above, in this study the parameters are set to be as follows: 1) the number of random sampling, M, is specified to 10,000, 2) the group size, *Ratio*, is adopted to be 0.50, 0.55 and 0.60 respectively, 3) the length of observation interval, T, is selected to be 6 and 12 months respectively, and 4) the stopping criteria are that the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when it reaches 2,000 times. For each observation interval, i.e., 6months and 12 month, both the non-normalised and normalised degrees of market segmentation are plotted in Figures 4.4 and 4.5 while the exact values of degrees of market segmentation are reported in Tables II, III in the Appendices for reference.

[95] Some of these liberalisation policies are *de facto* ineffective.

Figure4. 4 The Non- and Normalsied Degrees of Market Segemtation (T=6months)



Notes: For each year and each pair of markets, both the non-normalised and normalised degrees of market segmentation are reported, wherein the number of random sampling *M* is adopted to be 10, 000 and the length of observation interval *T* to be 6 months. The stopping criteria applied are that the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2,000. In this figure, subfigures A, B and C represent the non-normalised degrees of stock market segmentation of two pairs of markets, i.e., China and the world, the US and the world, as *Ratio* takes the value of 0.50, 0.55 and 0.60 correspondingly. Subfigure D reports the normalised degree of stock market segmentation between China and the world as *Ratio* takes the value of 0.50, 0.55 and 0.60 respectively. All statistics are plotted against the end of each time interval.

Subfigures A, B and C show that the non-normalised degrees of stock market segmentation are time-varying for two pairs of markets, China-World, and US-World. The non-normalised degree of stock market segmentation between the US and the world does not stay constant, even though the US stock market is generally regarded as the most open one in the world. The compound impact of international factors, such as the volatility of oil price, on the pricing differential of the global stock markets can be reflected by the non-normalised degree of stock market segmentation between the US and the world. This is because that the non-normalised degree between the US and

the world is time-varying, even it is regarded as the benchmark of the lowest global segmentation in the world. This phenomenon confirms that it is necessary to control the impact of international factors, when analysing the impacts of China's financial liberalisation on stock market segmentation between China and the world.

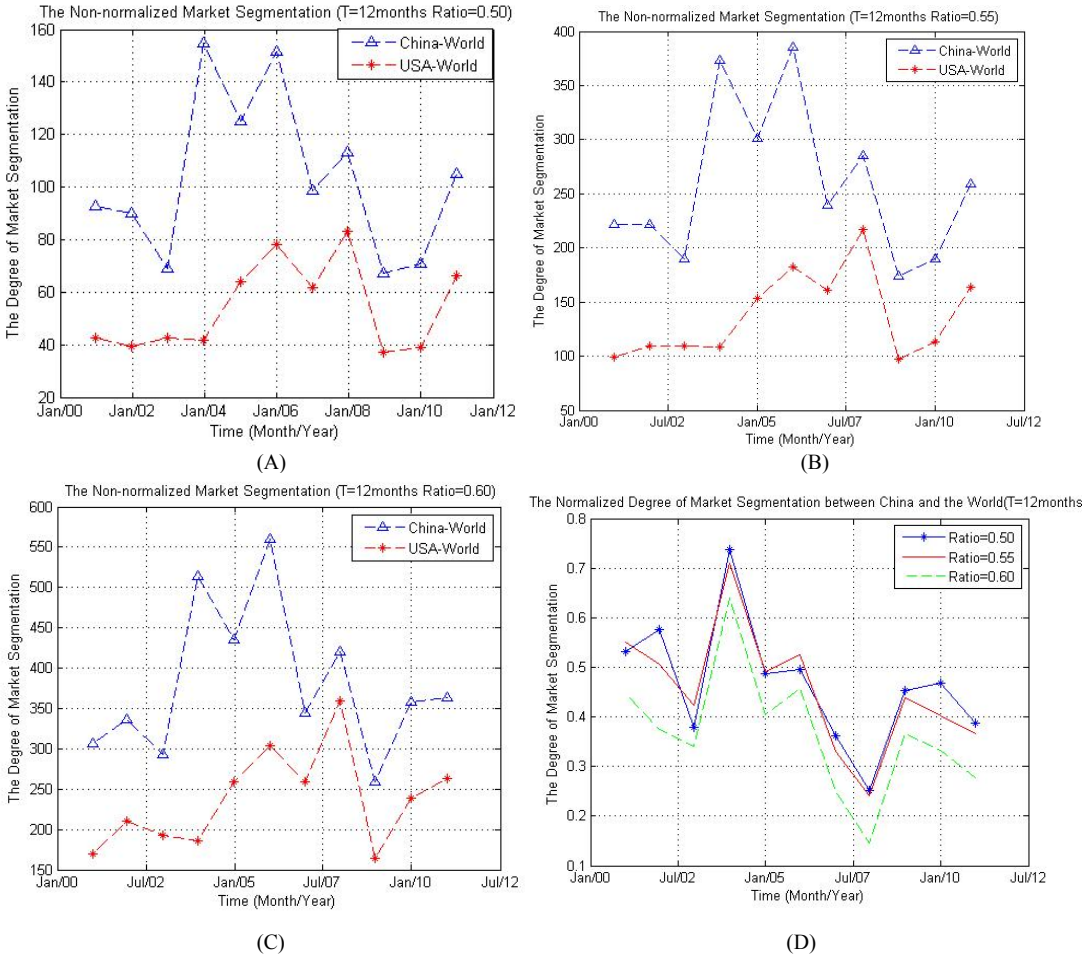
Meanwhile, subfigures A to C also display that the degree of stock market segmentation between China and the world is normally higher and more volatile than the one between the US and the world. By subfigures A, B, C, however, it is hard to find any trend of market segmentation for each pair of markets in the long term. This finding also proves that the non-normalised index, which is commonly employed in the current study, can hardly provide sensible explanation on the trend of market segmentation as they vary with the group size.

On the contrary, subfigure D shows that the stock market segmentation between China and the world follows the trend, which declines from July 2001 to June 2007 steadily, and then climbs to a sub-peak and goes down from July 2007 to July 2010. The trend will be explained in more detail in association with financial liberalisation events in the next subsection. Meanwhile, subfigure D also shows that for each period the normalised degrees of stock market segmentation, which are obtained under different group sizes *Ratio*, almost follow the same trend though they are not exactly the same value. That is to say, the group size do has impact on the estimated values of market segmentation. It is inconvincible if someone tries to measure the degree of market segmentation without taking group size into account. This finding is consistent with those of other relevant studies on size distortion, such as Ren and Shimotsu (2009). To alleviate the impacts of group size on estimated values, the average trend is employed in examining the effectiveness of financial liberalisation events.

To provide a more comprehensive overview, this study also gauges the degrees of market segmentation between China and the world by an observation interval of 12

months. As shown by Figure 4.5 in the below, the results are consistent with those with an observation interval of 6 months.

Figure4. 5 The Non- and Normalsied Degees of Market Segemtation (T=12months)



Notes: For each year and each pair of markets, both the non-normalised and normalised degrees of market segmentation are reported, wherein the number of random sampling *M* is adopted to be 10, 000 and the length of observation interval *T* to be 12 months. The stopping criteria applied are that the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2,000. In this figure, subfigures A, B and C represent the non-normalised degree of stock market segmentation of two pairs of markets, i.e., China and the world, the US and the world, as *Ratio* takes the value of 0.50, 0.55 and 0.60 respectively. Subfigure D reports the normalised degree of stock market segmentation between China and the world as *Ratio* takes the value of 0.50, 0.55 and 0.60 respectively. All statistics are plotted against the end of each time interval.

4.5.3 China's financial liberalisation and stock market segmentation

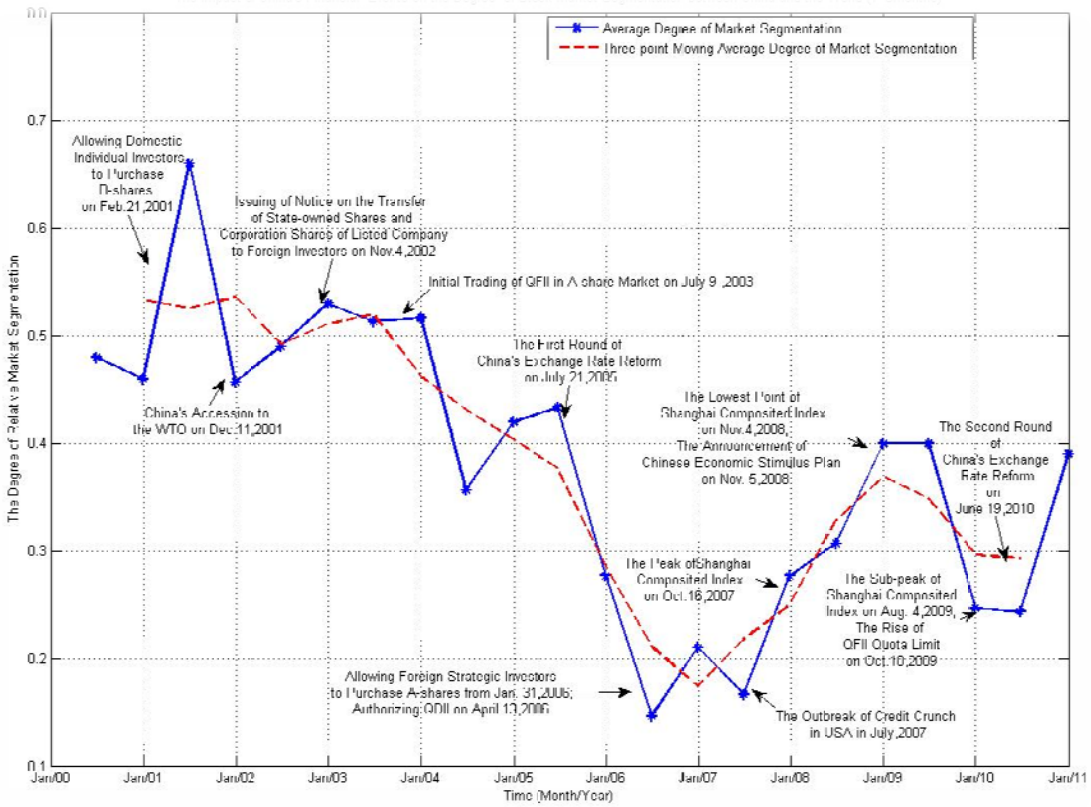
This subsection is going to examine whether China's financial liberalisation policies have decreased the degree of stock market segmentation between China and the world. More specifically, which kind of China's financial liberalisation events are and to

what degree they have reduced the stock market segmentation between China and the world since China's accession to the WTO in 2001.

However, this study does not intend to claim that all the impacts of China's financial liberalisation on international market integration will be taken into account. As mentioned in Chapter 2, not only the direct impacts of financial liberalisation but also its collateral impacts, via the development of financial market, contribute to international market integration. Meanwhile, other regulatory reforms can also contribute international market integration through the development of financial market. This study takes into account the direct impacts of financial liberalisation on international market integration, while ignoring the collateral impacts of financial liberalisation and other regulatory reforms on this issue. Admittedly, this is a limitation of this study. Nevertheless, it does not belong to this study exclusively, because the existing literature has not provided a feasible way to dismantle the combined impacts of financial liberalisation and other regulatory reforms on international market integration. Meanwhile, it is reasonable to associate the direct impacts of financial liberalisation with international market integration, since the collateral impacts of financial liberalisation and other regulatory reforms depend on the development of financial market, which needs a long time to take effect.

Since the length of observation interval does not influence the findings too much, this study takes an observation interval of 6 months for instance. This case provides more observations to analyse the impacts of China's financial events on the degree of market segmentation. The relationship between China's financial liberalisation events and the degree of stock market segmentation is reported in Figure 4.6 as follows, while the exact values are reported in Table IV in the Appendices for reference. The average degree of stock market segmentation here is the mean value of normalised degrees, which are obtained under different group sizes, i.e., *Ratio* equals 0.50, 0.55 and 0.60 respectively. The trend line in red is obtained by the three-point moving average of the average degree of stock market segmentation with equal weights.

Figure4. 6 China's Financial Events and Stock Market Segmentation Degree



Notes: For the period from January 2000 to December 2010, the normalised degree of stock market segmentation between China and the world is gauged by the weak-form measure, wherein the number of random sampling M is adopted to be 10, 000 and the length of observation interval T to be 6 months. The stopping criteria applied are that the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2,000. The trend line in red is the three-point moving average of the average degree of stock market segmentation. All statistics are plotted against the end of each time interval.

From the trend line in Figure 4.6, the normalised degree of stock market segmentation between China and the world has gone through three stages: 1) the stationary period from January 2001 to June 2003, 2) the decreasing period from July 2003 to June 2007 and 3) the rising and falling period from July 2007 to June 2010. In stage 1 the normalised degree of market segmentation varies from 0.49 to 0.53 slightly. In this period financial liberalisation events, such as allowing domestic investors to purchase B shares, and issuing the notice on transfer the state-owned and corporation shares to foreign investors, might be ineffective since they did not decrease the degree of market segmentation greatly. On the contrary, financial liberalisation events taking place in stage 2 might be effective since the normalised degree of market

segmentation has been decreased significantly from 0.52 to 0.18. These events include the QFII programme, the first round of exchange rate reform and the QDII programme[96]. In stage 3 the normalised degree of market segmentation rises from 0.18 to 0.36 and then declines to 0.295. This phenomenon coincides with the intuition that market segmentation tends to increase during the financial crisis period and to decrease after financial crisis. Overall, as there has been a significant decline in the normalised degree of market segmentation in the period from 2002 to 2006, China's financial liberalisation can be regarded as effective to some degree since its accession to the WTO in 2001.

As for the impacts of specific events on market segmentation, particular attention should be paid into two events: 1) allowing domestic investors to purchase B shares and 2) the second round of China's exchange rate reform. Intuitively, financial liberalisation events are expected to decrease market segmentation if they are effective. As for the lifting ownership restriction on B shares in 2001, however, the degree of market segmentation increases to certain content in the event period and falls back to the original level in the post-lifting period. Similarly, the second round of China's exchange rate reform has witnessed an increase of market segmentation in the event period, which is distinct from that in the first round of exchange rate reform. The effects of these two issues are quite different from those of other events and need particular explanations.

There are several reasons for these anomalies. As far as the issue of allowing domestic investors to purchase B shares is concerned, the abnormal change in market segmentation is mainly attributed to the inter-integration effect, namely, the integration between A- and B-share markets. As well documented by the recent literature, there have been persistent and significant discount price discounts on

[96] Early before the exchange rate reforms in 2005 and 2010, China has already carried out a reform of exchange rate system in 1994, which abandoned the double-track exchange rate system and adopted the unification of exchange rates based on market supply and demand. But this reform can hardly be regarded as an epoch-making one due to the slight appreciation of RMB in the post-event period, which rises by only 5% against US Dollar during the period January 1994 to June 2005.

(foreign) B shares relative to (local) A shares though they are identical with respect to shareholder rights. The price discounts are mainly due to market segmentation (Chiu, Lee, & Chen, 2005) since domestic investors were only allowed to trade A shares while foreign investors could only purchase B shares before February 2001. After this ownership restriction lifting, the price discounts generally decreased from an average of 72% to 43%, which was primarily driven by the great increases in B shares prices relative to A shares (Chan, Menkveld, & Yang, 2008). During the period between February 19 and June 1, 2001 the B-share market indices of Shanghai and Shenzhen rose by 178% and 122% respectively, while the A-share indices increased by only 10.9% and 8.6% respectively (Lee, Rui, & Wu, 2008). In the short term these sudden and dramatic increases in B shares market generated disturbance to China's stock market, and therefore increased the pricing differential between China and the world stock markets. Consequently, the degree of market segmentation between China and the world stock markets increased significantly in the event period.

In the long term, however, the ownership restriction lifting did not decrease the stock market segmentation between China and the world as what it did to the one between A- and B-share markets. As found by Darrat, Gilley and Wu (2010) that prices in the A- and B-share markets were closely connected in the long-run and the equilibrium relationship enhanced in the post-lifting period. By allowing domestic investors to purchase B shares, however, the decrease of market segmentation between A- and B-share markets did not decrease the segmentation between the A-share market and other markets. For example, the price discount of H-share market relative to A-share market remained virtually unchanged while the B-share price discount declined considerably after the event (Lee, Rui, & Wu, 2008). After the restriction lifting, actually, the B-share market has been to some degree incorporated into and dominated by the A-share market due to the relative small capital value of the B-share market. That is to say, the inter-integration between A- and B-share markets could only arouse

disturbance to market segmentation between China and the world stock markets in the short term rather than decreased market segmentation between them in the long term.

Regarding the second round of exchange rate reform, the rise of market segmentation in the event period is primarily accredited to the increasing flexibility of exchange rate by the second round reform. Actually the restart of exchange rate reform in June 2010 was the continuation of the first round of reform in July 2005, which was interrupted by the financial crisis in 2008. The central parity of RMB against the US dollar had appreciated 21.88% during the period from July 2005 to the end June, 2010, which was followed by an appreciation of 5.21% in the period between July 2010 and June 2011. However, in recent years the persistent appreciation of the RMB has spurred perplexities to the Chinese government due to the insufficient flexibility of exchange rate, among which are the rapid growth of foreign exchange reserve, the continuous inflow of hot money as well as the large increases of transaction cost for exporters.

In order to overcome the drawbacks of the first round of exchange rate reform, increasing the flexibility of exchange rate has been proposed as the core mechanism of the second round of exchange rate reform. In the period from June 21 to December 31, 2010, the flexibility of exchange rate increased greatly, wherein the maximum volatility of central parity of the RMB against the US dollar in every other day reached 295 basis points; the average volatility of that in a single day was 64 basis points; averagely the maximum volatility of transaction price relative to the central parity in a single day was 0.16%; as well as the maximum volatility in a single day was 113 basis points on average. During the period between January 4, and June 18, 2010, by contrast, the maximum volatility of transaction price relative to the central parity in a single day was only 0.02% on average; and the maximum volatility in a single day was 18 basis points averagely.

The increasing flexibility of China's exchange rate can influence the degree of stock market segmentation between China and the world in a two-fold way. On the one hand,

the flexibility of exchange rate may increase risk to cross-market transactions, which impedes the capital flow across borders and spurs market segmentation between them to some extent. On the other hand, the flexibility of exchange rate may induce disturbances to the estimated degree of market segmentation, as all sector indices of China's stock market have been converted into the US dollars. These disturbances on price indices can increase the pricing differentials between markets, and thereby boosts the degree of market segmentation.

4.6 Conclusions

This chapter mainly employs the weak-form measure to gauge the degree of market segmentation between China and the world since China's accession to the WTO in 2001. The primary reason for adopting the weak-from measure is that this method can avoid the joint test on model specification and market segmentation, which are commonly found in the existing literature. After checking the performance of stopping criteria and random sampling procedure, this study gauges both the non-normalised and normalised degrees of market segmentation. In order to alleviate the impact of size distortion, the same numbers of sector indices are randomly drawn from each market to form paired subsets with the same group size.

From the perspective of the non-normalised degrees of market segmentation, this chapter finds that: 1) the non-normalised degrees for two pairs of markets, i.e., China-World, and US-World, are both time-varying; 2) the non-normalised degree of market segmentation between China and the world stock markets is normally higher and more volatile than the one between US and the world stock markets; 3) the non-normalised degree of market segmentation can hardly provide any sensible explanation on the trend of market segmentation, as the estimated trend varies with group size; as well as 4) the group size do has impact on the estimated values of market segmentation, and therefore, the estimated values are inconvincible if size distortion has not been taken into account.

In contrast with the traditional non-normalised degree, the normalised degree of market segmentation is more informative. From the normalised degrees, this chapter finds that: 1) the normalised degree of stock market segmentation between China and the world has gone through three stages, which include the stationary period from January 2001 to June 2003, the decreasing period from July 2003 to June 2007, as well as the rising and falling period from July 2007 to June 2010; 2) as the degree of market segmentation declines significantly in the event period, some events of China's financial liberalisation might be regarded as effective, which include the QFII programme, the first round of exchange rate reform and the QDII programme, while others might be ineffective, such as allowing domestic investors to purchase B shares, and issuing the notice on transfer the state-owned and corporation shares to foreign investors; and 3) in an overall view, China's financial liberalisation in the post-WTO accession period can be considered to effective as there has been a significant decline of market segmentation degree in the period from 2002-2006.

CHAPTER 5: MEASURING MARKET INTERDEPENDENCE BETWEEN CHINA AND THE WORLD STOCK MARKETS THROUGH THE MULTI-FACTOR R-SQUARED MEASURE

5.1 Introduction

This chapter is going to examine market interdependence between China and the world stock markets since China's entry into the WTO in 2001. The purpose of this chapter is twofold: 1) to judge whether China's financial liberalisation has spurred stock market interdependence between China and the world in the post-WTO accession period; and 2) to pave the way for examining the interrelation between market integration and market interdependence in the next chapter.

Motivated by these purposes, this study is going to gauge the non-normalised degree of market interdependence by the multi-factor R-squared measure, which is based on the principal component analysis and proposed by Pukthuanthong and Roll (2009; 2011). This measure avoids both the bias caused by the non-stationarity of variables in the cross-market correlation coefficient analysis and the possible problem of multicollinearity in a multivariate regression model. As the non-normalised degree of market interdependence is proved to be time-varying, the chapter is going to normalise the non-normalised degree by taking the non-normalised one between the US and the world as a benchmark. In comparison with the non-normalised degree, the normalised degree provides more useful information, especially when analysing the impacts of China's financial liberalisation events on stock market interdependence between China and the world. Furthermore, the normalised degree of stock market interdependence between China and the world is going to be adopted in the next chapter to examine the interrelation between market integration and market interdependence.

The rest of this chapter is as follows. Section 2 is the literature review on the subject. Section 3 introduces the methodology of multi-factor R-squared measure, which is going to be adopted in this study. Section 4 presents empirical analysis, including the data and indices descriptions, and empirical procedures. Section 5 reports the empirical results. Section 6 concludes this chapter.

5.2 Previous literature on examining financial market interdependence

A vast literature has addressed the issue of measuring financial market interdependence. A common feature of this literature is that it measures market interdependence in terms of volatility spillover or market comovement. Some studies focus on only the return movement across markets, while some others studies take into account both the first and the second moments of equity prices in examining market interdependence (Mukherjee & Mishra, 2010). Apart from examining only the presence of market interdependence, some studies focus on the impacts of some special events, such as financial crisis, financial liberalisation event as well as policy announcement. For example, Arshanapalli and Doukas (1993) examine the international stock market linkages in the pre- and post-October 1987 periods. Yang, Kolari and Min (2003) study the interdependence of stock markets in the Asian financial crisis in 1997. Darrat and Benkato (2003) examine market interdependence under financial crises by the case of the Istanbul Stock Exchange. Meanwhile, Connolly and Wang (2003) investigate the potential influence of macroeconomic news announcements made in the US, the UK and Japan on equity market comovement. Beine and Candelon (2011) study the impact of financial liberalisation on the degree of stock market co-movement among emerging economies.

Furthermore, some studies manage to find the possible determinants and transmission mechanisms behind this issue. For example, Chan (1993) regards that stock returns become positively cross-autocorrelated when prices adjust to true value. Pirinsky and Wang (2006) argue that there is a significant geographic component related to the

trading patterns of local residents since strong comovement in stock returns has been found in the same geographic area. Similarly, Lucey and Zhang (2010) find that country-pairs exhibit higher market interdependence if they share smaller cultural distance. However, Chong, Wong, and Zhang (2011) find that a common border (or language) does not influence the stock market correlations. The correlations are negatively related to the Great Circular Distance (GCD) between their financial centres and positively associated with the duration of overlapping trading hours among stock exchanges and the colonial links between countries.

Within recent literature, some consensus appears to be emerging though the nature and degree of financial market interdependence may seem to differ widely, which are dependent on the time period scrutinized and the markets involved. Firstly, market interdependence varies over time (Koch & Koch, 1991; Solinik, Boucrelle, & Fur, 1996; Hu, Lin, & Kao, 2008). Secondly, market comovement tends to present itself in markets within a short distance rather than those farther apart (Bracker, Docking, & Koch, 1999; Pirinsky & Wang, 2006; Chong, Wong, & Zhang, 2011; Eckel, Loffler, Maurer, & Schmidt, 2011). Thirdly, market interdependence increases as economic integration intensifies, such as bilateral trade (Bracker, Docking, & Koch, 1999; Johnson & Soenen, 2002; Pretorius, 2002; Tavares, 2009; Walti, 2011). Fourthly, market interdependence is most likely high in volatile bear markets. (Longin & Solnik, 2001; Ang & Bekaert, 2002; Aityan, Ivanov-Schitz, & Izotov, 2010). Lastly, there has been an increase in international market interdependence among equity markets over the past three decades (Longin & Solnik, 1995; Bruno, Boucrelle, & Yann, 1996; Baele & Inghelbrecht, 2010; Aityan, Ivanov-Schitz, & Izotov, 2010).

Apart from depending on the time period scrutinized and the markets involved, empirical results also heavily rely on the measuring methodologies. For example, by an adjusted correlation coefficient measure Forbes and Rigobon (2002) find a high level of interdependence rather than contagion among stock markets in the 1997 Asian crisis, the 1994 Mexican peso crisis, and the 1987 stock market crash. This conclusion

is contrary to those of previous studies using conventional correlation measure. Generally, in the existing literature the interdependence between financial markets is measured either by the model-free statistics or by specific models accounting for complex relationships and effects, such as time lag.(Aityan, Ivanov-Schitz, & Izotov, 2010). The most popular methodologies can be generally categorized into four groups: 1) the cross-market correlation coefficient, 2) the ARCH and GARCH models, 3) cointegration and Granger analysis, 4) Vector Autoregression (VAR), as well as the generalized impulse response function (IRF) and the generalized variance decomposition (GVD) (Forbes & Rigobon, 2002; Elyasiani & Zhao, 2008). In empirical analysis, these methodologies are usually employed jointly to assess market interdependence.

5.2.1 Cross-market correlation coefficient analysis

The cross-market correlation coefficient is by far the most widely used method for assessing the interdependence between two financial markets[97]. There is a large body of literature assessing the interdependence of financial markets by correlation analysis, among which are Solinik, Boucrelle and Fur (1996), Jr, Nunes, Ceretta and Silva (2005), Caporale, Cipollini and Spagnolo (2005), Hong, Tu, and Zhou (2007), as well as Hu, Lin and Kao (2008). Cheng (1998) examines the stock market comovement between the UK and the US by the factor analytic approach and the canonical correlation analysis. Since correlation measure is conditional on market volatility, Forbes and Rigobon (2002) propose an adjusted correlation coefficient measure. More sophisticatedly, Engle (2002) proposes a Dynamic Conditional Correlation (DCC) model to examine correlation dynamics among assets. Aityan, Ivanov-Schitz and Izotov (2010) propose a model-free time-shift asymmetric correlation measure for studying the correlations and interdependences between international stock markets.

[97] Correlation coefficient is a measure of association between two variables, which are not designated as dependent or independent. The two most popular correlation coefficients are: Spearman's correlation coefficient and Pearson's product-moment correlation coefficient.

Eckel, Loffler, Maurer and Schmidt (2011) introduce a mark correlation function for the analysis of spatial stock market correlations.

However, there are some drawbacks of measuring market interdependence by the correlation coefficient analysis. Firstly, as noted by Dumas, Harvey and Ruiz (2003), and Carrieri, Errunza and Hogan (2007), the estimated values by correlation measure usually underestimate the degree of market interdependence. Secondly, the non-stationarity of time series can also lead to a biased estimation (Kiranand, 2004). Lastly, the commonly employed Dynamic Conditional Correlation (DCC) model is a joint test of marekt interdependence and model specification since a two-step estimation procedure is generally adopted. The dynamic conditional correlations between equity market returns are usually estimated from the standardised residual series, which are obtained from the estimation of the univariate GARCH model for the return series of equity market.

5.2.2 ARCH and GARCH models

Another popular method for assessing financial market interdependence is the Autoregressive Conditional Heteroskedasticity (ARCH) model (Engle R. F., 1982) and its augmentation, i.e., the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model (Bollerslev, 1986). The GARCH model has led to a variety of modifications, including the multivariate GARCH (MGARCH), the Integrated GARCH (IGARCH), the Exponential GARCH (EGARCH), the Quadratic GARCH (QGARCH), the GARCH-in-mean (GARCH-M), the Threshold GARCH (TGARCH) and many others[98]. The GARCH family has also been developed to capture some basic features of stock returns and volatility behaviours, such as volatility persistence, the risk-return relationship, the dependence of stock return volatility on the past return innovation and/or on its own past terms (Tsouma, 2007).

[98] For the excellent reviews on the ARCH and GARCH models, please refer to Bollerslev, Chou, and Kroner (1992), and Bauwens, Laurent, and Rombouts (2006).

By adopting the ARCH and GARCH models, numerous empirical studies have assessed financial market interdependence, among which are Hamao, Masulis and Ng (1990), Engle and Susmel (1993), Longin and Solnik (1995), Christofi and Pericli (1999), Chelley-Steeley (2000), Balaban, Bayar and Kan (2001), Berben and Jansen (2005), Baele (2005), Baur and Jung (2006), Saleem (2009), as well as Mukherjee and Mishra (2010). Using the ARCH and GARCH models, volatility spillover has been widely observed within and among developed American, European, as well as emerging markets. Although these studies provide important evidence of volatility spillover across markets, only a few of them, for example, Berben and Jansen (2005; 2009), have offered quantitative values of market interdependence explicitly.

5.2.3 Cointegration and Granger causality analyses

In parallel with the ARCH and GARCH models, cointegration and Granger causality analyses are also popularly employed to assess the interdependence between two financial markets, because they take account of the non-stationarity of time series. Consider that two markets are highly interdependent, there should be: 1) no lagged price adjustments across the two markets in the short term, and 2) equilibrium between returns in the two markets in the long term. Cointegration analysis provides an econometric technique for testing the long-run equilibrium relationship between non-stationary time series if a linear combination of these time series is stationary (Engle & Granger, 1987). Meanwhile, Granger causality analysis (Granger C. W., 1969) provides a statistical test for determining the lead-lag relationship between two time series, which is based on the forecasting ability of one time series for the other. Consequently, cointegration and Granger causality analyses can assess market interdependence from the long-term equilibrium relationship and the short-term dynamic relationship respectively.

Many studies have employed cointegraiton and Granger causality analyses to assess market interdependence, among which are Malliaris and Urrutia (1992), Masih and

Masih (1997; 1999), Bracker, Docking and Koch (1999) , Lucey and Voronkova (2008), Qiao, Chiang and Wong (2008), Gilmore, Lucey and McManus (2008), Awokuse, Chopra and Bessler (2009), Diamandis (2009), as well as Mylonidis and Kollias (2010). However, cointegration and Granger causality analysis are meant to capture market comovement and volatility spillover, but not to gauge the degree of market interdependence in a quantitative way.

5.2.4 VAR, IRF, and GVD models

Other commonly employed method of assessing market interdependence are the Vector Auto regression (hereafter, VAR) and its augmentations, such as the impulse response function (IFR), and the variance decomposition (VD). The VAR model can estimate a dynamic simultaneous equation system, which is free of a priori restrictions on the structural relationship among variables. Since there is no restriction imposed on the structural relationship, the VAR can be regarded as a flexible approximation to the reduced form of model, which is correctly specified but with an unknown structure of the actual economic variables (Eun & Shim, 1989). The VAR is appealing in providing empirical regularities among time series as the large-scale structural models can easily be misspecified sometimes. In the context of VAR, the impulse response function has developed to represent the reaction of any dynamic system in response to some external distribution. More specifically, the impulse response function describes how the economic system reacts to an exogenous impulse over time. Similarly, the variance decomposition indicates the amount of information of each variable, which contributes to the forecasts of other variables in a VAR model. In other words, the variance decomposition determines the proportion of forecast error variance of each variable, which can be explained by the exogenous shocks to other variables[99].

A large body of literature has examined the interdependence between two financial markets by using the VAR framework, which includes Eun and Shim (1989),

[99] For full description of traditional VAR, RIF, as well as GVD analysis, please refer to Koop, Pesaran and Potter (1996), Koop (1996), as well as Pesaran and Shin (1998).

Elyasiani, Perera and Puri, (1998), Knif and Pynnonen (1999), Dekker, Sen and Young (2001), Chen, Firth, and Rui (2002), Khalid and Kawai (2003), as well as Elyasiani and Zhao (2008), as well as Shamila (2011). Similar to the aforementioned ARCH and GARCH models, together with cointegration and Granger causality analyses, the VAR, the IRF, and the GVD models can hardly provide a quantitative degree of market interdependence though they are broadly employed to capture market comovement and volatility spillover.

To sum up, the aforementioned methods have both advantages and disadvantages for assessing financial market interdependence. Except for the correlation measure, these methods hardly offer a quantitative value of market interdependence, though they can capture market comovement and volatility spillover effectively. In order to study the relationship between market integration and market interdependence in the next chapter, a time series of degree of market interdependence is required here to match that of market integration obtained in Chapter 4. This study is going to employ the multi-factor R-squared measure to gauge the degree of market interdependence between two financial markets. In association with main component analysis, this method can offer a degree time series of market interdependence without suffering from the drawbacks of the conventional methods aforementioned. In the following section, this study is going to introduce the methodology in detail.

5.3 Methodology

Recently the multi-factor R-squared measure has emerged as a promising method for examining market interdependence via the dynamic application of principal components analysis (PCA). As this method requires neither the stationarity of variables nor the results of model dependency [100](Gilmore, Lucey, & McManus, 2008), it has received extensive attention from researchers, such as Pukthuanthong and Roll (2009), Yu, Fung and Tam (2010), as well as Berger, Pukthuanthong and Yang (2011).

[100]Model dependency usually refers to the case that empirical result is heavily dependent on modelling assumptions and specifications (Ho, Imai, King, & Stuart, 2007).

The multi-factor R-squared measure can be conducted using the following model. The return of country $j's$ market index is determined by

$$Return(j,t) = \alpha(j,t) + \sum_{i=1}^{NMC} \beta_i\,(j,t) f_i(W,t) + e(j,t) \qquad j = US, China \qquad (5\text{-}1)$$

where $Return(j,t)$ is the return of country $j's$ market index in period t, $\alpha(j,t)$ is a constant term, $\beta_i(j,t)$ is the sensitivity coefficient for i^{th} global industry factor $f_i(W,t)$, $e(j,t)$ is the estimation residual, and NMC is the number of global industry factors. This measure is based on the explanatory power of global industry factors for one country's stock market return. If this market is highly interdependent with the global stock market, its return will be mainly explained by the global industry factors rather than domestic ones.

In empirical study, the most influential global factors are generally obtained by the PCA. The global industry factor $f_i(W,t)$ can be replaced by the i^{th} main component[101], which can be converted from a matrix of the world stock market returns by the PCA. In order to capture the fundamental market interdependence rather than the temporary linkage[102], $f_i(W,t)$ is usually adopted to be an out-of-sample main component. For each period, the eigenvectors (weightings) of main components are sorted by their eigenvalues, which are in a descending order, and are multiplied by the global sectors returns in the subsequent period correspondingly to yield a set of out-of-sample main components[103]. More specifically, for each period the out-of-sample main components are obtained by multiplying global sectors returns in the current

[101] Main components can be sorted in descending order according to the proportions of total variance they explain. For example, the first main component explains the maximum proportion of total variance while successive components account for smaller amounts of that in the set of market variables. The relative importance of each main component is given by its associated eigenvalue, according to the proportion of the total variance it explains. For more details of the PCA, please refer to Jolliffe (2002).

[102] The temporary linkage can also be easily detected by the adjusted R squared measure in a multivariate regression with the main components in the same period as explanatory variables. These explanatory variables are obtained by multiplying the eigenvectors (weightings) with the same sectors returns in the same period. This study has also examined the temporary linkage between China and the world market. In the long term the empirical result follows a similar trend of fundamental interdependence mentioned below, but does not display the evolution of market interdependence that influenced by China's financial liberalization events.

[103] These main components can be regarded as the global industry groups as they are linear combinations of the original variables of global industries.

period with the old weighting structure in the prior period correspondingly. Equation (5-1) can be rewritten as:

$$Return(j,t) = \alpha(j,t) + \sum_{i=1}^{NMC} \beta_i(j,t)\gamma_i(W,t-1)Return(W,t) + e(j,t) \qquad (5\text{-}2)$$

where $\gamma_i(W,t-1)$ is the factor loading (i.e., eigenvectors or weightings) of the top i^{th} main component in period $t-1$. As these main components are orthogonal to each other, there should be no multicollinearity problem with the explanatory variables.

In Equation (5-2) the explanatory power of independent variables can be represented by the adjusted R^2, which is usually defined as:

$$adjR^2(j,t) = 1 - \frac{(n-1)}{(n-p-1)}\frac{SS_{err}(j,t)}{SS_{tot}(j,t)} \qquad j = US, China \qquad (5\text{-}3)$$

where $SS_{err}(j,t)$and $SS_{tot}(j,t)$ are the sum of squares of residuals and the total sum of squares respectively, n is the sample size, and p is the total number of regressors in the linear model (but not counting the constant term). As the adjusted R-squared normally ranges from 0 to 1, it is a good indication of stock market interdependence between country j and the world. If this index is lower, for example, it means that the country j's stock market return is less driven and can hardly be determined by the global industry factors, and vice versa. This study specifies the adjusted R^2 to be the non-normalised index, which is denoted as $I(\cdot)$. For example, $I((C,W),t)$ stands for the non-normalised index of financial market interdependence between China and the world while $I((U,W),t)$ is the non-normalised one between the US and the world at time t[104].

As financial liberalisation is not the only determinant of stock market interdependence, the degree of stock market interdependence between the US and the world is also time varying, even though the US stock market is generally regarded as the most influential and open one in the world. In order to mitigate the impact of international factors other than China's financial liberalisation, this study utilises the non-normalised

[104] Hereafter, without other specific definitions this study assigns the letter C to denote China, U to represent the US and W to stand for the world stock markets respectively.

degree of stock market interdependence between the US and the world as a benchmark for comparison[105]. A normalised index of stock market interdependence between China and the world is constructed, therefore, by dividing the non-normalised degree of market interdependence between China and the world by the non-normalised one between the US and the world in the same period. The normalised index is specified as:

$$NI((C,W),t) = \frac{I((C,W),t)}{I((U,W),t)} = \frac{\text{adj}R^2(C,t)}{\text{adj}R^2(U,t)} \quad (5\text{-}4)$$

where $NI((C,W),t)$ represents the normalised index of stock market interdependence between China and the world at time t. A bigger value of $NI(C,W)$ represents a higher degree of market interdependence between China and the world. $NI(C,W)$ takes the value of 1 when $I(C,W)$ equals $I(U,W)$. In this case, stock markets between China and the world are regarded to be highly interdependent, at least to the same degree as that between the US and the world.

However, it is worth noting that the normalised index cannot remove the compound influence of international factors on the market interdependence between China and the world stock markets completely. This approach implicitly assumes that international factors affect China's stock market in the same way as they influence the US stock market. If there are some differences between China and the US stock markets in terms of the response to international factors, the normalised index might lose some of its power. Nevertheless, it provides a simple and straightforward way to mitigate the impacts of international factors, other than China's financial liberalisation, on the market interdependence between China and the world stock market. For the purpose of generality, empirical results using non-normalised and normalised indices will be both reported in the following subsections.

[105] In economic reality the interdependence between US and the world stock markets can be regarded as the highest one at that time due to the size, power and openness of the US stock market.

5.4 Empirical analysis

This section is going to gauge the degree of stock market interdependence between China and the world since China's accession to the WTO in 2001. As there has been a series of financial liberalisation events implemented by the Chinese government during this period, it is expected to increase the degree of stock market interdependence between China and the world. This section is going to employ the multi-factor R-squared measure to provide some empirical supports on this issue. This section mainly includes: 1) indices and data descriptions, 2) empirical procedures, as well as 3) empirical results.

5.4.1 Indices and data descriptions

This subsection is going to introduce the indices and data for empirical study. In order to make measuring results comparable, indices and data are highly consistent with those in the previous Chapter 4. In so doing, the biases of data selection and index definition are believed to be mitigated to some extent.

This study adopts the same 39 sector indices to represent the world stock market. These indices are in level 3, which are defined by the Datastream database. Main components influencing the world stock market will be extracted from these sector indices by the PCA. As for China and the US stock markets, the Shanghai Composite Index and the Dow Jones Industrial Index are employed to represent these two markets respectively[106].

These data sets are daily price indices and range from January 3, 2000 to May 31, 2011, which are the same as the one for measuring market integration in Chapter 4. This period provides a base period of almost two years before China's accession to the WTO in 2001, and covers the period of China's financial liberalisation from December 11, 2001 to May 31, 2011. In order to trim the "stale" data, only those are

[106] The author has found very similar results using the S&P 500 Index for the US stock market, ceteris paribus.

"retained when both the US and China stock markets actually traded on the same calendar day. The retained "usable" values are standardized by the base prices on January 3, 2000 correspondingly, and are converted into weekly returns. Furthermore, all indices in local currency are transformed into the US dollars to remove exchange rate noise. For other details, please refer to the Data description in Chapter 4 and the Table I in the Appendices.

5.4.2 Empirical procedures

The empirical procedures involve three steps in gauging the degree of stock market interdependence between China and the world by the multi-factor R-squared measure. These steps are as follows:

Step 1: Selecting the length of observation interval. This study adopts the length of observation interval to be 6 months for two reasons. Firstly, the length of 6 months is believed to balance well the trade-off of capturing the impacts of financial liberalisation events on market interdependence and detecting the changing levels of market interdependence over time. The former aspect requires that the observation interval is long enough to allow financial liberalisation events to take into effect. Inversely, the latter expects that the length of observation interval is short enough to provide as many observations as possible. Secondly, this selection makes empirical results comparable across chapters because the length of observation interval is the same as the one in measuring market integration. Once the length of observation interval is selected, by a sliding observation window of fixed length the PCA provides a dynamic version to capture the evolving pattern of market interdependence over time. The full sample of 11-and-half years is divided into 22 subsamples by the observation window of 6 months[107].

[107] The last period from January 3 to May 31, 2011 is not included as a subsample since it is less than 6 months.

Step 2: Computing the main components. By the PCA, the eigenvectors for each main component are computed from the weekly returns of the world sector indices[108]. For each period these eigenvectors (weightings) are sorted by their eigenvalues from the largest to smallest value, and are multiplied by their sectors returns in subsequent period correspondingly to yield a matrix of out-of-sample main components[109]. The out-of-sample main components are designed to capture the fundamental interdependence of stock markets rather than the temporary linkage between them.

For example, the eigenvectors (weightings) are computed from the world 39 sectors returns of the first half year of 2000 by the PCA, and are multiplied by the returns of the same 39 sectors in the second half year of 2000 to generate a matrix of out-of-sample main components for the second half year of 2000. This computation keeps repeating itself for the subsequent half-year period; eigenvectors from 39 sectors returns of the second half year of 2000 are applied to the returns of the same sectors in the first half year of 2001, and so on until eigenvectors of the second half year of 2010 are applied to that of the first half year of 2011. These computations produce 21 out-of-sample main components.

In order to fully capture the fundamental linkage, this study retains the top 3, 4 and 5 main components respectively, which on average accounts for up to approximately 95%, 97% and 98% of the cumulative eigenvalues correspondingly[110]. Admittedly the number of main components retained is somewhat arbitrary. But it seems reasonable that most global shocks have been adequately captured by these industrial groups. Even if there is something omitted, it might not have much impact on the pattern of gauging market interdependence (Pukthuanthong & Roll, 2009). For the percentages of variance, which are explained by the cumulative eigenvalues of the top 3, 4 and 5

[108] For each main component, its eigenvectors (weightings) show the contribution of each variable to this component.
[109]These main components can be regarded as global industrial groups, as they are linear combinations of original variables of global industries.
[110] Intuitively, it can also be understood as "up to approximately 95%, 97% and 98% of the total volatility in the covariance matrix".

main components respectively in each subsample, please refer to Table V in the Appendices.

Step 3: Estimating the adjusted R squared value. Once the main components are identified, they can be included as explanatory variables in a linear multivariate regression. In order to gauge the degree of stock market interdependence between China and the world, and the one between the US and the world, these two regression equations employ weekly returns of the Shanghai Composite Index and the Dow Jones Industrial Index as dependent variable respectively. The values of adjusted R squared of these equations, therefore, are adopted to be the indices of market interdependence. These values represent to what degree the dependent variables are explained by the global industrial groups respectively.

5.5 Empirical results

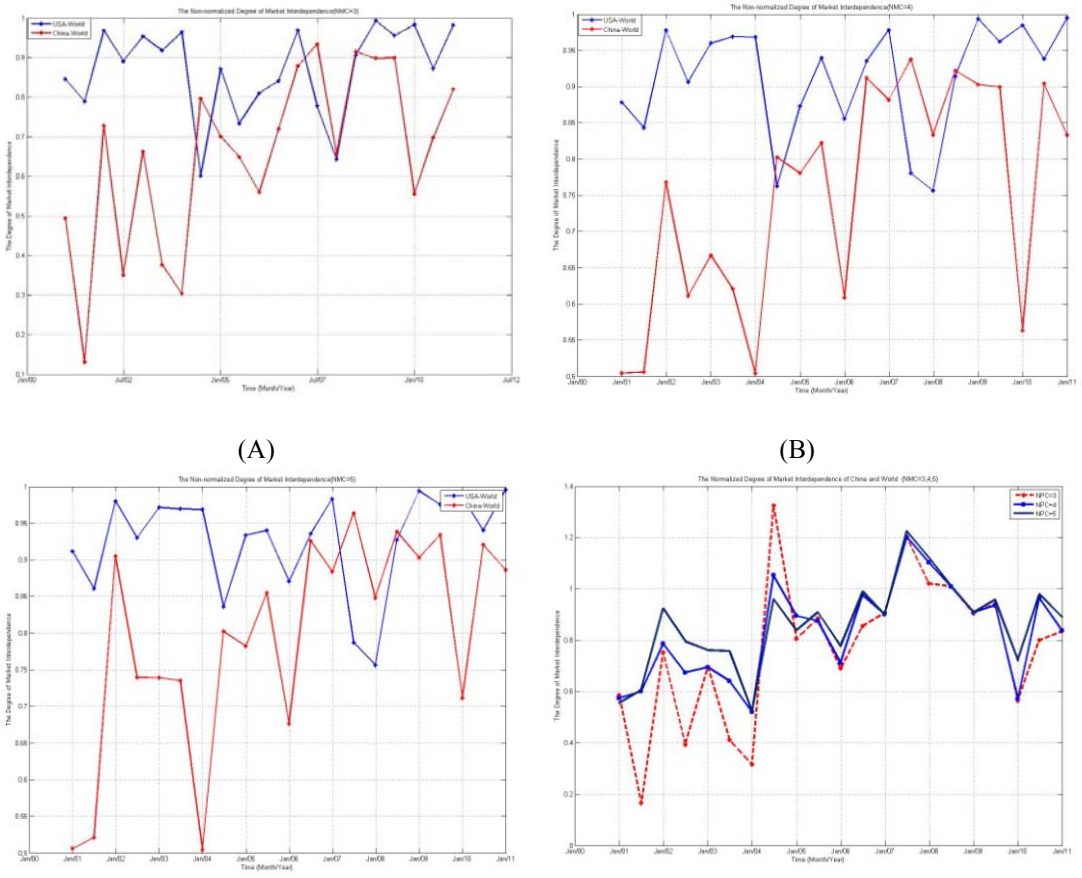
This section is going to report the main findings of empirical analysis, which include: 1) the non-normalised and normalised degrees of stock market interdependence; and 2) the impacts of China's financial liberalisation events on the stock market interdependence between China and the world. As a series of financial liberalisation policies has been implemented by the Chinese government after 2001, the degree of international market interdependence between China and the world stock market is expected to increase in the post-WTO accession period. Meanwhile, the degree of market interdependence shall be volatile, since financial liberalisation policies may have a variety of impacts on it. Furthermore, the degree of market interdependence might be influenced by the global financial crisis in 2008, as the market interdependence is normally inclined to increase in downturn period.

5.5.1 Measuring the degrees of stock market interdependence

This subsection is going to report the non-normalised and normalised degrees of stock market interdependence between China and the world since China's accession to the

WTO in 2001. These degrees are gauged by the multi-factor R-squared measure on the basis of the PCA. As aforementioned, this study specifies the length of observation interval to be 6 months and the number of main components to be 3, 4 and 5 respectively. Both the non-normalised and normalised degrees of market interdependence are plotted in Figure 5.1, while the exact values are reported in Table VI in the Appendices for reference.

Figure5. 1 The Non-normalised and Normalised Degrees of Market Interdependence



(A) (B)

(C) (D)

Notes: For each half year and each pair of markets, both the non-normalised and normalised degrees of market interdependence are reported in this figure, wherein the number of main components *NMC* takes the value of 3, 4, and 5 respectively, and the length of observation interval *T* is specified to be 6 months. In this figure, subfigures A, B and C represent the non-normalised degrees of stock market interdependence of two pairs of markets, i.e., China and the world, the US and the world, as *NMC* takes the value of 3, 4 and 5 correspondingly. In subfigures A, B and C the lines in blue represent the non-normalised degrees of stock market interdependence between the US and the world while the lines in red stand for the one between China and the world. Subfigure D reports the normalised degree of stock market interdependence between China and the world as *NMC* takes the value of 3, 4 and 5 respectively, which are shown by lines in red, blue and black correspondingly. All statistics are plotted against the end of each time interval.

Subfigures A, B and C show that the non-normalised degrees of stock market interdependence are time-varying for two pairs of markets, i.e., China-World, and US-World. The non-normalised degree of stock market interdependence between the US and the world does not stay constant, even though the stock market of the US is generally regarded as the most open and influential one in the world. From an alternative perspective, the non-normalised degree of stock market interdependence between the US and the world can be adopted to represent the compound impact of international factors on the interdependence of the global stock markets. This is because the non-normalised degree between the US and the world is time-varying, even though it is regarded as the benchmark of the highest global interdependence in the world. Hence, it is necessary to remove the compound influence of international factors, when analysing the impacts of China's financial liberalisation on stock market interdependence between China and the world.

Meanwhile, in comparison with the non-normalised degree of stock market interdependence between the US and the world, the one between China and the world is normally lower and more volatile. That is to say, China's stock market is usually less interdependent than the US stock market with the world stock market. However, it is worth noting that in some cases the degree of market interdependence between China and the world is higher than the one between the US and the world. These phenomena can be found in the second half year of 2003, and the period from the second half year of 2006 to the second half year of 2007. These anomalies are associated with investors' overreaction probably, which will be explained in detail later.

Regarding the tendency of market interdependence, from the non-normalised degrees there is an upward trend for market interdependence between China and the world while the one between the US and the world hovers at a high level in the long term. Since the non-normalised degrees in subfigures A, B and C do not offer much more precise information, the normalised degree is adopted and plotted in subfigure D.

Although the normalised degrees in subfigure D vary somewhat with the number of main components selected, they almost follow the same tendency. This verifies that the numbers of main components selected are reasonable since the omitted main components have relatively small influence. In order to mitigate the impacts of various numbers of selected main components, for the sake of caution, an average trend will be employed to examine the impacts of financial liberalisation events in next subsection.

Subfigure D displays that the stock market interdependence between China and the world has experienced three stages roughly: 1) the initial stage at low level; 2) the steady stage at moderate level; as well as 3) the rising-up and declining stage, which is followed by resumption. These stages will be explained in detail together with the impacts of financial liberalisation events in the following subsection.

5.5.2 China's financial liberalisation and stock market interdependence

This subsection is going to examine the impacts of China's financial liberalisation events on the interdependence between China and the world stock markets. More specifically, this study is to explore which kind of China's financial liberalisation events are and to what degree they have increased the interdependence of stock market between China and the world since China's accession to the WTO in 2001.

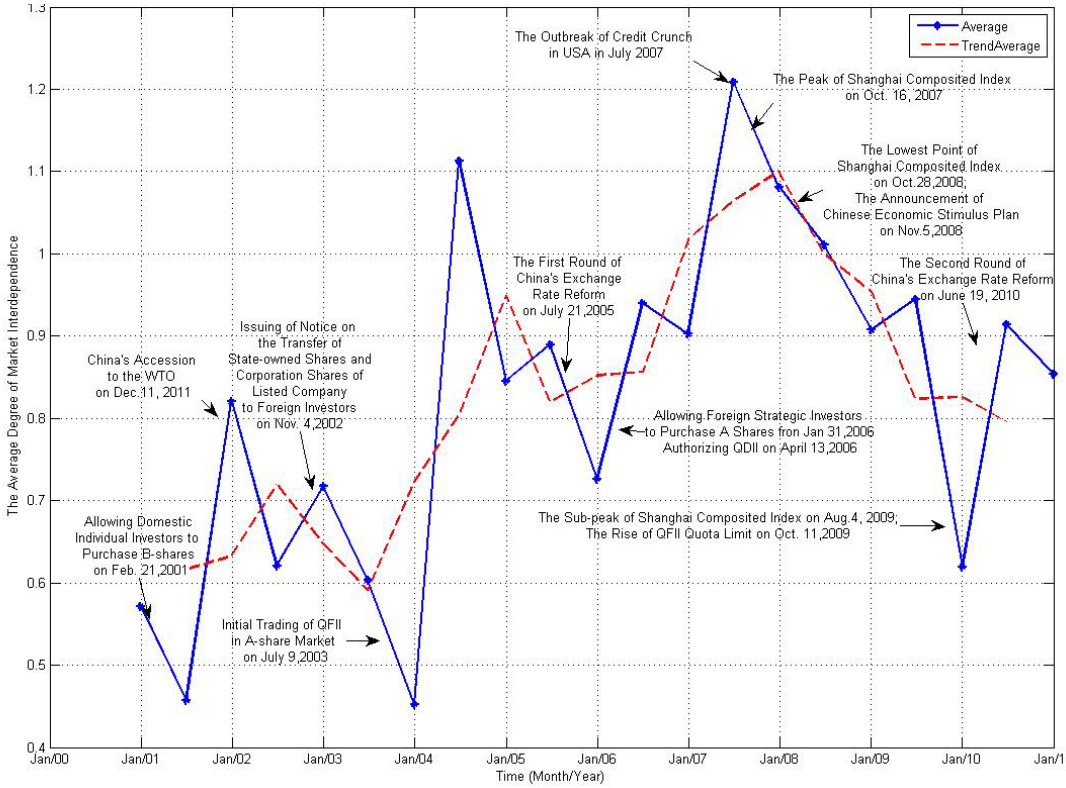
This study employs the normalised degree of market interdependence aforementioned to examine the relationship between China's financial liberalisation events and stock market interdependence. However, the purpose of this study is not to claim that China's financial liberalisation solely contributes to the market interdependence between China and the world stock markets. There are many domestic factors, other than financial liberalisation, can influence this issue, even after removing the compound impact of international factors by the normalised index. Similar to Chapter 4, this study focuses the direct impacts of financial liberalisation on international market interdependence, and ignores the collateral impacts of financial liberalisation

and other regulatory reforms on this issue. This is because that the collateral impacts depend on the development of financial market and need a long time to take effect.

As aforementioned, for each half year period the degree of market interdependence is estimated from the out-of-sample main components in the previous period, a one-period lagged effect should be considered when analysing the impacts of China's liberalisation events on stock market interdependence. The impacts of liberalisation events are reflected by comparing the normalised degree of market interdependence in the subsequent period to that in the current period. That is to say, a liberalisation event is regarded to exert a positive (negative) impact on market interdependence if there is a positive (negative) difference in the normalised degree of market interdependence between two periods.

The empirical results are plotted in Figure 5.2 as follows while the exact values are reported in Table VII in Appendices for reference. The degree of market interdependence is the average value of normalised degrees, which are obtained from the multivariate regressions with the top 3, 4 and 5 main components as explanatory variables respectively. The trend of market interdependence is obtained by the three-point moving average of market interdependence with equal weights. In Figure 5.2, the degree of market interdependence is indicated by the solid line in blue while its trend is shown by the dotted line in red.

Figure5. 2 China's Financial Events and Stock Market Interdependence Degree



Notes: For the period from July 2000 to December 2010, the normalised degree of stock market interdependence between China and the world and the three-point moving average trend are plotted in this figure, wherein the number of main components *NMC*, takes the value of 3, 4,and 5 respectively, the length of observation interval is 6 months. In this figure, the "*Average*" line (in blue) represents the average value of normalised degrees when the top 3, 4, and 5 main components are employed as explanatory variables; the "*Trend Average*" line (in red) stands for the market interdependence trend, which is obtained by a three-point moving average of "Average" values with equal weights. All statistics are plotted against the end of each time interval.

From the trend line in Figure 5.2, the degree of stock market interdependence between China and the world has gone through three stages: 1) the stationary stage at low level from July 2001 to June 2003; 2) the increasing and steady stage at moderate level from July 2003 to June 2006; as well as 3) the significant rising-up and falling stage from July 2006 to June 2010. To give an overview, there has been an upward trend in the period from China's accession to the WTO in 2001 to the emergence of the credit crunch in the US in July 2007, which was followed by a descending tendency in the following years.

In stage 1 the normalised degree of market interdependence was at a relatively lower level, which ranged from 0.452 to 0.820 with a mean of value of 0.632. In this period financial liberalisation events, such as allowing domestic investors to purchase B

shares on February 21, 2001, China's accession to the WTO on December 11, 2011, as well as issuing the notice on transfer the state-owned and corporation shares to foreign investors on November 4, 2002, might not have increased greatly the degree of stock market interdependence between China and the world in the long term. Although in the short term, the degree of market interdependence increased significantly in the second half year of 2001, this increase vanished soon after and the degree returned to the original level in the next period. Since there was no persistent increase in market interdependence during this period, China's financial liberalisation events in this period might be ineffective to a large extent. This view is consistent with previous conclusions in Chapter 4.

Regarding the sudden rising-up of market interdependence in this period, it may be attributed to investors' overreaction to the event of opening the B-share markets to domestic investors if a one-period lag is taken into account. The lifting of domestic ownership restriction boosted optimistic investors' sentiment in the domestic market in the short term though it did not enhance market integration between China and the world in the long term (which has been explained in Chapter 4).

On the one hand, the removal of domestic ownership restriction led to market enthusiasm probably. As shown by a steep increase in B-share trading volume, for example, a huge inflow of domestic capital rushed into the B-share market (Bohl, Schuppli, & Siklos, 2010). The trading volume of B shares in Shanghai and Shenzhen markets reached nearly to 300 billion Yuan (36.23 billion US dollars) in March, 2001. This was higher than that of the A-share market, even though the market size of B-share markets was only 0.1 times of that of the A-share markets. (Sun, Tong, & Yan, 2009). Correspondingly, in the first month after this reform the B-share Indices of Shanghai and Shenzhen increased 171% and 253% respectively. After the lifting of ownership restriction the average increase in B-share prices was 158.6% while that of A-share rose only 2.2% (Darrat, Gilley, Wu, & Zhong, 2010).

On the other hand, against a background of market enthusiasm, to large extent domestic investors ignored two detrimental factors associated with this event. Firstly, B shares were not under-valued in international markets though their prices were much lower than those of A shares. Due to their relative high prices, information and transaction costs, B shares proved to be unattractive to foreign investors. For example, there was a rather low market capitalization and liquidity of stocks listed in the B-share market (Bohl, Schuppli, & Siklos, 2010). As various measures were found to be ineffective, China's government opened the B-share markets to domestic individual investors to vitalize this market. Secondly, arbitrage across the A- and B- share markets could not take place in any real sense since the short selling was prohibited in China, and the RMB was not freely convertible. Although there were high discounts between A- and B-shares prices, investors could hardly benefit from arbitrage across two markets.

Optimistic investors' sentiment pushed asset prices away from fundamental values and caused overreaction to this event. As noted by Wu (2011), for example, evidence in support of market overreaction has been found during this period. The large rise in B-share prices not only aroused the attention of domestic investors but also helped existing foreign shareholders to cash out. For example, the Jiangling Motors Corp. announced on April 18, 2001 that one of its shareholders sold out 46.2 million shares on the secondary market, which was up to 5.35% of the total equity capital of this company. Similarly, foreign shareholders reduced their ownership in the China International Marine Containers (Group) Co., the Wuxi Little Swan Co., the Guangdong Provincial Expressway Development Co., and so on (Sun, Tong, & Yan, 2009). If two-stage strategies aforementioned were adopted, foreign investors may withdraw from the B-share markets and purchase equities in other markets as they tried to balance the portfolio. This might lead to an increase of market interdependence irrespective of fundamental change in cross-market linkage.

In stage 2 the normalised degree of market interdependence increased greatly from 0.452 to 1.113, and then hovered at a high level of 0.8608 on average in the following years. In comparison with stage 1, the average normalised degree increased by 42.8% from 0.632 to 0.903. If the one-period lagged effect is considered, stock market interdependence between China and the world at this stage might have been increased greatly by China's financial liberalisation events, which mainly included the QFII programme in July 2003, and the first round of exchange rate reform in July 2005.

Fundamentally, in the long term the large increase in market interdependence might be contributed to the rising-up of market integration in this period. As shown in Chapter 4, those two events aforementioned were effective and caused an increase of market integration. At the end of 2003, the initial 10 QFII were approved by the State Administration of Foreign Exchange (SAFE) of China to trade in the A-share market and the total quota reached 1.7 Billion USD[111]. As the QFII programme reduced the trade obstacles between China and the world market to some extent, this event, therefore, could facilitate transactions across borders and enhance the degree of market interdependence.

On the other hand, by the time of the first round of China's exchange rate reform in 2005 China abandoned strict pegging of its currency (the RMB) to the US dollar at an exchange rate of 8.28 and initiated the incorporation of a "reference basket" of currencies when choosing its target for the RMB. By taking into consideration the "reference basket" of currencies, this exchange reform increased the flexibility of the RMB exchange rate to some degree. The RMB was allowed to fluctuate by up to 0.3% (later changed to 0.5%) on a daily basis against the basket. More importantly, through this exchange rate reform the RMB has commenced its process of appreciation. On July 22, 2005 China adjusted the RMB from 8.28 to 8.11 against the dollar by a one-off appreciation of 2.1%. The central parity of the RMB against the US dollar appreciated 18.7% (or 20.8% if the initial appreciation of the RMB to the dollar was

[111] Source is from the website of the CSRC "*http://www.csrc.gov.cn/*"

included) from July 21, 2005 to the end July, 21 2008. To some extent this appreciation modified the undervaluation of the RMB against foreign currencies and boosted China's overall imports. This exchange reform might have enhanced the interdependence between China and the world market in terms of both financial and economic aspects.

Additionally market overreaction might have played an important role in the rising-up of market interdependence in the short term, which was especially significant in the case of the QFII programme. A sudden rising-up of market interdependence occurred in second half year of 2004, in which the normalised degree rose up from 0.452 to 1.113. A value of 1.113 meant that the degree of market interdependence between China and the world was 1.113 times of the one between the US and the world, which could not be fully explained by economic fundamentals alone. Apart from the aforementioned market integration, market overreaction might have also contributed to this sudden rising-up. In this case the normalised degree of market interdependence increased significantly in a very short time period and returned to a high level steadily, which is similar to the scenario of the opening up of the B-share markets to domestic individual investors.

Although controversy remains, foreign institutional investors are believed to have information advantages over domestic investors because of their sophisticated experience and expertise (DVORÁK, 2005). Meanwhile, as noted by Chen, Johnson, Lin, and Liu (2009), for example, foreign investor sophistication in interpreting information is an important determinant of investment performance difference between foreign and domestic investors. If market participants believe foreign institutional investors to have information or trading advantages, herding might be induced by the disclosure of their holdings, especially in the case that foreign trading is identifiable in many emerging markets (Chang C. , 2010). On the other hand, foreign institutional investors are more likely to be subject to volatility overseas than domestic investors in a partially segmented market, such as China. Domestic investors

are inclined to overreact to volatility overseas if herding behaviour occurs. Therefore, market interdependence could be increased greatly by market overreaction, especially in the initial entry period of QFII. In this period, domestic investors had rather relatively sparse information regarding the trading behaviours of QFII, herding of domestic investors was more likely to occur.

In stage 3 the normalised degree of market interdependence increased significantly from 0.940 to 1.209 in the period from July 2006 to June 2007, and then decreased steadily to the lowest point 0.619 in the second half year of 2009, which was followed by a resumption of the prior trend in 2010. More synoptically, in this stage stock market interdependence between China and the world might be associated with the financial crisis in 2008 rather than China's financial liberalisation events. The normalised degree of market interdependence rose up significantly in the pre-crisis period and declined steadily during the post-crisis period. On the contrary, in this period market interdependence might not have been influenced by China's financial liberalisation events, such as allowing foreign strategic investors to purchase A shares on January 31, 2006, and authorizing the QDII on April 13, 2006 as well as the second round of China's exchange rate reform on June 19, 2010.

Regarding the inverted U-shaped degree of market interdependence from July 2006 to December 2009, China's economy overheating might have contributed greatly to the sudden rising-up of normalised degree of market interdependence in the first half year of 2007 while China's economic stimulus plan might have played a very important role in the declining of market interdependence in the period from July 2007 to December 2009.

On the one hand, the normalised degree jumped from 0.902 to 1.209 in the first half year of 2007, which increased by 34%. The value of 1.209 meant that the degree of market interdependence between China and the world was 1.209 times of the one between the US and the world. This increase in market interdependence relative to

stage 2 could be mainly contributed to China's economy overheating. Economic overheating could not only boost economic activities across borders, such as bilateral trade, foreign investment, but also domestic and foreign investors' enthusiasm to some extent, which in turn led to an increase of cross-border economic activities further. As economic activities across border enhanced fundamentally, the degree of stock market interdependence between China and the world could be increased correspondingly by China's economy overheating.

For instance, in this period the Dow Jones Industrial Index climbed from 12,474 points on January 3, 2007 to 13,676 points on June 4, 2007, which increased by 9.6% moderately in 6 months. Compared with the stock market of the US, China's stock market was more enthusiastic. The Shanghai Composite Index rocketed by 59.6% in 5 months, which rose from 2,715 points on January 4, 2007 to 4,335 points on May 29, 2007. Even after the credit crunch began appearing in the US in July 2007, this tendency kept in both markets until the Shanghai Composite Index reached the peak value of 6,124 points on October 16, 2007 while Dow Jones Industrial Index climbed to the maximum of 14,614 points on October 9, 2007. The year to date increase was 125.5% for the Shanghai Composite Index and 17.2% for the Dow Jones Industrial Index respectively. Apart from the bubble in financial markets, China also suffered from the over-rapid investment growth, excessive credit, as well as oversized trade surplus in 2007. As a result, China's GDP growth reached 13% with a CPI of 4.8% in 2007. The National Development and Reform Commission had to claim on December 7, 2007 that the main objective of economic control in 2008 would be changed to prevent the economy from overheating further and inflation from increasing[112].

On the other hand, in the period of post-crisis period the normalised degree of market interdependence decreased steadily from 1.209 to the lowest point 0.619, which was probably due to China's economic stimulus plan in 2008-09. This plan amounting to 4

[112] Source is from the speech of Ma Kai, the chairman of the National Development and Reform Commission, in the Working Conference of National Development and Reform on December7, 2007.

trillion RMB (586 billion USD) was announced by China's government on November 9, 2008 as an attempt to offset the adverse impact of the global financial crisis on the second largest economy in the world. This stimulus package was mainly distributed to public infrastructure development, reconstruction works in region damaged by the Sichuan earthquake of 2008, as well as rural development and technology advancement, rather than social welfare improvement. By pumping a large amount of investment into the economy, this stimulus plan boosted China's economic growth greatly and helped to stabilize the world economy. As a result, China's GDP growth reached 8.7 % in 2009 and 10.3% in 2010 respectively.

China's economic stimulus plan might have decreased the degree of stock market interdependence between China and the world from two aspects. On the one hand, the linkage of economic fundamentals between China and the world was decreased by this plan to some degree as China's economic growth became less dependent on exports. With shrinking external demand, China's economic growth was maintained by boosting domestic demand. For example, China's net export of goods decreased by 34.3% from 298.13 billion US dollars in 2008 to 195.69 billion US dollars in 2009. On the other hand, this plan pumped excessive liquidity into China's stock market and housing market indirectly, which led to a market boom unrelated to the world market. The Shanghai Composite Index increased by 108.5% from the lowest points of 1664 points on October 28, 2008 to the sub-peak of 3478 points on August 4, 2009. Comparatively, in this period the Dow Jones Industrial Index paced up and down, decreasing from 9,625 points on November 4, 2008 to 6547 points on March 9, 2009, and then going back to 9320 points on August 4, 2009.

Regarding the increasing market interdependence from 0.619 to 0.914 in the first half year of 2010, this resumption was probably attributed to lifting of the upper limit of quotas for QFII on October 11, 2009 if the one-period lagged effect is considered. By the new rule a single institutional investor under the QFII programme was allowed to lift the upper limit on quotas to 1 billion US dollars from 800 million US dollars.

Meanwhile, the initial investment lock-up period was reduced to 3 months from one year for the medium to long term investors, such as pension funds, insurance funds, as well as mutual funds. This new rule increased the allure of China's stock market, which had a year-to-date increase of 54% nearly. Although this rule was criticized for perhaps its slow and limited impact, at least it was deemed widely to be a positive policy signal for boosting liquidity and investor sentiment further. For example, in the following year of 2010 the State Administration of Foreign Exchange (SAFE) of China newly granted 3.05 billion US dollars to QFII, which was comparable to 2009 (3.227 billion US dollars). As most overseas hedge funds seeking to invest in the A-share market had to lease quotas from the QFII programme members at that time[113], this new rule served as a strong policy signal of easy monetary and financial opening to investors. Inspired by this eye-catching event, domestic investors might have allocated more attention to information from overseas, which resulted in a quick response of China's stock market to overseas volatility, and therefore, an increase of market interdependence between China and the world.

Apart from the event of lifting of the upper limit of quotas for QFII in 2009, other China's financial liberalisation events in this stage might not have exerted too much influence on stock market interdependence between China and the world. These events were allowing foreign strategic investors to purchase A shares from January 31, 2006, authorizing the QDII on April 13, 2006, as well as the second round of China's exchange rate reform on June 19, 2010. This finding keeps consistent with the results of previous chapter. As found by Chapter 4, most of these events were regarded to be ineffective since they did not decrease, and even increased in some cases, the degree of market segmentation significantly.

[113] In order to curb speculative A-share investment, for example, this rule also prohibited investors from transferring or selling their quotas to others institutions.

5.6 Conclusions

This chapter mainly employs the multi-factor R-squared measure, which is associated with the PCA, to gauge the degree of stock market interdependence between China and the world since China's accession to the WTO in 2001. The primary motivation to employ this method is threefold: 1) this method can provide a quantitative degree of market interdependence between two markets; 2) this method requires neither the stationarity of variables nor the results of model dependency; as well as 3) this method can avoid the multicollinearity problem among explanatory variables. In order to provide more sensible interpretation, this chapter also constructs a normalised index to represent the relative degree of market interdependence between China and the world to the one between the US and the world. Main findings of this chapter are as follows.

By the traditionally non-normalised measure this chapter finds that: 1) the non-normalised degrees of stock market interdependence are time-varying for two pairs of markets, China-World, and US-World; 2) the non-normalised degree of stock market interdependence between China and the world is normally lower and more volatile than that between the US and the world; 3) in some cases the non-normalised degree of market interdependence between China and the world is higher than the one between the US and the world; as well as 4) this traditional non-normalised degree can hardly provide sensible explanation on the trend of market interdependence.

Compared to the conventionally non-normalised degree, the normalised degree of market interdependence provides more evidence on the impacts of China's financial liberalisation events. By the normalised measure this chapter finds that: 1) the normalised degree of stock market interdependence between China and the world has gone through three stages, which are the stationary stage at low level from July 2001 to June 2003, the significantly increasing and steady stage at moderate level from July 2003 to June 2006, as well as the significantly rising-up and falling stage from July 2006 to June 2010; 2) China's financial liberalisation might have played a very

important role in increasing market interdependence between China and the world, since there has been an upward trend in the period from China's accession to the WTO in 2001 to the emergence of the credit crunch in the US in July 2007; 3) there has been an inverted U-shaped degree of market interdependence from July 2006 to December 2009, which is probably attributed to China's economy overheating in the first half year of 2007 and to China's economic stimulus plan in 2008; 4) market interdependence might have been increased significantly and persistently by some (but not all) of China's financial liberalisation events, such as the QFII programme, the first round of exchange rate reform, which are found to be effective in Chapter 4; 5) apart from financial integration, many other factors might have also influenced market interdependence, among which are investors' overreaction, the linkage of economic fundamentals across markets, the impacts of policy signals; in addition to 6) it is inappropriate to capture financial market integration by market interdependence since market integration is not the only determinant resulting in increase of market interdependence.

CHAPTER 6: THE RELATIONSHIP BETWEEN MARKET INTEGRATION AND MARKET INTERDEPENDENCE: EVIDENCE FROM GRANGER CAUSALITY AND COINTEGRATION ANALYSES

6.1 Introduction

As aforementioned, the last decade has witnessed an increasing integration of stock market between China and the world, mainly thanks to China's financial liberalisation since its accession to the WTO in 2001. Meanwhile, the stock market interdependence between China and the world has also been significantly influenced by China's financial liberalisation since 2001. However, the relationship between stock market integration and stock market interdependence remains somewhat ambiguous.

Although market integration is regarded as a determinant of market interdependence (Geotzmann, Li, & Rouwenhorst, 2005), only a few empirical evidence has been provided to support this concept (Beine & Candelon, 2011; Walti, 2011). Since a good understanding of the determinants of stock market interdependence is helpful for international portfolio management, a large body of empirical literature has tried to identify the role of a set of factors. These factors include trade intensity (Tavares, 2009), financial development (Dellas & Hess, 2005), geographical distance (Chong, Wong, & Zhang, 2011; Eckel, Loffler, Maurer, & Schmidt, 2011), as well as business cycle synchronization (Brockman, Liebenberg, & Schutte, 2010). Generally, these factors are found to have explanatory power for market interdependence, though the results and conclusions differ greatly across studies.

This chapter is going to shed some light on the relationship between market integration and market interdependence from the case of China's stock market. More specifically, this chapter is going to answer whether and to what extent stock market

interdependence between China and the world has been increased by stock market integration since China's accession into the WTO in 2001.

On the basis of estimated values from Chapters 4 and 5, this chapter mainly examines the relationship between market integration and market interdependence by time series analysis. As the time series of market integration (or market interdependence) degree might be non-stationary, this chapter first applies the well known Augmented Dickey-Fuller (ADF) test to examine the unit root of these two time series. Once the order of integration is determined for each time series, this chapter performs the Modified WALD (MWALD) test to determine their causality relationship between them. Furthermore, this chapter examines the cointegration relationship between market integration and market interdependence by the Engle-Granger two-step approach. Given the small sample size of this study, for the sake of caution, bootstrap methods are adopted to reflect small sample size effect on these tests accordingly. As bootstrap does not require distributional assumptions, it can provide more accurate inference when sample size is small. In order to provide more precise information, this chapter compares the influences of China's financial liberalisation events on market integration and market interdependence correspondingly.

The rest of chapter is as follows: Section 2 provides a brief introduction of methodology; Section 3 performs empirical analysis and reports the results; Section 4 is the conclusion of this chapter.

6.2 Methodology

As the main purpose of this chapter is to examine the relationship between market integration and market interdependence, this section is going to introduce a series of tests and bootstrap procedures for empirical analysis, namely, the Augmented Dickey-Fuller (ADF) unit root test, the Modified WALD (MWALD) test, as well as the Engle-Granger two-step approach. These tests have been extensively documented, so this chapter will describe them briefly.

6.2.1 Unit root test and bootstrapping

Unit root test is normally adopted to determine whether a time series is non-stationary using the existence of a unit root as the null hypothesis. In order to avoid the spurious regression, a pre-testing of unit root is required for analysing the relationship among the possible non-stationary time series variables. Currently, there are several methods for testing unit root. The most widely used one is the Augmented Dickey-Fuller unit root test.

6.2.1.1 The Augmented Dickey-Fuller unit root test

The procedure for the Augmented Dickey-Fuller unit root test is applied to the following model

$$\Delta y_t = \tilde{\alpha} + \tilde{\beta} t + \tilde{\gamma} y_{t-1} + \sum_{J=1}^{p} \tilde{\beta}_J \Delta y_{t-J} + \varepsilon_t \qquad (6\text{-}1)$$

where Δ is the difference operator, $\tilde{\alpha}$ is a constant, $\tilde{\beta}$ is the coefficient on a time trend, p is the lag order of autoregressive process and ε_t is a white-noise innovation[114]. By including lags of the order p, the ADF formulation controls for autocorrelation. The unit root test is then performed under the null hypothesis $\tilde{\gamma} = 0$ against the alternative hypothesis of $\tilde{\gamma} < 0$ using the conventional t ratio for $\tilde{\gamma}$. After the t ratio[115] is computed, it can be compared to the relevant critical value for the Dickey-Fuller test[116]. The asymptotic distribution of the t ratio for $\tilde{\gamma}$ is independent of the number of lagged first differences, which are included in the ADF regression. Moreover, as pointed out by Said and Dickey (1984), the ADF test is asymptotically valid in the presence of a moving average (MA) component if sufficient lagged difference terms are included in the test regression. If the test statistic is more extreme than the critical value, the null hypothesis of $\tilde{\gamma} = 0$ is rejected, and therefore, no unit root is present[117].

[114] Imposing the constraints $\alpha = 0$ and $\beta = 0$ corresponds to modelling a random walk, while using $\beta = 0$ for modelling a random walk with a drift. Correspondingly, the ADF test has three main versions. The test equation has 1) an intercept, and 2) a deterministic time trend, as well as 3) both of them.

[115] The t ratio equals $\frac{\hat{\gamma}}{se(\hat{\gamma})}$, where $\hat{\gamma}$ is the estimate of γ, and the $se(\hat{\gamma})$ is the coefficient standard error.

[116] Mackinnon (MacKinnon, 1991) provides the finite-sample critical values for the ADF test.

[117] Normally the test statistic is negative.

6.2.1.2 The Residual-based ADF sieve bootstrap test

Since unit root tests often have serious size problems, bootstrap offers asymptotic refinement, which means that the gap between the true distribution and the bootstrap distribution declines faster than the one between the true distribution and the asymptotic distribution as sample size increases (Park, 2003). For hypothesis test, the critical values obtained by the bootstrap test are usually closer to the nominal level than that of an asymptotic test in finite sample size. Several bootstrap unit root tests have been proposed in the recent literature. They are either based on first-differenced data and the use of stationary bootstrap or sieve bootstrap, or on residuals from an auto-regression and the use of block bootstrap (Palm, Smeekes, & Urbain, 2008). This study is going to adopt the residual-based ADF sieve bootstrap test, as it normally performs better than other tests (Palm, Smeekes, & Urbain, 2008).

The residual-based ADF sieve bootstrap test is based on the test proposed by Chang and Park (2003). The latter is highly similar to the residual–based ADF test of Paparoditis and Politis (2005). For an ADF model as Equation (6-1), Chang and Park (2003) consider the data generating processes (DGP) as in the following equation

$$\widehat{\varepsilon_t} = \Delta y_t - \tilde{\alpha} - \tilde{\beta} t - \tilde{\gamma} y_{t-1} - \sum_{J=1}^{p} \widetilde{\beta_J} \Delta y_{t-J} \qquad t = p, \cdots, n \tag{6-2}$$

The exact bootstrap procedure can be described as follows.

Step 1: Fit an ADF model as Equation (6-1), and calculate the residual $\widehat{\varepsilon_t}$ from Equation (6-2) for $t = p, p+1, \cdots, n$, where n is the number of observation of time series y_t.

Step 2: Generate an $i.i.d$ sample ${\varepsilon_t}^*$ by drawing randomly with replacement from

$$\widehat{\varepsilon_t} - (n-p)^{-1} \sum_{t=1+p}^{n} \widehat{\varepsilon_t} \tag{6-3}$$

Step 3: Construct bootstrap errors by the recursion $u_t^* = \sum_{j=1}^{p} \beta_j \Delta y_{t-j}^* + {\varepsilon_t}^*$, and generate the bootstrap sample y_t^* according to the model specification: 1) $y_t^* = \tilde{\alpha} + u_t^*$

for the model with an intercept only, 2) $y_t^* = \tilde{\beta} t + u_t^*$ for the model with a deterministic component only, as well as 3) $y_t^* = \tilde{\alpha} + \tilde{\beta} t + u_t^*$ in case of a constant and a linear trend.

Step 4: Calculate the ADF coefficient statistic $(1 - \sum_{J=1}^{p} \widetilde{\beta_J})^{-1} n \, \tilde{\gamma}^*$ and the corresponding $t-$ statistic from the ADF regression

$$\Delta y_t^* = \tilde{\alpha}^* + \tilde{\beta}^* t + + \tilde{\gamma}^* y_{t-1}^* + \sum_{J=1}^{p} \widetilde{\beta_J}^* \Delta y_{t-\mathrm{J}}^* + \varepsilon_t^* \quad (6\text{-}4)$$

Step 5: Repeat Steps 2-4 for *M* times to find the bootstrap distributions where *M* denotes the number of bootstrap replications.

Under a series of assumptions given by Chang and Park (2003), the bootstrap distribution has been proved to converge to the same limit distribution as the asymptotic test statistics[118] (Palm, Smeekes, & Urbain, 2008).

6.2.2 The MWALD causality analysis and bootstrapping

Granger causality is a well known concept for testing the causal relationship between variables of interest. In a regression context, Granger causality is determined by running a regression of one variable on the past values of itself and that of any potential causal variable, and by testing the significance of estimated coefficient of the potential causal variable. However, the standard asymptotic distribution theory cannot be applied to test for Granger causality if the variables are non-stationary. To remedy this problem, Toda and Yamamoto (1995) introduce a modified WALD (MWALD) approach for testing Granger causality among possibly integrated variables. The MWALD test statistic has a asymptotically chi-square distribution irrespective of the order of integration or cointegration properties of the variables in the model (Hacker & Hatemi-J, 2006). This approach is applicable whether the variables in a VAR are stationary, integrated or cointegrated of an arbitrary order. Hence, this method has become one of the most widely applied tests for causality between possibly integrated

[118] For more details about assumptions and proof, please refer to the paper of Chang and Park (2003).

process if one's primary interest is testing the Granger-causality rather than the presence of unit roots or cointegration relationship.

6.2.2.1 The MWALD test for Granger causality analysis

Suppose that two time series variables x_t and y_t are stationary in levels $\big(I(0)\big)$or in first differences [119] $(I(1))$, Granger causality can be expressed in a vector autoregression process of order p (namely, $VAR(p)$ process) as follows (Lütkepohl & Riemers, 1992):

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \sum_{i=1}^{p} \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,i} & \alpha_{22,i} \end{bmatrix} \begin{bmatrix} x_{t-i} \\ y_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{6-5}$$

where y_t and x_t are n-dimensional vectors, and $\varepsilon_t = [\varepsilon_{1t}, \varepsilon_{2t}]'$ is a bivariate white noise process with mean zero and non-singular covariance matrix Σ_ε. In this process, x_t is not Granger-causal for y_t if and only if

$$\alpha_{21,i} = 0 \quad for\ i = 1,2, \dots, p \tag{6-6}$$

Conversely, y_t is not Granger-causal for x_t if and only if $\alpha_{12,i} = 0$ for $i = 1,2, \dots, p$. Let $\alpha = vec\big[A_1, \dots, A_p\big]$ be the vector of all VAR coefficients, where

$$A_i = \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,i} & \alpha_{22,i} \end{bmatrix}, \quad i = 1,\ 2, \dots,\ p.$$

Non-causality restrictions can be formulated as $R\alpha = 0$ with a suitable restriction matrix R, which has full row rank. Normally $R = S_1' \otimes S'$, where $S_1 = (1,0)'$, $S = I_p \otimes (0,1)'$, I_p is a p order identity matrix, and $\otimes$ is the Kronecker product. Thus testing for Granger-causality means testing

$$H_0: R\alpha = 0\ \ against\ \ H_1: R\alpha \neq 0 \tag{6-7}$$

Assume that there exists an asymptotically normally distributed estimator $\hat{\alpha}$ of α, that is, $\sqrt{T}(\hat{\alpha} - \alpha) \xrightarrow{d} N(0, \Sigma_{\hat{\alpha}})$, and therefore, $\sqrt{T}(R\hat{\alpha} - R\alpha) \xrightarrow{d} N(0, \Sigma_{\hat{\alpha}} R')$, where T is the sample size, $\xrightarrow{d}$ represents convergence in distribution and $\Sigma_{\hat{\alpha}}$ is the covariance

[119] That is to say, $\Delta x_t = x_t - x_{t-1}$ and $\Delta y_t = y_t - y_{t-1}$ are stationary.

matrix of the asymptotic distribution. Thus, the standard Wald statistic for testing H_0 is

$$\lambda_w = T\hat{\alpha}'R'(R\widehat{\Sigma_{\hat{\alpha}}}R')^{-1}R\hat{\alpha} \quad (6\text{-}8)$$

where $\widehat{\Sigma_{\hat{\alpha}}}$ is a consistent estimator of $\Sigma_{\hat{\alpha}}$. As pointed out by Sims, Stock and Watson (1990), and Toda and Phillips (1993), in general the Wald statistics has a nonstandard asymptotic distribution for cointegrated systems if α is estimated by the unrestricted multivariate least squares or the Johansen's maximum likelihood procedure. Furthermore, although the VAR coefficients may be estimated in first differences and λ_w has an asymptotic $\chi^2(p-1)$ distribution for testing Granger-causality if $r = 0$, the Wald statistics cannot be applied if variables are not integrated of the same order or not cointegrated (Kim & Kim, 2006). In addition, there may be severe pre-test biases, especially for finite samples, as a prior knowledge is required about the integration and cointegration properties of the time series.

To overcome these drawbacks, Toda and Yamamoto (1995) propose a different approach, namely the modified WALD test, for Granger-causality analysis. The modified WALD test is performed by the following augmented $VAR(p+d)$ model if the variables are integrated (Hatemi-J & Roca, 2007).

$$y_t = \hat{v} + \sum_{r=1}^{p+d} \widehat{A_r} y_{t-r} + \widehat{\varepsilon_t} \quad (6\text{-}9)$$

where the circumflex above a variable represents its estimated value, d is the integration order of the variable, and p is the optimal lag length of the VAR model. Hence, the null hypothesis of non-Granger causality is defined as the following:

H_0: the row j, column j element in A_r equals zero for $r = 1, \cdots, p$ (6-10)

It is worth noting that the parameters for the extra lag(s), i.e. d, are unrestricted in testing for Granger causality. As pointed out by Toda and Yamamoto (1995), these unrestricted parameters ensure that the standard asymptotic theory is applicable for a

possibly integrated or cointegrated VAR process, as far as the order of integration of the process does not exceed the true lag length.

Supposing initial values are given, the estimated $VAR(p+d)$ model can be rewritten compactly as (Hatemi-J & Roca, 2007):

$$Y = \widehat{D}Z + \hat{\delta} \tag{6-11}$$

where $Y \coloneqq (y_1, \cdots, y_T)\ (n \times T)$ matrix, $\widehat{D} = \left(\hat{v}, \hat{A}_1, \cdots, \hat{A}_p, \cdots, \hat{A}_{p+d}\right)(n \times (1 + n(p+d)))$ matrix, $Z \coloneqq (Z_0, \cdots, Z_{T-1})\ ((1 + n(p+d)) \times T)$ matrix, $Z_t \coloneqq \left[1, y_t, y_{t-1}, \cdots, y_{t-p-d+1}\right]'\ ((1 + n(p+d)) \times 1)$ matrix, for $t = 1, \cdots, T$, and $\hat{\delta} \coloneqq (\hat{\varepsilon}_1, \cdots, \hat{\varepsilon}_T)\ (n \times T)$ matrix.

The modified Wald (MWALD) test statistic for testing the null hypothesis of non-Granger causality is specified as

$$MWALD = (C\hat{\beta})' \left[C\left(\left(Z'Z\right)^{-1} \otimes S_u\right)C'\right]^{-1} (C\hat{\beta}) \sim \chi_{\mathrm{p}} \tag{6-12}$$

where $\otimes$ is the Kronecker product, C is a $p \times n(1 + n(p+d))$ selector matrix, S_u is the estimated variance-covariance matrix of residuals in Equation (6-12) when the restrictions implied by the null hypothesis of non-Granger causality is not imposed (i.e., the unrestricted model), $\hat{\beta} = vec(\widehat{D})$ and vec represents the column-stacking operator. In the selector matrix C, each of the p rows is associated with the restriction to zero of one parameter in β. The elements in each row are assigned the value of one if the related parameter in β is zero under the null hypothesis, otherwise the elements acquire the value of zero.

Using the compact notation, the null hypothesis of non-Granger causality is given by

$$H_0: C\beta = 0 \tag{6-13}$$

The MWALD test statistic is asymptotically χ^2 distributed with p degrees of freedom, which is the number of restrictions to be tested. Meanwhile, the MWALD test is computationally simpler than the traditional F-test for Granger-causality. The

procedure of MWALD test mainly involves three steps: 1) determine the maximum order of integration d_{max} and the lag length k of the VAR model; 2) estimate the $(k + d_{max})^{th}$ -order VAR model; as well as 3) test restrictions on the first k coefficient matrices by the standard asymptotic theory while ignoring the last d_{max} lagged vectors of that in the model.

It is worth noting that, in Step 1 the maximum order of integration d_{max} is usually determined by the standard unit root tests, among which are the Augmented Dickey-Fuller test, the Philips and Perron (PP) test, as well as Kwaitkowsi (KPSS) test. Meanwhile, the optimal lag length k is usually selected by the Akaike's Information Criterion (AIC), the Schwarz's Bayesian Criterion (SBC), as well as the Likelihood ration (LR) test. More recently, the modified Akaike's Information Criteria (MAIC) is developed by Qu (2007) from the analysis of Ng and Perron (2001). As pointed out by Qu (2007), the MAIC leads to VAR approximations with drastically improved size properties with little loss of power. This study is going to employ the well known ADF unit root test with MAIC to determine the maximum order of integration of variables.

6.2.2.2 The leveraged bootstrap simulation on the MWALD test

As pointed out by Hacker and Hatemi-J (2005), the MWALD test statistic over-rejects the null hypothesis, especially if there are non-normality and ARCH effect in the error terms. In order to improve the inference properties of tests for causality under such circumstances, they suggest using the leveraged bootstrap simulation. The bootstrap method estimates the distribution of a test statistic via re-sampling the underlying data, and decreases bias in inference by offering more precise critical values of the distribution.

This bootstrap method mainly involves three steps. The first step is to estimate Equation (6-11) with the restriction for the null hypothesis of non-Granger causality

imposed, and generate the simulated data, Y^*, from the estimated coefficient of the following regression.

$$Y^* = \widehat{D}Z + \delta^* \tag{6-14}$$

where $\widehat{D}$ is the estimated coefficient matrix of restricted model, which equals $YZ'(ZZ')^{-1}$, Z is the original data matrix, and δ^* is the bootstrapped residuals. The bootstrap residuals are randomly drawn with replacement from the regression's modified residuals with equal probability. The modified residuals are obtained from the regression's raw residuals to have constant variance, via the use of *leverages*[120]. Meanwhile, the bootstrap residuals are centred by subtracting the mean value from each of the modified residuals. This adjustment is to make sure that the mean of the bootstrapped residuals is zero.

The second step is to generate the empirical distribution for the MWALD test statistic by running the bootstrap simulation M times. The MWALD test statistics is calculated each time. In this way, it is able to find the $(\alpha)th$ upper quantile of the distribution of bootstrapped MWALD statistics, and to obtain the bootstrap critical values C_α^* for the α level significance level.

The final step is to calculate the MWALD statistic using the original data. The null hypothesis of non-Granger causality is rejected if the actual MWALD is bigger than C_α^*.

The leveraged bootstrap simulation calculates the actual critical values based on the empirical distribution of the data set, which is not required necessarily to be normally distributed (Hatemi-J & Irandoust, 2006). This approach is very useful if the asymptotic critical values are invalid for causality analysis.

[120] For more details about leverage adjustment, please refer to Davison and Hinkley (1999) and Hacker and Hatemi-J (2005).

6.2.3 The residual-based cointegration analysis and bootstrapping

It is well known that regression involving non-stationary variables may result in spurious results. As pointed out by Engle and Granger (1987), however, the regression of non-stationary variables is not problematic if these variables are cointegrated. If two time series have the same order of integration, and if there is a linear combination of these series, which produces a stationary residual, these series are referred to as being cointegrated. Cointegration has two important implications for empirical analysis: 1) if two variables are $I(1)$ and cointegrated, there must be a Granger causality in at least one direction, because at least one variable is helpful for forecasting the other (Granger C. W., 1986; 1988); and 2) in the presence of cointegration, the VAR estimation in first difference will be misleading, as it omits the error correction term (Engle & Granger, 1987).

Several approaches have been proposed for testing cointegration, such as Johansen's (1990) trace and maximum eigenvalue tests, Engle-Granger's (1987) two-step procedure, Stock and Watson's (1993) principal component test, as well as Philips and Ouliaris' (1990) test. However, these approaches are large sample test, and are valid only if the asymptotic statistical properties of the test statistics are known (Pynnonen & Vataja, 2002). As found by Haug (1996), the most popular tests have relatively low powers in small samples. In order to remedy this problem, bootstrap approach has been applied in testing cointegration in small samples. Bootstrapping provides estimates for p values directly, which are much more informative than the fixed threshold critical values.

As the main purpose of this study is to examine the relationship between market integration and market interdependence, this chapter is going to adopt the residual-based cointegration test, which is proposed by Engle and Granger (1987). Meanwhile, this chapter will also employ a bootstrap test for bivariate cointegration, due to the small sample size of this study.

6.2.3.1 The Engle-Granger two-step approach for testing cointegration

Originally, a two-step procedure is proposed by Engle and Granger (1987) to test cointegration between two time series. In Step 1, the dependent variable y_t is regressed on the explanatory variable x_t in the following equation[121].

$$y_t = \alpha + \beta x_t + \varepsilon_t \tag{6-15}$$

In Step 2, the resulting error series ε_t from the first step is tested for stationarity. If the null hypothesis of a unit root in the error series ε_t is rejected, there is a cointegration relationship between the explained and explanatory variables. Meanwhile, if a cointegration relationship exists between two time series, there must be a mechanism taking the system back to the long-run equilibrium in the face of an innovation. Consequently, as shown by the representation theorem (Granger & Weiss, 1983), cointegration is equivalent to the existence of an error correction model.

6.2.3.2 Bootstrap testing for bivariate cointegration

As for bootstrapping cointegration tests, special attention should be paid into the structure of data generating process (DGP), because the true DGP is not known in practice. Especially, there is no model-based relationship between the residual series and independent variable series when no cointegration is present (Pynnonen & Vataja, 2002). Under the null hypothesis of no cointegration, Equation (6-15) might be spurious because there may be no well-defined contemporaneous dependence structure between x_t and ε_t (Pynnonen & Vataja, 2002). In order to avoid this problem, Pynnonen and Vataja (2002) propose the following bootstrap design.

Step 1: Estimate the regression, i.e., Equation (6-15), and get the residual series ε_t of this equation, then use the no trend version of ADF on this residual series.

Step 2: Generate bootstrap samples of the OLS residual ε_t, which is denoted as $\tilde{\varepsilon}_t$. The bootstrapped residual $\tilde{\varepsilon}_t$ is generated under the hypothesis that it is integrated.

[121] In Equation (6-15), α is an intercept term.

This data generating process leads to the desired hypothesis that y_t and x_t are not integrated.

Step 3: Generate $\tilde{y}_t$ by $\tilde{y}_t = \hat{\alpha} + \hat{\beta}x_t + \tilde{\varepsilon}_t$, where $\hat{\alpha}$ and $\hat{\beta}$ are the estimated coefficients of Equation (6-15) on the original data. Next re-estimate α_b and β_b from the bootstrap sample, and extract the residual series $\varepsilon_{b,t}$, then compute the bootstrap t value, denoted as t_b, by the ADF test.

Step 4: Compute the bootstrap p_b value for the null hypothesis of no-cointegration as the fraction the ADF bootstrap t_b value exceeds (on the negative side) the original t value of the residuals of the cointegration regression by the ADF test.

$$p_b = \frac{1}{M}\sum_{j=1}^{M} I\left(t_{b,j} < t_{obs}\right) \tag{6-16}$$

where M is the number of bootstrap samples, $t_{b,j}$ is the ADF bootstrapped t value from the jth bootstrap sample, t_{obs} is the ADF t statistic from the original sample, and $I(\cdot)$ is the indicator function that takes the value 1 if the condition is true, and zero otherwise.

The bootstrap p_b values are regarded as being asymptotically equivalent to the asymptotic ones if the distributional assumptions behind the large sample approximation are valid (Pynnonen & Vataja, 2002).

6.3. Data description

For empirical analyses, this section utilises the average values of normalised degrees of market segmentation and market interdependence between China and the world stock market from Chapters 4 and 5 respectively, which are both examined by an observation interval of 6 months. In order to provide a pair-wise comparison between two time series of market integration and market interdependence, this section discards the initial period from January 3, 2000 to June 30, 2000, due to the

unavailability of market interdependence degree in this period[122]. Thus, the full sample period covers from the second half year of 2000 to the end of 2010, and provides 21 observations for each time series correspondingly[123]. The data series are displayed in Table 6.1 and Figure 6.1. For ease of expression, hereafter, this chapter denotes the *Seg* as the market segmentation between China and the world stock markets while the *Inter* as the market interdependence between them. For the exact values of *Seg* and *Inter*, please refer to Tables IV and VII in the Appendices.

Table 6. 1 Descriptive Statistics for *Seg* and *Inter*

Variables	Mean	Minimum	Maximum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Observations
Seg	0.3763	0.147	0.66	0.13396	0.043566	2.3333	0.385578	21
Inter	0.8189	0.452	1.209	0.20931	-0.131036	2.2386	0.567342	21

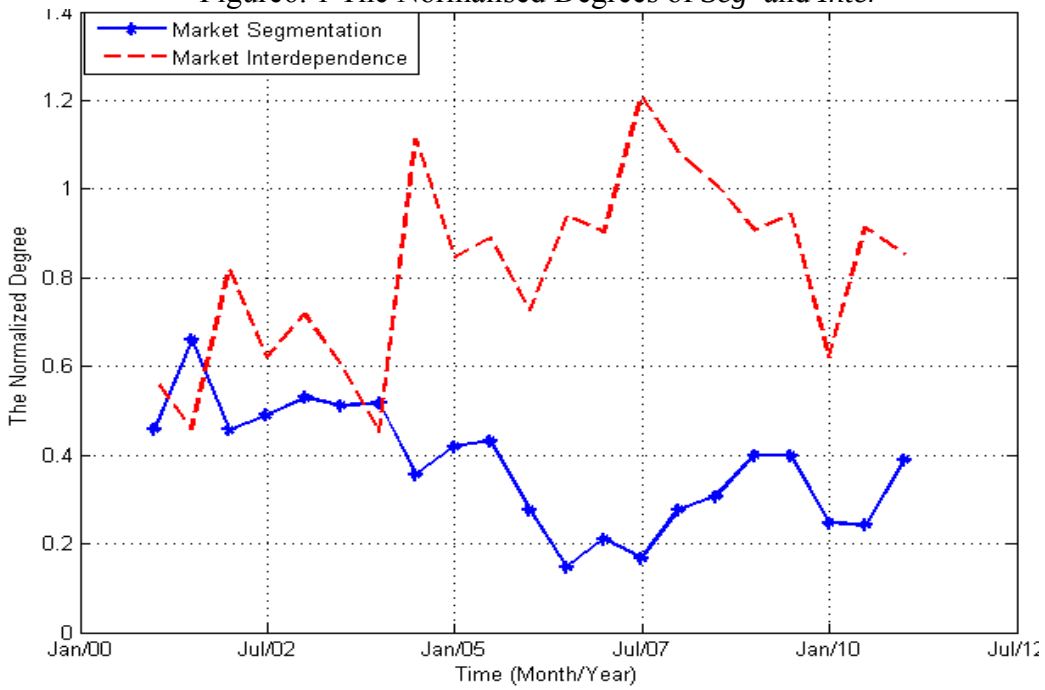
As can be seen from Table 6.1, the Jarque-Bera test indicates that none of *Seg* and *Inter* follows a normal distribution[124]. The null hypothesis of normal distribution cannot be rejected at 5% significance level. In order to provide a general view on the interrelation of market integration and market interdependence, they are depicted in Figure 6.1.

[122] For each period the degree of market interdependence is estimated from the adjusted R-squared of rolling regression model, which includes a set of out-of-sample main components of the prior period as explanatory variables. The degree of market interdependence is, therefore, unavailable for the initial period from January 3, 2000 to June 30, 2000.

[123] By an observation interval of 6 months, there are 22 and 21 observations in the original time series of normalised degree of market integration and market interdependence respectively.

[124] P-values of Jarque-Bera statistic are 0.8205 and 0.7530 for *Seg* and *Inter* respectively.

Figure6. 1 The Normalised Degrees of *Seg* and *Inter*



Notes: For the period from January 2000 to December 2010, the degrees of market segmentation and market interdependence between China and the world stock market are the average values of normalised degrees obtained from Chapters 5 and 6 respectively, wherein the length of observation interval *T* is adopted to be 6 months. All statistics are plotted against the end of each time interval.

There are several noteworthy features that can be seen in Figure 6.1. Firstly, market interdependence (*Inter*) is more volatile than market segmentation (*Seg*). This is probably attributed to the difference between market integration (inversely, segmentation) and market interdependence in their determinants. Compared to market integration, market interdependence might be broadly influenced by many factors other than financial liberalisation, such as investors' overreaction, the linkage of economic fundamentals as well as the synchronization of monetary policy across countries. Secondly, market segmentation and market interdependence move opposite to each other in the long term. Theoretically market interdependence can be increased by market integration (inversely, segmentation) since the removal of trade obstacles is helpful for market comovement and volatility spillover across markets. Lastly, the gap between market interdependence and market segmentation has widened after the second half year of 2003. This may be attributed to the initial trading of QFII in the A-share market on July 9, 2003. As aforementioned, this issue has initiated the process of *de facto* liberalisation of China's stock market, since this process has decreased

market segmentation to a large extent. After the second half year of 2003, there has been a significant increase of market interdependence, along with an evident decline of market segmentation. As a result, there has been a wide gap between market segmentation and market interdependence.

6.4 Empirical analysis

In order to provide more empirical evidence, this section is going to analyse the relationship between market integration and market interdependence by a series of empirical tests. Firstly, this chapter examines the stationarity properties of time series of market integration (and market interdependence) degrees by the ADF test, and performs the residual-based ADF sieve bootstrap test to provide bootstrapped critical values. Secondly, this chapter performs the causality analysis between market integration and market interdependence by the MWALD approach, and carries out the leveraged bootstrap simulation on the MWALD test. Thirdly, this chapter performs cointegration analysis on the relationship between market integration and market interdependence by the Engle-Granger two-step approach, and performs the bootstrap test for bivariate cointegration. Finally, this chapter employs an event-specific analysis to compare the influences of China's financial liberalisation events on market segmentation and market interdependence correspondingly. As for software for empirical tests, the bootstrap tests are performed using GAUSS 10, while others are with Eviews 5.1.

6.4.1 Unit root tests results

A necessary condition for Granger causality and cointegration tests is that variables are either stationary or integrated at the same order. For example, these variables are both $I(1)$, i.e., stationary in first difference. To test for stationarity, this chapter performs the well-known ADF unit root test and the residual-based ADF sieve bootstrap test jointly. On the one hand, as shown by the t statistics and p values of the ADF unit root test, both the time series of market segmentation and market

interdependence are $I(1)$ at the significance level of 5%. On the other hand, the residual-based ADF sieve bootstrap test shows that the time series of market segmentation and market interdependence are $I(1)$ at the significance level of 10 % and 5% respectively. That is to say, the conventional ADF unit root test by the asymptotic distribution theory might over-reject the null hypothesis. Nevertheless, both the ADF unit root test and bootstrap test show that it is necessary to account for the non-stationarity of time series in the following analyses. The results of ADF unit root test and bootstrap test are reported in Table 6.2.

Table 6. 2 ADF Unit Root and Bootstrap Tests for *Seg* and *Inter*

Variables		*t*-statistics	*p*-values	Bootstrapped critical values (10%, 5%, 1%)		
Seg	Level	-1.910902	0.3209	-4.2226	-5.3111	-7.7546
	First difference	-5.624028***	0.0002	-5.0940	-6.5973	-9.4437
Inter	Level	-2.348391	0.1683	-6.1327	-7.8080	-10.7417
	First difference	-7.871670***	0.0001	-4.4803	-6.0053	-8.8911

Notes: The ADF regressions are specified to have an intercept but not a deterministic trend. The number of lags is selected by the modified Akaike Information Criteria. The *t*-statistics and *p*-values are obtained from Mackinnon (1991), according to the asymptotic distribution theory. *** denote rejection of the null hypothesis of a unit root at the 1% significance level. The bootstrapped critical values are obtained by the residual-based ADF sieve bootstrap test, in which the number of bootstrap replications is set to be 1000.

6.4.2 Causality analysis results

In order to apply the MWALD test and to obtain the valid test statistics, it is necessary to pre-specify the maximal order of integration d_{max} for time series in the system and the optimal lag k for the VAR model. As shown by the result of ADF unit root test aforementioned, both time series are integrated of order one. That is to say, the maximal order of integration d_{max} is 1. To determine the optimal lag k, the conventional Akaike Information Criteria is applied in the VAR system[125]. In the two-equation VAR system, *Seg* and *Inter* are used as the endogenous variables, while the exogenous variables are their lagged terms, as well as a constant term. The optimal lag k is found to be 2 as it has the minimum AIC value. The result of optimal lag selection is reported in Table 6.3.

[125] Although the modified Akaike Information Criteria is more preferable in determining the optimal lag length, this test has to employ the conventional Akaike Information Criteria as the former is not provided by the software Eviews 5.1 for Granger-causality test.

Table 6. 3 Test for the Selection of Optimal Lag

Dependent Variables	1	2	3	4	5
Seg	-1.541496	-1.763472	-1.663466	-1.538683	-1.224077
Inter	-0.430240	-0.669990	-0.459464	-0.177041	0.027661

Notes: For each single equation with arbitrary lagged terms, the AIC value is reported in this table. The maximum of lagged terms in VAR system is specified to be 5.

As d_{max} is determined to be 1 and k to be 2, a VAR with 3 lags is estimated to test Granger causality between *Seg* and *Inter*. The MWALD test is then applied to examine whether the coefficients of the first 2 lagged variables are jointly equal to zero. Meanwhile, the leveraged bootstrap simulation is carried out on the MWALD test to obtain the bootstrapped p values. The bootstrap simulation is conducted using a programme procedure provided by Hacker and Hatemi-J (2006). The results of the MWALD and bootstrap tests are reported in Table 6.4.

Table 6. 4 The MWALD and the Leveraged Bootstrap Tests for Granger Causality

Null hypothesis	d_{max}	k	Chi-square	*df*	*p*-values	Bootstrap critical values		
						10%	5%	1%
Seg does not Granger cause *Inter*	1	2	7.3165**	2	0.0258	5.951	8.050	15.110
Inter does not Granger cause *Seg*	1	2	2.4877	2	0.2883	5.404	7.550	13.880

Notes: In this table d_{max} denotes the maximal order of integration; k denotes the optimal lag; *df* denotes the degree of freedom for Chi-square test; ** denote significance at the 5% level.

As might be seen from Table 6.4, a unidirectional causality running from market segmentation *Seg* to market interdependence *Inter*, but not the other way around, has been found by the MWALD test at the significance level of 5%, and by the leveraged bootstrap test at the significance level of 10%. The MWALD test is more likely to reject the null hypothesis of non-Granger causality when using the asymptotic distribution theory than using the bootstrapped critical values. Although there is a slight difference between statistical significances, both the MWALD test and the leveraged bootstrap test find that there is a unidirectional causal relationship from market segmentation to market interdependence. That is to say, the decrease of market segmentation can help increase market interdependence, but not vice versa.

From an alternative perspective, this finding confirms that market integration and market interdependence are different but highly connected issues. On the one hand, there should be a bidirectional causal relationship between them if they are the same issue. On the other hand, there should not be any causality running from one to the other if they are unrelated. In order to examine whether there is a long-term equilibrium relationship between market integration and market segmentation, the following subsection is going to perform the cointegration analysis.

6.4.3 Cointegration analysis results

For cointegration analysis, this study adopts the two-step approach of Engle and Granger (1987) and the bivariate cointegration bootstrap test. The results are reported as follows.

With market interdependence *Inter* as dependent variable, the cointegration regression gives[126]:

$$Inter_t = 1.214 - 1.052Seg_t + \varepsilon_t \qquad (6\text{-}17)$$

$$(11.5062^{***}) \quad (-3.9695^{***})$$

$$Adjusted\ R^2 = 0.4245 \qquad D.W. = 1.917$$

By the modified Akaike Information Criteria the ADF unit root test shows that the residual series is stationary in level, i.e., $I(0)$. The results of ADF test on the residual from Equation (6-17) are reported in Table 6.5. Meanwhile, the result of bivariate cointegration bootstrap test is also reported in Table 6.5.

Table 6. 5 The ADF Unit Root and the Bivariate Cointegration Bootstrap tests

ADF unit root test			Bootstrap test
Residual	*t*-statistic	*p*-value	p_b-value
Level	-4.296171***	0.0035	0.0170

Notes: As for the ADF unit root test, the number of lags is selected by the modified Akaike Information Criteria. The p-value is reported for the *t*-statistic test correspondingly. *** denote rejection of the null hypothesis of a unit root at the 1% significance level. The p_b-value is for the bivariate cointegration bootstrap test, in which the bootstrap replication is set to be 1000.

[126] In Equation (6-17), values in parenthesis are *t* statistics; *** denotes significance at the 1% level; D.W. is the Durbin-Watson statistics; ε_t is the residual at time t.

As may be seen from Table 6.5, there is a long-term cointegration relationship between market segmentation and market interdependence. The null hypothesis of non-cointegration is rejected by the ADF unit root test at the significance level of 1%, and by the bivariate cointegration bootstrap test at the significance level of 5%. Compared with the bootstrap test, the ADF unit root test is inclined to over-reject the null hypothesis in small sample size, though these two tests reach similar conclusions.

As shown by Equation (6-17), the degree of market interdependence is in inverse ratio to that of market segmentation. For every unit decrease in market segmentation, market interdependence increases 1.052. In other words, the decline of market segmentation is related to an increase of market interdependence. For example, the removal of trade obstacles between markets contributes to volatility spillover and market comovement across borders. Meanwhile, the adjusted R^2 in Equation (6-17) shows that only 42.45% of variance is explained by this model. That is to say, market interdependence is partially determined by the degree of market segmentation. Apart from market segmentation, there are other factors influencing market interdependence. These findings support the hypothesis of this study that market integration (segmentation) and market interdependence are highly connected but different issues. Market integration (segmentation) is an important, but not the only, determinant of market interdependence.

6.4.5 Financial events analysis

In order to provide more details on the relationship between market integration and market interdependence, this subsection is going to examine this issue by an event-specific analysis. The influences of financial event are measured by the ratio of change in market segmentation degree and that in market interdependence degree respectively. For period t the ratios of changes of degrees Δk_t are computed as follows:

$$\Delta k_t = \frac{k_{t+1}-k_{t-1}}{k_{t-1}} \times 100\% \quad k = Seg, Inter, \quad t = 2, \cdots, l-1 \tag{6-18}$$

where l is the length of the time series of observations[127]. In so doing, the current period t is regarded as the event period, and thus $t-1$ indicates the period prior to the event while $t+1$ is for the post-event period. This influence of financial event is reflected by the difference in degrees between the pre- and post-event periods. The influence of financial events on market segmentation and market interdependence are reported in Table 6.6.

Table 6. 6 The Influences of Financial Events on Seg and $Inter$

No.	Financial events	Time	$\Delta Seg(\%)$	$\Delta Inter(\%)$
1	Allowing domestic individual investors to purchase B shares	2001/02/21	-0.72	43.36
2	China's accession to the WTO	2001/12/11	6.52	8.56
3	Issuing notice on the transfer of state-owned shares and cooperation shares of the listed company to foreign investors	2002/11/04	4.76	-2.90
4	Initial trading of the QFII programme in the A-share market	2003/07/09	-30.52	84.58
5	The first round of China's exchange rate reform	2005/07/21	-66.15	5.62
6	Allowing foreign strategic investors to purchase A shares	2006/01/31	-24.10	24.24
7	Authorizing the QDII programme	2006/04/13		
8	The outbreak of credit crunch in the USA	July, 2007	31.75	19.84
9	The announcement of China's economic stimulus plan	2008/11/05	30.43	-6.53
10	The rise of QFII quota limit	2009/10/10	-39.17	-3.18
11	The second round of China's exchange rate reform	2010/06/19	58.11	37.96

Notes: In this table, ΔSeg and $\Delta Inter$ indicate the percentages of change in Seg and $Inter$ between the pre- and post-event periods respectively. For the event of China's accession to the WTO, the period prior to this event is selected to the second half year of 2000, as there have been anomalies in Seg and $Inter$ due to allowing the domestic individual investors to purchase B shares in the first half year of 2001.

There are several main features that might be seen in Table 6.6. Firstly, in most cases the percentages of change in the degrees of market segmentation and market interdependence are opposite to each other, except for the event of China's accession to the WTO, the announcement of China's economic stimulus plan and the second round of China's exchange rate reform. That is to say, in most cases financial liberalisation events can reduce market segmentation and therefore enhance market interdependence, if they are *de facto* effective. This finding is consistent with the

[127] In this chapter l is specified to be 21, as there are 21 observations in each time series.

previous conclusion that there has been a negative correlation between market segmentation and market interdependence in the long term.

Secondly, since July 9, 2003 the QFII programme has embarked on the process of *de facto* finanical liberalisation, which includes the first round of China's exchange rate reform, allowing foreign strategic investors to purchase A shares, as well the QDII programme. This process has decreased market segmentation between China and the world stock markets greatly and increased market interdependence between them notably. On the contrary, since there have been tiny changes in market segmentation degree, financial liberalisation events in the pre-QFII period might be regarded as ineffective, among which are the opening B shares to domestic investors, China's accession to the WTO as well as the transfer of state-owned shares and cooperation shares of the listed company to foreign investors. Although the event of opening the B-share markets to domestic investors might be *de facto* ineffective, it has resulted in a significant increase of market interdependence due to investors' overreaction in China's stock market.

Thirdly, the outbreak of credit crunch in the US in July 2007 has interrupted China's financial liberalisation, and has significantly increased both market segmentation and market interdependence. Following this event, two other financial events have increased market segmentation, which are the announcement of China's economic stimulus plan in 2008 and the second round of China's exchange rate reform in 2010. Influenced by China's economic stimulus plan, China's stock market has been largely driven by domestic factors rather than international ones, resulting in an increases of market segmentation and a decline of market interdependence. Similarly, the second round of China's exchange rate reform has increased the volatility of RMB exchange rate significantly. This reform has added considerable risk to cross-market transactions, and therefore increased market segmentation.

Lastly, investors' overreaction has been observed in two cases: 1) the opening of the B-share markets to domestic individual investors and 2) the initial trading of the QFII programme in the A-share market. As for the event of opening the B-share markets to domestic individual investors, there has been an increase of market interdependence by 43.23%, corresponding to a decline of 0.72% in market segmentation. Similarly the event of initial trading of QFII programme has witnessed an increase of market interdependence by 84.58% relative to a drop of 30.52% in market segmentation. For these two events, the relative changes of market interdependence to market segmentation are much higher than their counterpart in the long term relationship.

To a large extent, these findings from the event-specific analysis are consistent with those found in Chapters 4 and 5. Generaly, financial liberalisation events are inclined to decrease market segmentation, and therefore, to increase market interdependence if they are *de facto* effective. However, in some cases market interdependence might over-react to *de jure* financial liberalisation event, even though this event does not reduce market segmentation.

6.5 Conclusions

This chapter mainly examines the relationship between market integration and market segmentation by a series of tests, namely, the ADF unit root test, the MWALD causality test, and the Engle-Granger two-step approach for co-integration test. Meanwhile, this chapter performs bootstrapping on these tests correspondingly, due to the small sample size of this study. The bootstrap tests include the residual-based ADF sieve bootstrap test, the leveraged bootstrap simulation on the MWALD test, as well as the bivariate cointegration bootstrap test. Against the bootstrapped critical values, the conventional statistics are more likely to over-reject the null hypothesis when using asymptotic distribution theory, though similar findings have been found in this study.

The ADF unit root and bootstrap tests show that both time series of degrees of market integration and market interdependence are stationary in first difference. Since both two time series are non-stationary, the MWALD test is applied to test causality relationship between them. A unidirectional causal relationship has been found from market segmentation (inversely, market integration) to market interdependence. In addition, this chapter finds that market integration and market interdependence are cointegrated in the long term by the Engle-Granger two-step approach. The causality and cointegration relationship between market integration and market interdependence are generally supported by bootstrap tests. In the end, using the event-specific analysis this chapter finds that financial liberalisation events are likely to reduce market segmentation and increase market interdependence if these events are *de facto* effective. In some cases market interdependence might increase greatly even without a significant decline in market segmentation. From the perspective of China's stock market, this chapter provides supportive evidence for the hypothesis that market integration and market interdependence are highly connected but different issues. Market integration is one, but not the only, determinant of market interdependence.

CHAPTER 7: CONCLUSIONS

This chapter is devoted to a summary of this thesis, and to suggest possible directions for further work. Firstly, this chapter reviews briefly the entire study presented in this thesis, and summarises the main findings of provides supportive evidence for the hypothesis. Secondly, the implications of these findings and policy proposals are presented in this chapter. Thirdly, this chapter discusses the limitations of this study. Lastly, recommendations for further study are addressed in the end of this chapter.

7.1 Summary of the main findings

In three quantitative studies, this thesis has carefully examined three important issues related to China's financial liberalisation on stock market in the post-WTO accession period. More specifically, this chapter has gauged the degrees of market integration and market interdependence between China and the world stock markets respectively, and then has examined the relationship between market integration and market interdependence.

In the first empirical study (Chapter 4), this thesis has examined whether and to what degree China's financial liberalisation has decreased the market segmentation between China and the world stock markets after China's accession to the WTO in 2001. The non-normalised degree of stock market segmentation between China and the world has been gauged directly by the weak-form measure. As non-normalised degree of market segmentation is usually time-varying, the non-normalised degree of stock market segmentation between the US and the world has also been gauged to provide a benchmark for evaluating the normalised degree of stock market segmentation between China and the world. For these purposes, the dataset has been constructed from daily sector indices of equity market in level 3, which are defined by the Datastream database. In this dataset, sector indices have been selected for China, the US and the world stock markets, covering the period from January 3, 2000 to May 31, 2011.

Regarding the empirical study, firstly, this chapter has checked the performance of the stopping criteria of iterative process, and that of the random sampling procedure respectively. After extensive comparisons, this chapter has specified the maximum of iterations to 10,000 and the stopping criteria to be that an iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when iterations reaches 2000. Secondly, this chapter has gauged both the non-normalised and normalised degrees of market segmentation between China and the world stock markets in the post-WTO accession period. Lastly, this chapter has analysed and explained the impacts of China's financial liberalisation events on stock market segmentation.

Using the normalised degree of market segmentation, the thesis provides supportive evidence that China's financial liberalisation might have decreased international segmentation between China and the world stock markets. Most, but not all, of China's financial liberalisation events might have decreased stock market segmentation greatly. These events can be regarded as effective, among which are the QFII programme, the first round of exchange rate reform and the QDII programme. Some *de jure* financial liberalisation events, however, might not have reduced stock market segmentation, such as the event of China's accession to the WTO, allowing domestic investors to purchase B shares, as well as issuing the notice on transfer the state-owned and corporation shares to foreign investors. As for the second round of exchange rate reform, this reform might have even increased stock market segmentation between China and the world.

Meanwhile, the normalised degree of market segmentation indicates that the process of China's financial liberalisation has been interrupted by the global financial crisis in 2008. The normalised degree of market segmentation between China and the world stock markets has experienced three stages, which include the stationary period from January 2001 to June 2003, the decreasing period from July 2003 to June 2007, as well as the rising and falling period from July 2007 to June 2010. The process of *de*

facto liberalisation of China's stock market has been initiated by the QFII programme in July 2003, but has been suspended by the outbreak of credit crunch in the US in July 2007. The rising and falling of stock market segmentation between China and the world in the period from July 2007 to June 2010 may be mainly attributed to the global financial crisis in 2008.

Furthermore, from the perspective of methodology one conclusion can be drawn from the non-normalised index of market segmentation. The non-normalised index, which has been extensively employed in the existing literature, can hardly provide sensible explanation on the tendency of market segmentation as the estimated values vary with group size. The estimated values are not convincible enough if the size distortion has not been taken into account.

In the second empirical study (Chapter 5), this thesis has examined whether and to what degree China's financial liberalisation has influenced the market interdependence between China and the world stock markets after China's accession to the WTO in 2001. This chapter has gauged the non-normalised degree of stock market interdependence between China and the world in the post-WTO accession period by the multi-factor R-squared measure. This method is proposed by Pukthuanthong and Roll (2009; 2011) on the basis of the principal components analysis. Similar to measuring market segmentation in Chapter 4, this chapter has also gauged the non-normalised degree of market interdependence between the US and the world stock markets in the same period, which has been adopted as a benchmark for evaluating the normalised degree of stock market interdependence between China and the world. In order to make results comparable across chapters, this chapter has also adopted the same sector indices for the world stock market. The Shanghai Composite Index is adopted to represent Chinese stock market while the Dow Jones Industrial Index is selected for the stock market of the US. In these datasets, all indices are daily price indices and cover the same period from January 3, 2000 to May 31, 2011. After the normalised degree of stock market interdependence between China and the world

is obtained, this chapter has examined the impacts of China's financial liberalisation events on stock market interdependence between China and the world. Main findings of this empirical analysis are as follows.

Using the non-normalised degree of stock market interdependence, this chapter finds that: 1) stock market interdependence is time-varying for two pairs of markets, i.e., China-World and US-World; 2) stock market interdependence between China and the world is normally lower (in some cases, even higher), and more volatile than the one between the US and the world; as well as 3) the non-normalised index that has been commonly adopted in the existing literature can hardly offer sensible explanation on the tendency of market interdependence, and therefore, it is necessary to develop an alternative measure to capture stock market interdependence.

Using the normalised degree of stock market interdependence, this chapter has provided more valuable findings. Firstly, China's financial liberalisation might have played a very important role in increasing stock market interdependence between China and the world in the period from China's accession to the WTO in 2001 to the emergence of the credit crunch in the US in July 2007. China's financial liberalisation events in this period, such as the QFII programme, the first round of exchange rate reform, have been found to be *de facto* effective via measuring market segmentation in Chapter 4. Secondly, there has been an inverted U-shaped degree of market interdependence from July 2006 to December 2009, which may be attributed to China's economy overheating in the first half year of 2007 and to China's economic stimulus plan in 2008. Lastly, apart from market integration, many other factors, such as investors' overreaction, may have also contributed to the increase in stock market interdependence. Consequently, it is inappropriate to determine whether financial liberalisation events are *de facto* effective by the increase of market interdependence, including volatility spillover and market comovement.

In the third empirical study (Chapter 6), this thesis has examined the relationship between market integration and market interdependence by a series of tests, namely, the ADF unit root test, the MWALD test for causality analysis, the Engle-Granger two-step approach for cointegration analysis, as well as the event-specific analysis for China's financial liberalisation events. In order to control the bias caused by small sample size on statistical inference, this thesis has conducted bootstrapping on these tests correspondingly. These bootstrap tests include the residual-based ADF sieve bootstrap test, the leveraged bootstrap simulation on the MWALD test, as well as the bivariate cointegration bootstrap test. For empirical analysis, a dataset has been constructed by the normalised degrees of market segmentation and market interdependence between China and the world stock, which are obtained from Chapters 4 and 5 respectively.

The main findings of this chapter are fivefold. The first one is that both time series of degrees of market integration and market interdependence have been found to be stationary in first difference. The non-stationarity of time series should therefore be taken into account in empirical analysis. The second one is that there has been a unidirectional causal relationship from market integration to market interdependence. The third one is that there has been a cointegration relationship between market integration and market interdependence. The fourth one is that market integration and market interdependence are highly connected but different issues. Market integration is one, but not the only, determinant of market interdependence. The last one is that the conventional tests are more likely to reject the null hypothesis when using asymptotic distribution critical values than using those provided by bootstrapping, though similar findings have been found in this study.

7.2 Policy implications

China's financial liberalisation has greatly increased market integration and market interdependence between China and the world stock markets in the long term, which

may create new challenges to the security and stability of China's stock market. The Chinese government should carefully handle these challenges while reaping the benefits of financial liberalisation. Based upon the main findings, some policy implications are drawn as follows.

Firstly, the Chinese government should substantially lift QFII quota to help QFII behave as strategic investors. In the initial stage, QFII have been expected to undertake long-term investment strategies, which are helpful for developing a more stable and healthy stock market environment, due to their status and strength as international institutional investors. Drawing the lessons from Asian countries in the Asian financial crisis, China has taken a cautious approach in the implementation of the QFII programme by setting strict entry criteria, despite the pressure from its WTO commitments on financial market liberalisation. As a result, the QFII has been too constrained to play the role of strategic investors, though the entry of QFII has increased the international market integration between China and the world stock markets. As pointed out by Tan (2009), for example, none of the QFII has any desire to take an active management role to enhance the corporate governance directly in the Chinese companies they invest in. In a highly speculative market, such as China's stock market, the QFII are more inclined to maximise investment returns from all opportunities, which often results in short-term movements (Tam, Li, Zhang, & Yu, 2010). Because of their quota limitation, the QFII have had to settle for being market followers instead of market makers. As the expected contributions of the QFII have not manifested yet within a limited scale of operations, the QFII quotas should be enlarged substantially to enable them to behave as strategic investors.

Secondly, the Chinese government should reform the regulatory framework of the QDII programme. In 2006 the QDII programme has been initially implemented to ease the appreciation pressure of the RMB, and to provide domestic investors with opportunities to invest in international capital markets with a broad range of products. Although the inception of the QDII programme was greeted with fanfare initially,

Chinese investors have given a tepid response to them in the following years. For example, at one time China halted the issuance of new QDII quotas following the last approval in May 2008, which partially reflected the unattractiveness of QDII products up to that point. The muted reaction to the QDII could be attributed to the steady appreciation of the RMB against the US dollar, the turmoil of the US subprime crisis, the booming of Chinese domestic stock markets, as well as the poor performance of QDII. More fundamentally, the multi-faceted regulatory framework with strict regulations has been a potential factor hindering the development of the QDII in the institutional level.

On the one hand, the QDII products can be divided into three broad groups, while each of them is primarily regulated by a different regulator correspondingly. The bank products are primarily regulated by the China Banking Regulatory Commission (CBRC), and securities institution related products are supervised by the CSRC while insurance company products are regulated by the China Insurance Regulatory Commission (CIRC). Additionally, the State Administration Foreign Exchange (SAFE) and the People's Bank of China (PBC) also regulate QDII products. By adopting a variety of regulations, the multi-faceted regulatory framework has resulted in a somewhat chaotic environment for the implementation of the QDII programme. On the other hand, the regulations are quite strict in governing the operations of the QDII, such as the permissible investment. Both the CBRC Circular and the CSRC Regulations prohibit the QDII from investing in hedge funds, while this kind of investment is allowed by some foreign regulatory authorities, such as the Hong Kong Securities and Future Commission, and the Monetary Authority of Singapore. In order to vitalize the QDII programme, the Chinese government should consolidate the regulatory framework while loosening up strict regulations.

Lastly, the Chinese government should pay more attention to financial crisis contagion in the era of financial liberalisation. After China's entry into the WTO, China has liberalised its financial market greatly, according to its WTO accession commitments.

Currently, China faces the increasing pressure of the full foreign-exchange convertibility between the RMB and foreign currencies. The Chinese government will probably perform capital account liberalisation in the future, and its economy will be more exposed to global financial market risks. In order to tackle with this challenge, the Chinese government needs to build up a more sound and efficient financial system from the following aspects at least. The first one is that the Chinese government needs to reform the banking-dominated financial system and to build a balanced financial system of direct and indirect finance. The second one is that the Chinese government needs more efforts to eliminate illegal practices through comprehensive laws and regulations. The last one is that the Chinese government needs to make extra efforts to upgrade the accounting and reporting practices of securities firms to follow international standards.

7.3 Limitations and future studies

Like any empirical research, this thesis also has limitations, some of which will be improved in further research. Firstly, this thesis has only gauged market segmentation by the weak-form measure while the strong-form measure is left for further study. Although inter-temporal arbitrage was unlikely to happen until the stock index futures were launched on April 16, 2010 in China's stock market, the strong-form measure deserves its attention for a comprehensive understanding of this issue. Secondly, this thesis has only tried to mitigate the size distortion by controlling sample size passively, rather than to propose a more efficient method to avoid such a distortion fundamentally. According to the recent progress in the study of SDF, a weighting function is expected to be incorporated into these measures in future work. Lastly, this thesis has not provided more informative explanation on how market interdependence has been influenced by financial liberalisation and other factors, such as investors' overreaction. A better understanding of the influence mechanisms will be helpful to mitigate the adverse effects of financial liberalisation, especially for financial crisis contagion.

Apart from the improvements of limitations discussed above, this thesis may offer another two perspectives for possible future research at least. One study might be conducted to examine the impacts of China's financial liberalisation on stock market efficiency. More specifically, the aim is to examine whether and to what extent the efficiency of Chinese stock market has been enhanced by China's financial liberalisation events. As the sophisticated foreign institutional investors have been allowed to trade A shares in 2003, the domestic financial institutions have been forced to learn the advanced technology and to adopt the best international practices due to the increasing level of competition. For example, foreign securities firms have considerable expertise in dealing with the advanced techniques in portfolio management and in providing better service to customers. The efficiency of China's stock market is therefore expected to increase substantially. Being a useful measure of the effectiveness of China's financial liberalisation, the degree of stock market integration provided by this thesis can be adopted to examine the relationship between financial liberation and market efficiency.

The other study may be performed to explore arbitrage and portfolio diversification opportunities across markets in the era of financial liberalisation. Financial liberalisation has dual effects on arbitrage and portfolio diversification across market. On the one hand, financial liberalisation may reduce market segmentation, for example, the removal of foreign ownership restriction, and therefore facilitate transactions across borders. On the other hand, financial liberalisation may increase market integration and interdependence, and therefore, the opportunities of arbitrage and portfolio diversification across markets are inclined to vanish. However, financial liberalisation does not necessarily mean the absence of arbitrage and portfolio diversification opportunities. For example, in the second half year of 2009 both market segmentation and market interdependence are found to decrease at the same time. The opportunities of arbitrage and portfolio diversification across markets are

expected to be observed in the firm-level, as this thesis has provided an average degree of market segmentation in the country-level.

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APPENDICES

Table I: Sector Indices for China, USA and the World

Part A: China's Stock Market

Index Identification of China's Stock Market	*DataStream Mnemonic*	*Datastream Availability*		*Usable Daily Returns*	*Usable Weekly Return*		
		Begins	*Ends*		*Numbers*	*Mean*	*Variance*
CHINA-DS Oil & Gas Prod - PRICE INDEX (~U$)	OILGPCH (PI)~U$	December 02,1994	May 31,2011	2661	566	0.105	1.328
CHINA A-DS Oil/Eq Svs/Dst - PRICE INDEX (~U$)	OILESCA (PI)~U$	November 26,1998	May 31,2011	2661	566	0.066	1.238
CHINA A-DS Alt. Energy - PRICE INDEX (~U$)	ALTENCA (PI)~U$	December 26,2007	May 31,2011	805	173	0.021	1.767
CHINAA-DS Chemicals- PRICE INDEX (~U$)	CHMCLCA (PI)~U$	November 13,1992	May 31,2011	2661	566	0.080	1.056
CHINA A-DS Forestry & Pap - PRICE INDEX (~U$)	FSTPACA (PI)~U$	December 06.1993	May 31,2011	2661	566	0.058	1.205
CHINA A-DS Ind. Met & Mines - PRICE INDEX (~U$)	INDMTCA (PI)~U$	January 06,1994	May 31,2011	2661	566	0.068	1.177
CHINA A-DS Mining - PRICE INDEX (~U$)	MNINGCA (PI)~U$	July 01,1998	May 31,2011	2661	566	0.105	1.316
CHINA A-DS Con & Mat - PRICE INDEX (~U$)	CNSTMCA (PI)~U$	March 26,1993	May 31,2011	2661	566	0.057	1.021
CHINA A-DS Aero/Defence - PRICE INDEX (~U$)	AERSPCA (PI)~U$	December 18,2000	May 31,2011	2439	520	0.122	1.407
CHINA-DS General Inds - PRICE INDEX (~U$)	GNINDCH (PI)~U$	March 23,1994	May 31,2011	2661	566	0.156	1.366
CHINA A-DS Eltro/Elec Eq - PRICE INDEX (~U$)	ELTNCCA (PI)~U$	February 02,1994	May 31,2011	2661	566	0.032	1.095
CHINA-DS Inds Eng - PRICE INDEX (~U$)	INDENCH (PI)~U$	December 29,1993	May 31,2011	2661	566	0.132	1.395
CHINA A-DS Inds Transpt - PRICE INDEX (~U$)	INDTRCA (PI)~U$	March 04,1993	May 31,2011	2661	566	0.034	0.987
CHINA A-DS Support Svs - PRICE INDEX (~U$)	SUPSVCA (PI)~U$	October 08,1993	May 31,2011	2661	566	0.097	1.347
CHINA A-DS Auto & Parts - PRICE INDEX (~U$)	AUTMBCA (PI)~U$	December 04,1992	May 31,2011	2661	566	0.083	1.233
CHINA-DS Beverages - PRICE INDEX (~U$)	BEVESCH (PI)~U$	July 26,1993	May 31,2011	2661	566	0.195	1.545
CHINA A-DS Fd Producers - PRICE INDEX (~U$)	FOODSCA (PI)~U$	November 01,1994	May 31,2011	2661	566	-0.001	1.265
CHINA A-DS H/H Gds,Home Con - PRICE INDEX (~U$)	HHOLDCA (PI)~U$	January 06,1994	May 31,2011	2661	566	0.085	1.163
CHINA A-DS Leisure Gds - PRICE INDEX (~U$)	LEISGCA (PI)~U$	January 06,1994	May 31,2011	2661	566	0.019	1.160
CHINA A-DS Personal Goods - PRICE INDEX (~U$)	PERSGCA (PI)~U$	May 09,2002	May 31,2011	2130	454	0.106	1.266
CHINA-DS H/C Eq & Svs - PRICE INDEX (~U$)	HCEQSCH(PI)~U$	February 27,2004	May 31,2011	1708	362	0.267	1.710
CHINA A-DS Pharm & Bio - PRICE INDEX (~U$)	PHARMCA (PI)~U$	June 29,1993	May 31,2011	2661	566	0.050	1.006
CHINA A-DS Gen Retailers - PRICE INDEX (~U$)	GNRETCA (PI)~U$	September 02,1992	May 31,2011	2661	566	0.092	1.092
CHINA A-DS Media - PRICE INDEX (~U$)	MEDIACA (PI)~U$	November 12,1996	May 31,2011	2661	566	0.017	1.329
CHINA A-DS Travel & Leis - PRICE INDEX (~U$)	TRLESCA (PI)~U$	June 07,1993	May 31,2011	2661	566	0.076	1.184
CHINA-DS Fxd Line T/Cm - PRICE INDEX (~U$)	TELFLCH (PI)~U$	November 15,2002	May 31,2011	2003	428	0.132	1.345
CHINA A-DS Mobile T/Cm - PRICE INDEX (~U$)	TELMBCA (PI)~U$	April 7,1993	May 31,2011	2661	566	0.047	1.481
CHINA A-DS Electricity - PRICE INDEX (~U$)	ELECTCA (PI)~U$	March 16,1993	May 31,2011	2661	566	0.040	1.018
CHINA A-DS Gs/Wt/Mul Util - PRICE INDEX (~U$)	GWMUTA (PI)~U$	May 18,1993	May 31,2011	2661	566	0.040	1.251
CHINA A-DS Banks – PRICE INDEX (~U$)	BANKSCA (PI)~U$	August 16,1991	May 31,2011	2661	566	0.045	0.991
CHINA-DS Nonlife Insur - PRICE INDEX (~U$)	NLINSCH (PI)~U$	November 6,2003	May 31,2011	1777	377	0.158	1.860

CHINA-DS Life Insurance - PRICE INDEX (~U$)	LFINSCH (PI)~U$	December 18,2003	May 31,2011	1748	371	0.148	1.409
CHINA-DS Real Est Inv,Svs - PRICE INDEX (~U$)	RLISVCH (PI)~U$	July 26,1993	May 31,2011	2661	566	0.193	1.483
CHINA A-DS S/W & Comp Svs - PRICE INDEX (~U$)	SFTCSCA (PI)~U$	June 18,1996	May 31,2011	2661	566	0.050	1.219
CHINA-DS Tch H/W & Eq - PRICE INDEX (~U$)	TECHDCH (PI)~U$	June 10,1997	May 31,2011	2661	566	0.111	1.479

Part B: the US' Stock Market

Index Identification of US's Stock Market	*Datastream Mnemonic*	*Datastream Availability*		*Usable Daily Returns*	*Usable Weekly Return*		
		Begins	*Ends*		*Numbers*	*Mean*	*Variance*
US-DS Oil & Gas Prod - PRICE INDEX (~U$)	OILGPUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.085	0.781
US-DS Oil/Eq Svs/Dst - PRICE INDEX (~U$)	OILESUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.089	1.005
US-DS Alt. Energy – PRICE INDEX (~U$)	ALTENUS (PI)~U$	Nov. 17,2005	May 31,2011	1300	277	0.180	1.976
US-DS Chemicals – PRICE INDEX (~U$)	CHMCLUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.067	0.861
US-DS Forestry & Pap - PRICE INDEX (~U$)	FSTPAUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.054	1.182
US-DS Ind. Met & Mines - PRICE INDEX (~U$)	INDMTUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.104	1.337
US-DS Mining – PRICE INDEX (~U$)	MNINGUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.120	1.273
US-DS Con & Mat – PRICE INDEX (~U$)	CNSTMUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.073	0.991
US-DS Aero/Defence – PRICE INDEX (~U$)	AERSPUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.062	0.733
US-DS General Inds – PRICE INDEX (~U$)	GNINDUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.014	0.842
US-DS Eltro/Elec Eq – PRICE INDEX (~U$)	ELTNCUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.054	0.855
US-DS Inds Eng – PRICE INDEX (~U$)	INDENUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.093	0.924
US-DS Inds Transpt – PRICE INDEX (~U$)	INDTRUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.067	0.751
US-DS Support Svs – PRICE INDEX (~U$)	SUPSVUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.032	0.662
US-DS Auto & Parts – PRICE INDEX (~U$)	AUTMBUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.034	1.027
US-DS Beverages – PRICE INDEX (~U$)	BEVESUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.034	0.551
US-DS Fd Producers – PRICE INDEX (~U$)	FOODSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.036	0.510
US-DS H/H Gds,Home Con - PRICE INDEX (~U$)	HHOLDUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.024	0.636
US-DS Leisure Gds – PRICE INDEX (~U$)	LEISGUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.039	0.779
US-DS Personal Goods - PRICE INDEX (~U$)	PERSGUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.047	0.641
US-DS Tobacco – PRICE INDEX (~U$)	TOBACUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.075	0.805
US-DS H/C Eq & Svs – PRICE INDEX (~U$)	HCEQSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.056	0.604
US-DS Pharm & Bio – PRICE INDEX (~U$)	PHARMUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.018	0.591
US-DS Fd & Drug Rtl – PRICE INDEX (~U$)	FDRGRUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.057	0.653
US-DS Gen Retailers – PRICE INDEX (~U$)	GNRETUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.040	0.765
US-DS Media – PRICE INDEX (~U$)	MEDIAUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.028	0.788
US-DS Travel & Leis – PRICE INDEX (~U$)	TRLESUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.057	0.869
US-DS Fxd Line T/Cm - PRICE INDEX (~U$)	TELFLUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	-0.003	0.761

US-DS Mobile T/Cm – PRICE INDEX (~U$)	TELMBUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.012	1.347
US-DS Electricity – PRICE INDEX (~U$)	ELECTUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.036	0.613
US-DS Gs/Wt/Mul Util - PRICE INDEX (~U$)	GWMUTU S(PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.027	0.712
US-DS Banks – PRICE INDEX (~U$)	BANKSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.036	1.151
US-DS Nonlife Insur – PRICE INDEX (~U$)	NLINSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.026	0.703
US-DS Life Insurance – PRICE INDEX (~U$)	LFINSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.070	1.113
US-DS Real Est Inv,Svs - PRICE INDEX (~U$)	RLISVUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.080	1.162
US-DS REITs – PRICE INDEX (~U$)	REITSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.074	0.898
US-DS Financial Svs(4) - PRICE INDEX (~U$)	FNSVSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.048	1.000
US-DS Eqt Ivst Ins – PRICE INDEX (~U$)	EQINVUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.059	1.391
US-DS S/W & Comp Svs - PRICE INDEX (~U$)	SFTCSUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.012	0.869
US-DS Tch H/W & Eq - PRICE INDEX (~U$)	TECHDUS (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.027	1.040

Part C: the World's Stock Market

Index Identification of the World's Stock Market	*Datastream Mnemonic*	*Datastream Availability*		*Usable Daily Returns*	*Usable Weekly Return*		
		Begins	*Ends*		*Numbers*	*Mean*	*Variance*
WORLD-DS Oil & Gas Prod - PRICE INDEX (~U$)	OILGPWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.080	0.786
WORLD-DS Oil/Eq Svs/Dst - PRICE INDEX (~U$)	OILESWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.086	0.939
WORLD-DS Alt. Energy - PRICE INDEX (~U$)	ALTENWD (PI)~U$	Sept. 18,1991	May 31,2011	2661	566	0.101	1.296
WORLD-DS Chemicals - PRICE INDEX (~U$)	CHMCLWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.062	0.708
WORLD-DS Forestry & Pap - PRICE INDEX (~U$)	FSTPAWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.024	0.718
WORLD-DS Ind. Met & Mines - PRICE INDEX (~U$)	INDMTWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.092	1.040
WORLD-DS Mining - PRICE INDEX (~U$)	MNINGWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.112	1.087
WORLD-DS Con & Mat - PRICE INDEX (~U$)	CNSTMWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.050	0.725
WORLD-DS Aero/Defence - PRICE INDEX (~U$)	AERSPWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.056	0.667
WORLD-DS General Inds - PRICE INDEX (~U$)	GNINDWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.024	0.703
WORLD-DS Eltro/Elec Eq - PRICE INDEX (~U$)	ELTNCWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.033	0.783
WORLD-DS Inds Eng - PRICE INDEX (~U$)	INDENWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.062	0.792
WORLD-DS Inds Transpt - PRICE INDEX (~U$)	INDTRWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.050	0.625
WORLD-DS Support Svs - PRICE INDEX (~U$)	SUPSVWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.021	0.651
WORLD-DS Auto & Parts - PRICE INDEX (~U$)	AUTMBWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.041	0.701
WORLD-DS Beverages - PRICE INDEX (~U$)	BEVESWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.048	0.488
WORLD-DS Fd Producers - PRICE INDEX (~U$)	FOODSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.043	0.455
WORLD-DS H/H Gds,Home Con - PRICE INDEX (~U$)	HHOLDWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.015	0.525
WORLD-DS Leisure Gds - PRICE INDEX (~U$)	LEISGWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.005	0.676

WORLD-DS Personal Goods - PRICE INDEX (~U$)	PERSGWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.040	0.571
WORLD-DS Tobacco – PRICE INDEX (~U$)	TOBACWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.070	0.585
WORLD-DS H/C Eq & Svs - PRICE INDEX (~U$)	HCEQSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.054	0.551
WORLD-DS Pharm & Bio - PRICE INDEX (~U$)	PHARMWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.020	0.507
WORLD-DS Fd & Drug Rtl - PRICE INDEX (~U$)	FDRGRWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.029	0.508
WORLD-DS Gen Retailers - PRICE INDEX (~U$)	GNRETWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.035	0.654
WORLD-DS Media - PRICE INDEX (~U$)	MEDIAWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.011	0.679
WORLD-DS Travel & Leis - PRICE INDEX (~U$)	TRLESWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.034	0.646
WORLD-DS Mobile T/Cm - PRICE INDEX (~U$)	TELMBWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.004	0.795
WORLD-DS Electricity - PRICE INDEX (~U$)	ELECTWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.035	0.483
WORLD-DS Gs/Wt/Mul Util - PRICE INDEX (~U$)	GWMUTWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.037	0.551
WORLD-DS Banks - PRICE INDEX (~U$)	BANKSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.033	0.792
WORLD-DS Nonlife Insur - PRICE INDEX (~U$)	NLINSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.025	0.694
WORLD-DS Life Insurance - PRICE INDEX (~U$)	LFINSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.033	0.922
WORLD-DS Real Est Inv,Svs - PRICE INDEX (~U$)	RLISVWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.045	0.743
WORLD-DS REITs - PRICE INDEX (~U$)	REITSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.051	0.704
WORLD-DS Financial Svs(4) - PRICE INDEX (~U$)	FNSVSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.032	0.818
WORLD-DS Eqt Ivst Ins - PRICE INDEX (~U$)	EQINVWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.030	0.601
WORLD-DS S/W & Comp Svs - PRICE INDEX (~U$)	SFTCSWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.005	0.831
WORLD-DS Tch H/W & Eq - PRICE INDEX (~U$)	TECHDWD (PI)~U$	Jan. 1,1973	May 31,2011	2661	566	0.005	0.973

Notes: This table reports the basic information of sector indices in Level 3, which are defined by the Datastream database, for China, the US and the world stock markets respectively. All index values are converted into the US dollar, which are designated by the "(~U$)" in the columns of Index Identification and Datastream Mnemonic. The abbreviation "PI" in the Datastream Mnemonic column denotes a pure Price Index, which does not include dividends. All "Usable" returns are obtained from the original sector indices when both China and the US stock markets actually traded on the same calendar day.

Table II: The Non- and Normalsied Degrees of Market Segemtation (T=12months)

M=10000	**Ratio=0.50 T=12months**			**Ratio=0.55 T=12months**			**Ratio=0.60 T=12months**		
Time	mg(C,W)	mg(U,W)	S(C,W)	mg(C,W)	mg(U,W)	S(C,W)	mg(C,W)	mg(U,W)	S(C,W)
2000	92.80	43.47	**0.53**	221.87	99.51	**0.55**	306.44	169.84	**0.45**
2001	91.67	38.87	**0.58**	221.94	109.55	**0.51**	336.97	210.75	**0.37**
2002	69.81	43.32	**0.38**	189.51	109.12	**0.42**	293.03	193.32	**0.34**
2003	158.55	41.62	**0.74**	373.69	108.31	**0.71**	513.61	185.36	**0.64**
2004	126.15	64.65	**0.49**	301.53	153.53	**0.49**	435.25	259.01	**0.40**
2005	152.08	76.70	**0.50**	385.85	182.76	**0.53**	559.67	303.97	**0.46**
2006	99.21	63.26	**0.36**	239.28	160.45	**0.33**	344.59	258.53	**0.25**
2007	110.61	82.74	**0.25**	285.72	216.65	**0.24**	420.55	359.45	**0.15**
2008	67.35	36.86	**0.45**	173.65	97.45	**0.44**	258.98	164.19	**0.37**
2009	71.11	37.80	**0.47**	189.52	113.26	**0.40**	357.60	238.93	**0.33**
2010	104.87	64.34	**0.39**	258.93	163.86	**0.37**	363.48	262.77	**0.28**

Notes: For each year and each pair of markets, the degrees of stock market segmentation are reported in the format of non-normalised and normalised measure, wherein the number of random sampling M is adopted to be 10, 000 and the length of observation interval T to be 12 months. The stopping criteria applied are that the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2,000. In this table, *mg(C,W)* stands for the non-normalised degree of stock market segmentation between China and the world, and *mg(U,W)* is the one between the US and the world while *S(C,W))* represents the normalised degree of stock market segmentation between China and the world.

Table III: The Non- and Normalsied Degrees of Market Segemtation (T=6months)

M=10000	**Ratio=0.50 T=6months**			**Ratio=0.55 T=6months**			**Ratio=0.60 T=6months**		
Time	mg(C,W)	mg(U,W)	S(C,W)	mg(C,W)	mg(U,W)	S(C,W)	mg(C,W)	mg(U,W)	S(C,W)
Q1,2/2000	128.87	54.86	**0.57**	243.93	124.84	**0.49**	326.86	203.45	**0.38**
Q3,4/2000	187.77	88.22	**0.53**	362.48	193.4	**0.47**	497.99	311.12	**0.38**
Q1,2/2001	214.91	59.53	**0.72**	419.16	139.22	**0.67**	567.59	230.85	**0.59**
Q3,4/2001	110.24	51.89	**0.53**	228.19	122.45	**0.46**	335.22	207.56	**0.38**
Q1,2/2002	160.92	71.3	**0.56**	324.75	162.1	**0.50**	453.23	267.2	**0.41**
Q3,4/2002	113.56	47.66	**0.58**	217.78	99.42	**0.54**	297.47	156.55	**0.47**
Q1,2/2003	85.43	34.19	**0.60**	174.97	83	**0.53**	272.38	159.43	**0.41**
Q3,4/2003	178.63	73.97	**0.59**	339.1	160.59	**0.53**	454.24	257.53	**0.43**
Q1,2/2004	127.77	73.94	**0.42**	264.26	166.17	**0.37**	373.19	270.02	**0.28**
Q3,4/2004	86.95	48.18	**0.45**	192.03	102.52	**0.47**	390.6	259.43	**0.34**
Q1,2/2005	188.2	93.62	**0.50**	376.35	209.09	**0.44**	516.82	332.16	**0.36**
Q3,4/2005	108.59	76.94	**0.29**	237.26	158.63	**0.33**	514.33	405.63	**0.21**
Q1,2/2006	105.91	82.52	**0.22**	211.59	175.81	**0.17**	335.17	318.44	**0.05**
Q3,4/2006	126.92	91.04	**0.28**	258.1	201.42	**0.22**	362.2	315.43	**0.13**
Q1,2/2007	85.26	63.59	**0.25**	173.56	141.04	**0.19**	277.59	260.25	**0.06**
Q3,4/2007	103.28	62.67	**0.39**	197.43	137.35	**0.30**	400.07	343.56	**0.14**
Q1,2/2008	89.95	52.54	**0.42**	165.17	110.11	**0.33**	339.32	281.94	**0.17**
Q3,4/2008	42.64	18.05	**0.58**	81.32	47.91	**0.41**	177.65	140.55	**0.21**
Q1,2/2009	68.01	35.54	**0.48**	136.39	82.04	**0.40**	219.12	149.52	**0.32**
Q3,4/2009	107.05	66.36	**0.38**	199.71	146.89	**0.26**	413.09	371.56	**0.10**
Q1,2/2010	79.07	49.09	**0.38**	147.12	113.52	**0.23**	233.68	204.85	**0.12**
Q3,4/2010	108.16	54.95	**0.49**	212.69	125.13	**0.41**	440.08	321.61	**0.27**

Notes: For each half year and each pair of markets, the degrees of market segmentation are reported in the format of non-normalised and normalised measure, wherein the number of random sampling M is adopted to be 10, 000 and the length of observation interval *T* to be 6 months. The stopping criteria applied are that the iterative process stops either when the sum of the absolute changes in degree of the last 10 iterations is less than 0.001 times of the mean degree of the last 10 iterations or when the number of iterations reaches 2000. In this table, *mg(C,W)* stands for the non-normalised degree of stock market segmentation between China and the world, and *mg(U,W)* is the one for the US and the world while *S(C,W))* represents the normalised degree of stock market segmentation between China and the world.

Table IV: The Average Degree and Trend of Stock Market Segmentation

T=6 months	**Ratio=0.50**	**Ratio=0.55**	**Ratio=0.60**	**Ratio=0.50, 0.55, 0.60**	
Time	S(C,W)	S(C,W)	S(C,W)	Average	Trend Average
Q1,2/2000	0.57	0.49	0.38	0.48	
Q3,4/2000	0.53	0.47	0.38	0.46	0.53
Q1,2/2001	0.72	0.67	0.59	0.66	0.53
Q3,4/2001	0.53	0.46	0.38	0.46	0.54
Q1,2/2002	0.56	0.50	0.41	0.49	0.49
Q3,4/2002	0.58	0.54	0.47	0.53	0.51
Q1,2/2003	0.60	0.53	0.41	0.51	0.52
Q3,4/2003	0.59	0.53	0.43	0.52	0.46
Q1,2/2004	0.42	0.37	0.28	0.36	0.43
Q3,4/2004	0.45	0.47	0.34	0.42	0.40
Q1,2/2005	0.50	0.44	0.36	0.43	0.38
Q3,4/2005	0.29	0.33	0.21	0.28	0.29
Q1,2/2006	0.22	0.17	0.05	0.15	0.21
Q3,4/2006	0.28	0.22	0.13	0.21	0.18
Q1,2/2007	0.25	0.19	0.06	0.17	0.22
Q3,4/2007	0.39	0.30	0.14	0.28	0.25
Q1,2/2008	0.42	0.33	0.17	0.31	0.33
Q3,4/2008	0.58	0.41	0.21	0.40	0.37
Q1,2/2009	0.48	0.40	0.32	0.40	0.35
Q3,4/2009	0.38	0.26	0.10	0.25	0.30
Q1,2/2010	0.38	0.23	0.12	0.24	0.29
Q3,4/2010	0.49	0.41	0.27	0.39	

Notes: For each half year, this table reports the average degree and the trend of market segmentation between China and the world. In this table, *Ratio* stands for the group size; *T* represents the length of observation interval; *S(C, W)* is the normalised degree of market segmentation between China and the world; "Average" is the average value of the normalised degrees when *Ratio* takes the value of 0.50, 0.55 and 0.60 respectively; and "*Trend Average*" is the trend of market segmentation by the three-point moving average of "*Average*" values with equal weights. As the "*Trend Average*" is the three-point moving average of "*Average*", the values are unavailable for "*Trend Average*" in the first and the last period of observations. All statistics are reported against the end of each time interval.

Table V: Cumulative Percentages of Variance Explained by Main Components

Time	NMC=3	NMC=4	NMC=5
Q1,2/2000	90.380	95.387	96.674
Q3,4/2000	93.629	95.624	97.029
Q1,2/2001	88.890	94.820	96.745
Q3,4/2001	94.049	96.175	97.437
Q1,2/2002	94.311	96.332	97.702
Q3,4/2002	91.052	94.995	97.322
Q1,2/2003	97.472	98.208	98.784
Q3,4/2003	98.250	98.972	99.254
Q1,2/2004	88.439	93.426	96.570
Q3,4/2004	98.131	98.814	99.152
Q1,2/2005	95.286	97.235	98.050
Q3,4/2005	97.614	98.444	98.976
Q1,2/2006	97.315	98.323	99.028
Q3,4/2006	98.216	98.857	99.154
Q1,2/2007	98.569	99.078	99.449
Q3,4/2007	98.181	98.752	99.184
Q1,2/2008	95.590	97.583	98.505
Q3,4/2008	99.733	99.828	99.888
Q1,2/2009	98.763	99.204	99.485
Q3,4/2009	98.859	99.273	99.585
Q1,2/2010	97.477	98.663	99.254
Q3,4/2010	99.205	99.487	99.685
Average	**95.882**	**97.613**	**98.496**

Notes: For each half year, this table reports the cumulative percentages of variance, which are explained by the top 3, 4, and 5 main components respectively. In this table, *NMC* stands for the number of main components while *Average* represents the mean values of cumulative percentage in column. All statistics are reported against the end of each time interval.

Table VI: The Non- and Normalsied Degrees of Market Interdependence

	NMC=3 T=6months			**NMC=4 T=6months**			**NMC=5 T=6months**		
Time	I(C,W)	I(U,W)	NI(C,W)	I(C,W)	I(U,W)	NI(C,W)	I(C,W)	I(U,W)	NI(C,W)
Q1,2/2000									
Q3,4/2000	0.495	0.846	**0.585**	0.505	0.878	**0.574**	0.506	0.912	**0.555**
Q1,2/2001	0.130	0.789	**0.165**	0.506	0.843	**0.600**	0.521	0.861	**0.605**
Q3,4/2001	0.728	0.969	**0.752**	0.768	0.978	**0.785**	0.905	0.980	**0.923**
Q1,2/2002	0.350	0.891	**0.393**	0.611	0.906	**0.674**	0.740	0.930	**0.795**
Q3,4/2002	0.663	0.955	**0.695**	0.667	0.960	**0.695**	0.739	0.972	**0.761**
Q1,2/2003	0.377	0.918	**0.411**	0.621	0.969	**0.641**	0.735	0.970	**0.758**
Q3,4/2003	0.304	0.965	**0.315**	0.504	0.969	**0.521**	0.504	0.969	**0.521**
Q1,2/2004	0.797	0.601	**1.325**	0.802	0.762	**1.052**	0.802	0.836	**0.960**
Q3,4/2004	0.701	0.871	**0.805**	0.781	0.873	**0.894**	0.782	0.934	**0.838**
Q1,2/2005	0.649	0.734	**0.884**	0.823	0.940	**0.875**	0.855	0.940	**0.909**
Q3,4/2005	0.560	0.811	**0.690**	0.609	0.856	**0.711**	0.677	0.871	**0.777**
Q1,2/2006	0.720	0.842	**0.855**	0.912	0.935	**0.975**	0.926	0.935	**0.990**
Q3,4/2006	0.879	0.970	**0.906**	0.882	0.978	**0.901**	0.884	0.983	**0.899**
Q1,2/2007	0.934	0.778	**1.201**	0.938	0.780	**1.201**	0.964	0.787	**1.225**
Q3,4/2007	0.656	0.643	**1.020**	0.834	0.756	**1.102**	0.848	0.756	**1.121**
Q1,2/2008	0.915	0.907	**1.010**	0.922	0.914	**1.009**	0.939	0.927	**1.012**
Q3,4/2008	0.899	0.993	**0.905**	0.903	0.994	**0.909**	0.903	0.994	**0.908**
Q1,2/2009	0.900	0.956	**0.941**	0.900	0.962	**0.935**	0.934	0.976	**0.957**
Q3,4/2009	0.556	0.984	**0.565**	0.563	0.985	**0.572**	0.711	0.985	**0.722**
Q1,2/2010	0.698	0.872	**0.800**	0.904	0.938	**0.964**	0.921	0.940	**0.979**
Q3,4/2010	0.820	0.982	**0.835**	0.833	0.995	**0.837**	0.886	0.995	**0.890**

Notes: For each half year, this table reports the non-normalised and normalised degrees of market interdependence. In this table, *NMC* stands for the number of main components; *T* represents the length of observation interval; *I(C,W)* is the non-normalised degree of market interdependence between China and the world, *I(U,W)* is the one between the US and the world while *NI(C,W)* is the normalised degree of market interdependence between China and the world. As both non-normalised and normalised measures are estimated from out-of-sample main components, values are unavailable for all indices in the initial period, i.e., the first half year of 2000. All statistics are reported against the end of each time interval.

Table VII: The Degree and Trend of Stock Market Interdependence

T=6 months	**NMC=3**	**NMC=4**	**NMC=5**	**NMC=3,4,5**	
Time	NI(C,W)	NI(C,W)	NI(C,W)	Average	Trend Average
Q1,2/2000					
Q3,4/2000	0.585	0.574	0.555	0.572	
Q1,2/2001	0.165	0.600	0.605	0.457	0.616
Q3,4/2001	0.752	0.785	0.923	0.820	0.633
Q1,2/2002	0.393	0.674	0.795	0.621	0.719
Q3,4/2002	0.695	0.695	0.761	0.717	0.647
Q1,2/2003	0.411	0.641	0.758	0.603	0.591
Q3,4/2003	0.315	0.521	0.521	0.452	0.723
Q1,2/2004	1.325	1.052	0.960	1.113	0.803
Q3,4/2004	0.805	0.894	0.838	0.846	0.949
Q1,2/2005	0.884	0.875	0.909	0.890	0.820
Q3,4/2005	0.690	0.711	0.777	0.726	0.852
Q1,2/2006	0.855	0.975	0.990	0.940	0.856
Q3,4/2006	0.906	0.901	0.899	0.902	1.017
Q1,2/2007	1.201	1.201	1.225	1.209	1.064
Q3,4/2007	1.020	1.102	1.121	1.081	1.100
Q1,2/2008	1.010	1.009	1.012	1.010	1.000
Q3,4/2008	0.905	0.909	0.908	0.907	0.954
Q1,2/2009	0.941	0.935	0.957	0.944	0.824
Q3,4/2009	0.565	0.572	0.722	0.619	0.826
Q1,2/2010	0.800	0.964	0.979	0.914	0.796
Q3,4/2010	0.835	0.837	0.890	0.854	

Notes: For each half year, this table reports the average degree and trend of market interdependence between China and the world. In this table, *NMC* stands for the number of main components; *T* represents the length of observation interval; *NI(C, W)* is the normalised degree of market interdependence between China and the world; "*Average*" is the average value of normalised degrees when the top 3, 4, and 5 main components are employed as explanatory variables; and "*Trend Average*" is the trend of market interdependence by the three-point moving average of "*Average*" values with equal weights. As normalised degrees are estimated from out-of-sample main components, values are unavailable for all indices in the initial period, i.e., the first half year of 2000. Similarly, as "*Trend Average*" is the three-point moving average of "*Average*", values are unavailable for "*Trend Average*" in the second and the last period of observations. All statistics are reported against the end of each time interval.