Essays on International Trade and Stock Market Performance in China

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Abstract

This thesis examines different factors that affect risk and return of equities of Chinese firms engaging in international trades through three studies.

The first study investigates the sensitivity of exchange rate fluctuations to firm returns through exchange rate exposure. We improve methodologies employing in existing studies by constructing a firm-specific exchange rate index based on destination-specific export and import values. The empirical results show that our improvement can detect more percentage of firms showing significant exchange rate exposure than conventional approaches and that higher proportion of Chinese firms are exposed to exchange rate when the exchange rate regime is changed from fixed to managed float.

The second study decomposes risk premium of Chinese exporting firms by their export destinations to assess if return from exporting to each country is well rewarded for the risk taken, that is, having a positive risk premium. Risk premium of firms is assumed to be influenced by risk premium from a domestic market, risk premium contributions from current export destination countries and from potential export destination countries. Our methodology of risk premium decomposition takes into account the time-varying nature of risk factors of exports. The empirical results reveal that trading in a domestic market provides positive risk premium while current and potential exports can provide positive or negative risk premia depending on destination countries.

The last study explores volatility spillovers to Chinese stocks over trade, exchange rate and

stock market liberalization events in China. We investigate volatility spillovers from the major stock markets in the US, the UK and Japan to Chinese stocks. Besides, we also breakdown Chinese stocks by portfolios of exporting, domestic manufacturing and domestic services firms to investigate both volatility spillovers from foreign stock markets and volatility spillovers across portfolios. The stock return volatility of one variable is decomposed into its own volatility and volatility spillovers from others. The empirical results show that the nature and extent of volatility spillovers to Chinese stocks vary across economic liberalization episodes. Moreover, the main contributor of volatility spillovers from foreign markets is the US stock market. Nonetheless, in all events, the major source of volatility for Chinese stocks is mainly from shocks in Chinese market rather than shocks in international stock markets.

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Chapter 1

Introduction

China has been undergoing a period of extremely high economic growth and this, in part, is due to the continuing globalization resulting from the adoption of an open economy.

Global market opportunities and threats are major effects of globalization. On the one hand, globalization affects international trade by creating global market opportunities. Many studies have revealed that an entry to global markets enables firms to access to industrial and financial resources around the world and to expand their business into many new markets which help enhance firm performance (Hafsi (2001), Levitt (1993) and Shocker et al. (1994)). On the other hand, it brings in threats from international markets. An advent of global competitors along with an increasing intensity of competition, as well as higher cross-border market uncertainties, can be detrimental to firm performance (Scully and Fawcett (1994) and Jones (2002)). These two effects cause firms to adapt their organizational structures and strategies accordingly (Jones (2002) and Knight (2000)). In consequence, evolution of international trade in China is likely to impact Chinese firms' performance one way or another. Hence, investigating the relationships between globalization effects and Chinese firm performance will help us gain better understanding about the directions of the effects, determine appropriate strategies to better manage these effects, and help Chinese firms stay competitive in a globalized world.

The above topics have gained numerous attentions among academia. The vast number of empirical papers on international trade and firm performance generally conduct experiments through the first moment of firm performance (Bernard et al. (1995), Bernard and Jensen (1999), Bernard and Wagner (1997), Wagner (2007), Schank et al. (2007), Wagner (2012) and López (2006)). However, relatively little attention has been paid on investigating the extent to which global engagement affects the second moments of firm-level performances (Wei and Zhang (2006) and Girma et al. (2015)). Besides, most of existing literature in international trade rely on low-frequency data which naturally forces researchers to estimate volatility using rolling standard deviations which causes several shortcomings. For example, the volatility measured is assumed to be constant within the estimation window (Schwert (1989) and Bloom (2014)), sensitive to the length of the estimation window (Comin and Philippon (2006)) and underestimate volatility when episodes of high volatility are short-lived (Bachmann et al. (2013)).

Accordingly, this thesis aims to bridge the gaps existing in current researches about international trade and firm performance. By using of high-quality firm-level data along with high-frequency data to estimate risk and return at firm-level, our study provides empirical evidence on the linkages between firms' globalization and risk-return of Chinese listed companies.

1.1 Motivation

We begin our thesis with a study regarding the effect of exchange rates on stock return of listed companies in Chapter 2. Returns of firms that trade internationally (e.g., import, export and both) are known to be affected by fluctuation in exchange rates. The sensitivity of firm return to exchange rate is commonly measured in terms of exchange rate exposure.

Although there exists several researches exploring the existence of exchange rate exposure, the conclusions are ambiguous. One reason could be that exchange rate indices employed in past studies do not reflect true exchange rate exposure that trading firms experience. We therefore construct a firm-specific exchange rate index based on destination-specific export and import values. Accordingly, more accuracy in capturing firms' exchange rate exposure is expected when applying the proposed exchange rate index in the study.

Next, in Chapter 3, our attention is drawn to the issue of equity risk premium of exporting firms. Basically, exporting firms bear more risks than non-exporting counterparts in several aspects. They take risk on, for instance, uncertain exchange rates, transportation costs, overseas consumption in each of their export markets. A compensation for the risk taken, typically, is measured by risk premium. A positive risk premium indicates return rewarded is above that of a risk-free investment while a negative value denotes that risk-bearing investment is paid off lower than a risk-free investment. Hence, we aim to provide information to exporting firms the risk premium contribution from each of their current and potential export destinations. The study is motivated by the desire to provide useful information to support firms in choosing exports destination markets strategically. In addition, the information on risk premia of export destinations helps evaluate risk-return reward on current and potential export markets to keep their stock performance attractive to shareholders and investors. From investors' perspective, such knowledge is beneficial in allocating a portfolio to select firms that export to countries giving positive risk premia.

Lastly, Chapter 4 focuses on volatility spillover from international stock markets to Chinese stocks. Generally, stock return volatility is caused by shocks from domestic and foreign stock markets. In the past two decades, China's authorities implemented a series of economic liberalizations (e.g., trade, stock market and exchange rate liberalizations) which results in a closer connection between Chinese stock market and the world. This provides the motivation to investigate the extent to which economic and financial liberalizations has engendered volatility transmission to Chinese stocks. In addition, since a large body of literature usually study volatility spillover at country-level, it does not provide information if there is heterogeneity in volatility transmission across firm types which could be beneficial to policymakers in regulating stock market. In consequence, we break down Chinese stock markets into three portfolios, i.e., exporting, domestic manufacturing and domestic services firms to study further volatility spillover at deeper level.

1.2 Research Questions

This thesis studies several aspects that relate characteristics and activities of firms that trade internationally to risk and return of their equities. The key questions that are the guidelines for our studies in each chapter are given as follows:

In Chapter 2, we study exchange rate exposure at firm level differently from literature by using firm-specific exchange rate index. Typically, trade-weighted exchange rate index is widely employed in relevant studies where all firms are assumed to be exposed to the same set of currencies based on values their home country has been trading with other countries. As such, some firms are assumed to bear risk associated with currencies they are not trading with, which is likely to lead to unconvincing conclusion. Our proposed exchange rate index aims to more accurately represent the exchange rate risk that firms encounter. Moreover, our dataset covers two exchange rate regimes in China which allows us to explore if firms are more exposed to exchange rates during the managed float regime. Subsequently, the primary questions are:

- Does the firm-specific exchange rate index improve capturing exchange rate exposure of trading firms?
- Does the managed-float exchange rate regime result in more number of firms being

exposed to exchange rates?

In Chapter 3, we decompose the risk premium of Chinese exporting firms. It is assumed that both current and potential export destinations take part in total risk premium of an exporting firm. Once the risk premium is disintegrated into country contributions, it is interesting to see that

- How much is risk premium of Chinese exporting firms contributed from each export destination?

In Chapter 4, we estimate volatility spillover to Chinese stocks in various events of economic liberalizations. The study is conducted at two levels; the first one aggregates all Chinese stocks in the sample to represent Chinese stock market and the second one divides all Chinese stocks to the three separate portfolios of exporting, domestic manufacturing and domestic services firms. Consequently, we can observe both volatility transmitting from international stock markets to Chinese stocks and volatility spillover from foreign stock markets to each portfolio (which also includes volatility spillover among the portfolios). This study aims to answer the following key questions:

- What is the main source of volatility spillover to Chinese stocks: own volatility, shocks from international stock markets or shocks from other firm types in China?
- Is volatility spillover from each source to Chinese stocks different according to the nature of the economic liberalization events?

Apart from answering the above questions, in order to ascertain the robustness of the findings obtained, the thesis hence contains more refined questions in the sequel.

1.3 Contributions

The methodologies employed and findings documented in this thesis make several contributions to existing literature. In particular, the detailed datasets which we employ enable us to broaden issues that are previously explored by other scholars at firm-level.

In Chapter 2, we improve the proxy of exchange rate exposure in the models of Jorion (1990) and Allayannis and Ihrig (2001) from trade-weighted and industry-weighted exchange rate indices to firm-specific exchange rate index based on destination-specific export and import values. Moreover, although there are prevalent studies on exchange rate exposure at country-level, a firm-level exchange rate exposure of Chinese trading firms has not been studied elsewhere before.

In Chapter 3, the study of Fillat et al. (2015) which demonstrates an approach to geographically decompose risk premia of US MultiNational Enterprises (MNEs) is a cornerstone of our study in decomposing risk premium of Chinese exporting firms by their export destinations. The model of Fillat et al. (2015) represents risk associated with MNEs' affiliates through covariances between Gross Domestic Product (GDP) growth rates of the US and host countries. In contrast, we represent risk underlying in each export destination market of exporting firms by covariances between stock index returns of China and firm's export destinations. The advantages of using stock index returns are twofold. First, stock returns are more responsive to shocks and reflect investor expectations regarding economic condition. Thus, it is more forward-looking than GDP growth. Second, within equal timeframes, stock index returns have higher data frequencies available than GDP growth which provide us sufficient observations to estimate time-varying covariances. The latter benefit is also a key improvement on the methodology of Fillat et al. (2015) which assumes that covariances are constant over time.

In Chapter 4, we apply the methodology of Diebold and Yilmaz (2012) to measure volatility spillover from major stock markets to Chinese stocks in different economic liberalizations. Relevant studies that employ the same method explore volatility spillover at country-level and do not specifically focus on liberalization events. Our study at firm-type level (by segregating Chinese firms to exporting, domestic manufacturing and domestic services firms.) thus broadens the scope of the literature. To our knowledge, it is the first study that examines not only volatility transmission across stock markets but also volatility spillover across firm types. In addition, we use time series of conditional volatilities estimated from multivariate dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model instead of time series of unconditional volatilities as input of volatility spillover calculation. Our approach takes into account dynamic correlation among variables of interest which is ignored in the existing literature. Our measurement of volatility spillover should therefore provide more accuracy than that produced from existing approaches.

1.4 Thesis Outline

The rest of the thesis is organized as follows:

Chapter 2 investigates whether trading firms in Chinese stock market expose to exchange rate movements. We adopt the model developed by Allayannis and Ihrig (2001) and improve the proxy of an exchange rate index from trade-weighted exchange rate to firm-specific exchange rate based on destination-specific export and import values. The study inspects the number of firms showing significance exchange rate exposure over the fixed and managed float exchange rate regimes in China. Furthermore, additional analyses are performed to examine if appreciation or depreciation in local currency differently impacts firm returns. Also, we check if the estimation results are robust to outliers. Finally, determinants of exchange rate exposure are investigated.

Chapter 3 examines risk of Chinese exporting firms reflected by their equity risk premia. Firms exporting to different countries bear different underlying risks and hence they tend to have different risk premia. The study adapts the methodology of Fillat et al. (2015) which is originally used to geographically decompose risk premia of multinational enterprises. To study how much each country contribute to a risk premium of a Chinese exporting firm, we break down its risk premium by its existing and potential export destination countries. In consequence, the study provides benefit for exporting firms to choose export destinations where risks taken are well compensated by additional returns.

Chapter 4 studies volatility spillovers from international stock markets to Chinese stock market. A volatility spillover is measured through a spillover table developed by Diebold and Yilmaz (2012) which decomposes volatility of a variable into its own variance and volatility spillovers from others. We examine volatility transmitted to Chinese stocks in two levels; the first one concerns with volatility from foreign stock markets to stocks of all Chinese listed firm in aggregate while the second one separates Chinese firms into separate stock portfolios of exporting firms, domestic manufacturing firms and domestic services firms to inspect deeper for volatility spillovers across portfolios. We examine volatility spillovers from major stock markets (the US, the UK and Japan) to each portfolio and volatility spillovers across portfolios. The study provides insights on different levels of volatility spillovers from the sources (international stock markets as well as portfolios) under different economic liberalization episodes in China which is useful for policy makers in regulating the stock market.

Reviews of related literature are presented separately in each of Chapter 2 to Chapter 4. Lastly, Chapter 5 concludes the main findings of our works.

Chapter 2

Stock Returns and Exchange Rate Exposure: How important are firm-specific exchange rates?

2.1 Introduction

Exchange rate exposure, defined as the existence of foreign exchange rate risk on the value and stock price of firms, has been a topic of empirical investigation in the international and financial economics literature. For example, Jorion (1990), Bartov and Bodnar (1994) and Amihud (1994) find little evidence of significant effect of exchange rate changes on firm value for a small number of US firms. In addition, Bodnar and Gentry (1993) and Griffin and Stulz (2001) find a weak relationship between stock returns and exchange rate risk at the industry level across countries. On the other hand, He and Ng (1998), Chow and Chen (1998), Dominguez and Tesar (2001) and Koutmos and Martin (2003) provide strong evidence to support significant exchange rate exposure.

A major weakness of the existing literature and a reason that can also possibly explain the prevalence of studies that document insignificant exposure, is the absence of credible firm-specific exchange rate indices based on detailed information on firms' exporting and importing dynamics. It has been noted that the weighting of different currencies in aggregate exchange rates indices is unlikely to representative for each firm, Bartram (2004). In addition, using the trade-weighted exchange rate with weights deriving from national trade figures with major trading partners is documented to understate the extent of exposure, Dominguez and Tesar (2001). The main objective of this study, therefore, is to contribute to the literature by constructing firm-specific exchange rate indices based on destination-specific export and import values and to investigate the existence of exchange rate exposure in Chinese listed companies during 2000-2006.

China fixed its currency (The Chinese Yuan, CNY) until July 2005 then adopted a managed float exchange rate regime based on market supply and demand with reference to a basket of currencies[1]. Then in July 2008, the CNY was once again pegged to the US dollar in order to help its economy to ride through the global financial crisis, and this continued until 2010 after which it returned back to a managed float exchange rate regime. We exploit this interesting feature of Chinese exchange rate regimes, and make an additional contribution to the literature by testing the effects of exogenous changes exchange rate system on firms' exchange rate exposure in China. In this study, our dataset is ranging from 2000-2006 which covers two distinct exchange rate regimes, i.e., fixed exchange rate during January 2000 - July 2005 and managed float regime from August 2005 - December 2006. In later experiments, the two subperiods are marked as period 1 and period 2 to investigate if more number of firms are found exposed to exchang rate under the managed float regime.

The methodology employed in measuring exchange rate exposure in our study is adapted

[1]The central bank revealed that the Dollar, Euro, Yen and Korean Won are the main currencies in the basket. Others include the Singapore Dollar, Pound Sterling, Malaysian Ringgit, Russian Rouble, Australian Dollar, Thai Baht and Canadian Dollar. The weightings are however undisclosed.

from the work of Allayannis and Ihrig (2001) in which their trade-weighted exchange rate is replaced with our version of firm-specific exchange rate exposure. The exchange rate exposure estimation model proposed by Allayannis and Ihrig (2001) is acknowleged for its strong benefit in being able to identify channels of exchange rate exposure. The model postulates that changes of exchange rate exposure are determined by industry's markup, hence comtemporaneous effects of exchang rate movements on firm returns can be sensibly explained, unlike models without markups. It is also reported in the study of Allayannis and Ihrig (2001) that more firms are found significantly exposed to exchange rate comparing to the case that estimation models do not include markups. Likewise, we also investigate if the number of firms with significant exposure is increasing when markups are incorporated into an estmation model.

Despite of the growing international importance of Chinese economy, the exchange rate exposure has not been adequately examined in China. Thus, besides its academic contribution, we hope that our study contributes to the policy implications regarding the vexed issue of China's exchange rate management policy.

The rest of the paper is organized as follows. Section 2.2 provides a review of relevant prior studies. Section 2.3 discusses background about exchange rate regimes in China. The theoretical framework underpinning our empirical model is presented in Section 2.4. Section 2.5 presents the data and key variables used in our analyses. Section 2.6 exhibits econometric models employed in this study. The main findings of our study are discussed in Section 2.7. Results from further studies and robustness check are presented in Section 2.8. Lastly, Section 2.9 summarizes findings of our study.

2.2 Literature Review

After the abolishment of Bretton Woods fixed-parity system in 1970s, exchange rate risks have become increasingly important in international trade and financial management. Movement of exchange rates affect firm's cash flow and its valuation. Accordingly, exchange rate is a crucial issue that many studies give more concerned.

Typically, how currency fluctuations affect firm value is studied on the exchange rate exposure – the sensitivity of firm value to currency movements. According to Dumas (1978), Adler and Dumas (1984) and Hodder (1982), exchange rate exposure of firms can be measured by the sensitivity of stock returns to exchange rate movement. Alternatively, one can also quantify the exposure as the sensitivity of cash flows to exchange rate movements.

Many studies investigate the exchange rate exposure by using standard regression (Capital Asset Pricing Model, CAPM). Firm returns are regressed on market portfolio return and a return on an exchange rate. Jorion (1990), Bartov and Bodnar (1994) and Amihud (1994) are among the first who studied the foreign exchange rate exposure and found low or negligible levels of exposure of US multinational corporations.

Jorion (1990) is the first to measure the impact of exchange rate exposure and its determinants. He examined the exposure to foreign currency risk by using 287 US multinational and monthly data for a period from 1971 to 1987. He regressed the firm's stock returns on the rate of change in trade-weighted exchange rates and the rate of return on the Center for Research and Security Prices (CRSP) value-weighted market index. The result shows that there is a weak evidence of such a relation existing. Moreover, this study finds that the foreign sales ratio representing the degree of involvement in foreign operations is an important determinant of exchange rate exposure. In addition to the work of Jorion, Amihud (1994) finds weak support of exchange rate exposure for 32 large US exporters during 1982 to 1988. He argues that cash flows are not immediately affected by exchange rate changes and firms' financial statements information reaches the market with a time lag. Hence, he adds lagged effect of exchange rate variability on firm value and finds there is significant.

Bartov and Bodnar (1994) find that systematic error from estimating the correlation between exchange rate changes and stock returns may cause previous studies failed to identify significant exchange rate exposure for a sample of 208 US firms. Their discovery implies that stock price adjustments arising from exchange rate movement take time. As a result, lagged exchange rate is taken into account as another explanatory variable. The results point out that there is no significant relationship between stock returns and exchange rate changes at the same period but there is a significant correlation between one period lagged fluctuations in exchange rate and stock returns. One explanation is that it takes time for the market to fully realize the potential impact on firms' cash flows.

In contrast to the previous studies, Choi and Prasad (1995) use 409 US multinational firms to investigate the exchange rate movement during 1978-1989 and find significant exchange rate exposure to firm values. Specifically, 60 percent of firms with significant exchange rate exposure benefit from a depreciation of the dollar.

One explanation for the weak relationship between firm values and exchange rate changes is that prior studies have mainly focused on studying the exchange rate exposure of US multinationals and it is not clear whether these empirical results are merely a spurious correlation that may not be confirmed in other countries. Therefore, some studies test the exchange rate exposure in other countries. For instance, He and Ng (1998) use a sample of Japanese firms to test and find a strong contemporaneous relation between foreign sales and exposure, but find no evidence of a lagged relation.

Many researchers have conjectured that firms in small, open countries are more sensitive to exchange rate exposure than firms in larger and less open economies. This leads to a number of studies focusing on multi-national rather than single national data. Bodnar and Gentry

(1993) elevate from firm-level to industry-level to investigate the impact of exchange rate exposure by adding trade-weighted exchange rates to the model for industry portfolios in each three countries, namely, Canada, Japan and the USA. The result of these countries have the same, about 20-35 percent of industries have significant exchange rate exposure. From this specification, the effect of exchange rate movements on industry returns is larger for Canada and Japan than the USA. Moreover, they also decompose industry exchange rate exposure into components of many variables such as a non-traded industry dummy variable, an import penetration ratio, an export ratio, a measure of the reliance on internationally-priced input and the ratio of foreign assets to total assets. The results present that these characteristics influence an industry exchange rate exposure for all three countries in a manner that is broadly consistent with economic theory.

Dominguez and Tesar (2001) use eight industrialized and developing countries to test and find a statistically significant level of exposure during 1980-1999. About 23 percent of firms and 40 percent of industries are exposed to at least one of the trade-weighted exchange rate, the US dollar and the currency of the country's major trading partner. Moreover, exposure is correlated with firm size, multinational status, foreign sales, international assets, competitiveness and trade at the industry level. However, Allayannis and Ihrig (2001) suggest that excluding information about the level of markups in an industry will produce less precise estimates of exposure. Their paper investigates how to properly specify and test for the factors that affect exchange rate exposure for 82 US manufacturing industries between 1979 and 1995. A theoretical model is developed explicitly identifying the sources of exposure. Their study adds the markup into the model which imported input and final goods markup vary over time. The results point out that 4 of 18 industry groups are significantly exposed to exchange rate changes through at least one of the channels of exposure, namely, the competitive structure of the market where the final output is sold, export share and industry structure, and imported input share and imported input competitive structure. In total, a

1 percent appreciation of the dollar reduces on average the returns of an industry by 0.13 percent. The statistics suggest that incorporating markups in the measure of exchange rate exposure improves upon previous measures, when markups are volatile. The exchange rate exposure increases as industry's markup falls.

The second explanation on why previous literature find no evidence of significant exposure to exchange rate risk for stock returns is possibly due to the use of exchange rates proxies such as bilateral exchange rate, common exchange rate indices and firm-specific exchange rate indices which give different results on exchange rate exposure significance. One aspect which has drawn attention to many scholars is the selection of the exchange rate index. Empirical researches often create a proxy of exchange rate to translate all the exchange rate movements affecting the sample firms' value. The single currency can be possibly used, as appeared in Booth and Rotenberg (1990), Williamson (2001), Glaum et al. (1998), Entorf and Jamin (2007) and Priestley and Ødegaard (2006) under the assumption that firms' value in the sample is largely affected by the exchange rate movement of one single trading partner. Apart from single currency proxy, a trade-weighted exchange rate indices are also widely used as seen in the works of Jorion (1990), Bartov and Bodnar (1994), Amihud (1994), Bartov and Bodnar (1994), Choi and Prasad (1995), Donnelly and Sheehy (1996), He and Ng (1998), Chow and Chen (1998), Ihrig (2001) and Bodnar and Wong (2003).

However, using a trade-weighted index may underestimate corporate exposure in out-of-sample period if collected data are of low and negative correlations than usual. Miller and Reuer (1998) include the most relevant currencies by using a principal components factor analysis to alleviate the underestimation problem. Another concern on the use of trade-weighted indices is the lack of power if a firm is mostly exposed to only one or a few currencies within the basket. Dominguez and Tesar (2001) document that this is a main shortcoming of using a trade-weighted basket of currencies in exposure tests. This may lead to an underestimation of the exposure of the firm. One possible way to mitigate this problem is to create firm and industry specific exchange rates. Therefore, the more pertinent indices should be a function of the firm-strategic position. Khoo (1994), Ihrig (2001), Muller and Verschoor (2004) and Fraser and Pantzalis (2004) find more significant exposure with firm-specific indices than earlier exposure studies.

Consequently, Ihrig (2001) presents a method to construct firm-specific exchange rate indices for each firm based on the number and locations of a multinational's subsidiaries. With the available data of locations and numbers of MNCs, the exchange rate is a weighted average of the home currency bilateral exchange rates for where its subsidiaries are located. The weight given to a country's exchange rate is associated with the number of subsidiaries located in that country relative to the total number of foreign subsidiaries of the MNC. Using these indices in the simple Jorion model, she pointed out that the number of US multinationals with significant exposure rises from 10 percent to 16 percent by using firm-specific exchange rates for a sample of 226 MNCs. According to this result, she argued that exchange rate exposure by using firm-specific exchange rates is much more prevalent than the previous studies.

Fraser and Pantzalis (2004) examine the relationship between changes in foreign exchange rates and stock prices of US MNCs by using firm-specific foreign exchange rate indices based on the structure of each company's geographic network of foreign subsidiaries. There are two approaches to forming each firm's index in this paper. First, the index is a subsidiary-weighted index. In this instance, the firm-specific index is the product of a row vector of subsidiary weights (measured as the ratio of subsidiaries in a particular country over the total number of foreign subsidiaries) and a column vector of the returns of the respective bilateral US–foreign currency exchange rates at time t . Secondly, the index is an equal-weighted index. In this case, the firm-specific index is the product of a row vector of weights measured as $1/n$ (where n is the number of foreign countries within which the MNC operates) and a column vector of the returns of the respective bilateral US–foreign currency exchange rates at time t. The results show that there are more firms with significant exposure than when a common foreign exchange rate index is used as in comparable studies. This means that the choice of a foreign exchange variable is critical when evaluating the determinants of exposure.

One of the objectives is constructing the firm-specific exchange rate based on destination-specific export and import values. Our exchange rate index aims to represent trade values distribution over individual firm's export destinations and import origins. A trading-partner country with large net export value to a firm will earn significant weight in the firm's exchange rate index and thus imply the potential of exchange rate exposure on that trading-partner's currency. Comparing to the subsidiary-weighted index (based on MNEs) in Fraser and Pantzalis (2004), our new exchange rate index specifies exchange rate exposure more precisely on the sources of exchange rate exposure. Trade values by export destinations or import origins are used to calculate the weight for the index instead of subsidiary locations, reflecting more precise sources of exchange rate exposure.

In addition, Bartov and Bodnar (1994) exhibit that past studies fail to appropriately identify the relationship between exchange rates and stock prices due to asymmetries in the impact of appreciations and depreciations among other complexities. Appreciations and depreciations of currencies can influence differently how firm returns respond to exchange rate movements, indicating asymmetries in the exposure. Additionally, Koutmos and Martin (2003) examined the hypothesis that the exchange rate exposure is asymmetric over appreciation-depreciation cycles. The asymmetric exchange rate exposure is implied in some theoretical models to explain firm's behaviour such as a firm's asymmetric pricing-to-market, hysteretic behaviour and asymmetric hedging behaviour. The results show that there is significant exchange rate exposure in about 40 percent of the country-sector models and over 40 percent of the significant exposure turn out to be asymmetric. Moreover there is asymmetric exposure within the financial sector, which may be attributed to asymmetric hedging, and within the consumer non-cyclical sector, which may be attributed to asymmetric price to market and/or hysteretic behaviour. In addition, the error term exhibits time varying variance at both market level and the country-sector level.

Lin (2011) investigated empirically the foreign exchange exposure on stock returns in the Asian emerging markets from July 1997 to November 2010. Many Asian emerging countries' currencies severely fluctuated in value during the 1997 and the 2008 financial crisis and hence it is important to examine the impact of foreign exchange rate change on stock returns in these markets to see whether foreign exchange exposure became more significant or larger during the crisis periods. The asymmetric exchange exposure framework and real exchange rates are used in this paper to capture the different exposure between currency appreciation and depreciation and the high inflation effect in the emerging markets. Using firm level analysis, it shows that foreign exchange exposure became more significant or greater during the 1997 Asian crisis and the 2008 global crisis periods, despite the frequent central banks' interventions during these periods. The greater exchange exposure during the crisis periods can be attributable to net exporters or firms with dollar assets, implying that firms can reduce exchange exposure by decreasing their export ratio or dollar assets holding during times of crisis. Moreover, during the 1997 Asian crisis period and the tranquil period prior to the 2008 global crisis, in all of the significant exchange exposure cases, the domestic market portfolio damages from domestic currency depreciation were consistent with the phenomenon of "liability dollarization" in emerging markets.

The other possible explanation for the absence of evidence on the significant exposure of stock returns to exchange rate is due to the fact that corporations using foreign currency hedging instruments may have reduced the ability of these studies to identify a significant contemporaneous correlation between stock returns and exchange rate fluctuations. Empirical studies of the incentives to hedge for multinational firms also support this conjecture. Chowdhry and Howe (1999) and Pantzalis et al. (2001) explore why those firms have insignificant exchange rate exposure and found that multinational firms may employ financial or operational hedged to mitigate foreign currency risk. Additionally, Hsin et al. (2007) explored why the literature finds no prevailing evidence of significant exposure to exchange rate risk for US stocks. They contribute to the extant literature by adding to the empirical understanding of the pattern of revision with regard to the lagged currency exposure and its association with exchange rate risk pricing. They revealed the crucial role played by the lagged exposure. However, the currency risk for the overall sample does not become more significant to pricing. Their study provides evidence consistent with the asymmetric hedging hypothesis, in that asymmetric hedging is found to be responsible for reshaping the relationship between firm's characteristics and its currency exposure.

What distinguishes Júnior (2009) from others is that he investigated the exchange rate exposure of a sample of non-financial Brazilian firms from 1999 to 2009 using nonlinear models to address firms' exchange rate exposure. The results confirm the importance of using non-linear models to address firms' exchange rate exposure. The nonlinear model increases in the number of firms exposed to exchange rate compared to linear model. Moreover, the study points out that exporters and companies that hold foreign currency denominated debt are more likely to be exposed to exchange rate fluctuations and that the non-linearity of firms' foreign exchange exposure is associated with the use of foreign currency derivatives.

A few studies have examined the exchange rate exposure of Chinese firms in the recent years. Aggarwal et al. (2011) examine the foreign exchange risks faced by Chinese companies. The study for Chinese firms finds that the stock returns of Chinese firms are exposed to exchange rate risk significantly during July 2005 to July 2006. When the Yuan appreciates, some firms' values decrease while for many firms, their stock returns increase. This means that Yuan appreciation does not hurt the competitiveness of many firms. Moreover, the magnitudes of the currency risk coefficients for Chinese companies (less than 10 percent) are smaller than those previously documented for firms in other countries (20-40 percent). In addition, Chinese exporters have insignificant currency risk exposure associated with the currencies of China's top four trading partners: the EU, the US, Japan and Hong Kong. However, the results indicate that Chinese exporters are exposed to risk related to the association of southeast asian nations (ASEAN) currency index. Yuan appreciation also impacts exporters to India, Australia and Russia in industries such as construction, machinery/equipment and healthcare/pharmaceutical.

Wang and Di Iorio (2007) examine the role of both local beta and global betas in explaining stock returns in the Chinese A-share market by using an extension of the Fama and Macbeth cross-sectional regression model. The results show that both the conditional local beta and the global betas have no significant relationship with stock returns in A-shares. Moreover, firm factors such as the book-to-market ratio and firm size are important in explaining stock returns.

Chen et al. (2010) examine stock return predictability in China for the sample period from 1995 to 2007. They find relatively weak predictability for Chinese stocks. In addition, they test two hypotheses for the cause of weak returns predictability and find support for both hypotheses. The first hypothesis is return predictors in China are less heterogeneously distributed than they are in the US. Another is stock prices are less informative in China than they are in the US.

Unlike previous studies on China, our study examines exchange rate exposure in China by constructing the firm-specific exchange rate indices and separate analysis into two periods according to different exchange rate regimes. The first period, the dollar-pegged policy, is from January 2000 to July 2005 and the second ranges from August 2005 to December 2006 to cover the manged float exchange rate regime.

Table 2.1: Summary of empirical literature.

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Jorion (1990)		•	1971-1987	U.S. multinational.	$R_{it} = \beta_{oi} + \beta_{1i}R_{mt} + \beta_{2i}\Delta EX_t + \mu_t$	Trade-weighted exchange rates.	First person who measured impact of FX exposure and its determinants. Find insignificant relationship.
Bodnar and Gentry (1993)	•		1979-1988	Canada, Japan, the US.	$R_{i,t} - rf_t = \beta_{0,i} + \beta_{1,i}(R_{m,t} - rf_t) +$ $\gamma_0 PCXR_t + \sum_{k=1}^{n}\gamma_k(C_{k,t}PCXR_t) + \varepsilon_{i,t}$ $i = 1,\ldots,l$ Where $PCXR_t$ is the percentage change in the trade-weighted nominal exchange rate in month t, $C_{k,t}$ is the set of characteristics for industry i	Trade-weighted exchange rates.	Find that from 20 to 35% of industries in Canada, Japan, and the United States have significant exchange rate exposure as measured by the coefficient on the foreign exchange variable.
Amihud (1994)		•	1982-1988	U.S. exporters.	$RP_t = \alpha + \beta RM_t + \delta_k DX_{kt} + \varepsilon_t$ $RP_t = \text{constant} + aRM_t + bRP_{t-1} +$ $cDX_{r_{t-1}} + dDX_{r_{t-2}} + \ldots + hDX_{r_{t-6}} + \varepsilon_t$ Where DX_{kt} is the difference of the exchange rate	Trade-weighted exchange rate index.	Find significant effect when lagged FX fluctuation is applied.

Table 2.2: Summary of empirical literature (continued).

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Bartov and Bodnar (1994)		•		The US.	$ASP_{i,t} = \alpha_o + \sum_{j=0}^{n} c_j \Delta CUR_{i,t-j} + \varepsilon_{i,t}$ where $ASP_{i,t}$ is the abnormal stock performance for security i in period t (in percentage form), $\Delta CUR_{i,t-j}$ is the percentage change in a trade-weighted U.S. dollar exchange rate index for the period t to j	Trade-weighted U.S. dollar exchange rate index.	Stock price adjustments arising from exchange rate movement take time. They recognize that past studies may fail to identify the exposure due to asymmetries in the impact of appreciations and depreciations.
Choi and Prasad (1995)		•	1978-1989	U.S. multinational.	$R_{it} = \alpha_i + \beta_{1i} R_{mt} + \gamma_i e_t + v_{it}$	Dollar value of one unit of a trade-weighted basket of currencies.	Find significant exchange rate exposure to firm values.
He and Ng (1998)		•	1979-1993	Japan.	$R_{it} = \beta_{i0} + \beta_{ix} R_{xt} + \beta_{im} R_{mt} + \mu_{it}$	Trade-weighted exchange rates.	Nearly 25% of the 171 Japanese multinationals exhibit significant exchange rate exposure. Find a strong contemporaneous relation between foreign sales and exposure, but find no evidence of a lagged relation.

Table 2.3: Summary of empirical literature (continued).

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Allayannis and Ihrig (2001)	•		1979-1995	82 U.S. manufacturing industries.	$R_{it} = \beta_{0i} + \beta_{1i}R_t^m +$ $\beta_{2i}\left[\left(\frac{1}{\hat{MKUP}_{it}}\right)+\left(\frac{X_{it}}{V_{it}}\right)\left(1+\frac{1}{\hat{MKUP}_{it}}\right)\right]\Delta ER_t +$ $\beta_{3i}\left[\left(\frac{M_{it}}{V_{it}}\right)\left(\frac{1}{\hat{IMKUP}_{it}}\right)\right]\Delta ER_t + \varepsilon_{it}$ Where ΔER_t is the rate of return on a real dollar exchange rate index; $\hat{MKUP}_{it}$ is the price cost mark-up of the final output good market of industry i at time t; $\hat{IMKUP}_{it}$ is the imported input price cost markup of industry i at time t; $\frac{M_{it}}{V_{it}}$ is the share of imported inputs in industry i at time t; $\frac{X_{it}}{V_{it}}$ is the share of exports in industry i at time t.	Trade-weighted monthly dollar index.	4 of 18 of the US manufacturing industry groups are significantly affected by exchange rate movements, a larger number of industry groups than previously thought. The result provides evidence that excluding markups produces less precise estimates of exposure.
Ihrig (2001)		•	1995-1999	The US.	$R_t^i = \alpha_0^i + \alpha_1^i R_t^m + (\beta_1^i + \beta_2^i I_t^i)\Delta e_t^i + \varepsilon_t^i$ where I^i is an exchange-crisis indicator function	Firm-specific exchange rate index based on the number and locations of a multinational's subsidiaries.	Find significant effect when using firm-specific exchange rate.

Table 2.4: Summary of empirical literature (continued).

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Jorion (1990)		•	1971-1987	U.S. multinational.	$R_{it} = \beta_{oi} + \beta_{1i} R_{mt} + \beta_{2i} \Delta EX_t + \mu_t$	Trade-weighted exchange rates.	First person who measured impact of FX exposure and its determinants. Find insignificant relationship.
Bodnar and Gentry (1993)	•		1979-1988	Canada, Japan, the US.	$R_{i,t} - rf_t = \beta_{0,i} + \beta_{1,i}(R_{m,t} - rf_t) +$ $\gamma_0 PCXR_t + \sum_{k=1}^{n} \gamma_k (C_{k,t} PCXR_t) + \varepsilon_{i,t}$ $i = 1,\ldots,l$ Where $PCXR_t$ is the percentage change in the trade-weighted nominal exchange rate in month t, $C_{k,t}$ is the set of characteristics for industry i	Trade-weighted exchange rates.	Find that from 20 to 35% of industries in Canada, Japan, and the United States have significant exchange rate exposure as measured by the coefficient on the foreign exchange variable.
Amihud (1994)		•	1982-1988	U.S. exporters.	$RP_t = \alpha + \beta RM_t + \delta_k DX_{kt} + \varepsilon_t$ $RP_t = \text{constant} + aRM_t + bRP_{t-1} +$ $cDX_{r_{t-1}} + dDX_{r_{t-2}} + \ldots + hDX_{r_{t-6}} + \varepsilon_t$ Where DX_{kt} is the difference of the exchange rate	Trade-weighted exchange rate index.	Find significant effect when lagged FX fluctuation is applied.

Table 2.5: Summary of empirical literature (continued).

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Dominguez and Tesar (2001)	•		1980-1999	Eight industrialized and developing countries.	$R_{i,t} = \beta_{0,i} + \beta_{1,i} R_{m,t} + \beta_{2,i} \Delta S_t + \varepsilon_{i,t}$	Two common ER and firm specific rate corresponding to the currency of the firm's major trading partner.	Find significant FX exposure in industry level.
Koutmos and Martin (2003)	•		1992-1998 (w)	The US, the UK, Japan, Germany.	$R_t = \beta_0 + \beta_1 R_{m,t} + \theta^+ x^+{}_t + \theta^- x^-{}_t + \varepsilon_t$ $R_t = \beta_0 + \beta_1 R_{m,t} + (\beta_x + \beta_{D,x} D_t) x_t + \varepsilon_t$ where $\beta_x = \theta^+ , \beta_{D,x} = (\theta^+ - \theta^-)$ *and* $D_t = 1$ *if* $x_t < 0$ *and zero otherwise*	Bilateral exchange rates.	There is significant exchange rate exposure in about 40 percent of the country-sector models and over 40 percent of the significant exposure turns out to be asymmetric.
Fraser and Pantzalis (2004)		•	1995-1999	The US.	$R_{it} = \beta_0 + \beta_1 FX_t + \varepsilon$ $R_{it} = \beta_0 + \beta_1 FX_t + \beta_2 MKT + \varepsilon$ $R_{it} = \beta_0 + \beta_1 FX_t + \beta_2 FX_{t-1} + \varepsilon$ $R_{it} = \beta_0 + \beta_1 FX_t + \beta_2 FX_{t-1} + \beta_3 MKT_t + \varepsilon$ $\beta_{1i} = \gamma_0 + \gamma_1 NETSTR_i + \varepsilon$ Where $NETSTR_i$ is a measure of a firm's foreign operations network	Firm-specific exchange rate indices based on the structure of each company's geographic network of foreign subsidiaries.	Using firm-specific exchange indices, more firms have significant exposure than when a common foreign exchange rate index is used as in comparable studies.

Table 2.6: Summary of empirical literature (continued).

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Muller and Verschoor (2004)		•	1990-2001	The US.	$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \Gamma_i \Theta_t + \varepsilon_{i,t}$ where $\Gamma_i \Theta_t = \gamma_{EU.i}\theta_{EU.t} * D_{EU.i} + \gamma_{UK.i}\theta_{UK.t} * D_{UK.i} + \gamma_{AS.i}\theta_{AS.t} * D_{AS.i} + \gamma_{AU.i}\theta_{AU.t} * D_{AU.i} + \gamma_{LA.i}\theta_{LA.t} * D_{LA.i} + \gamma_{SA.i}\theta_{SA.t} * D_{SA.i}$ and $\theta_{EU.t}, \theta_{UK.t}, \theta_{AS.t}, \theta_{AU.t}, \theta_{LA.t}, \theta_{SA.t}$ denote the fluctuations of the price of one U.S. dollar in Euros, UK, a basket of Asian currencies, Australian dollars, a basket of Latin American currencies and South African and $D_{EU.t}, D_{UK.t}, D_{AS.t}, D_{AU.t}, D_{LA.t}, D_{SA.t}$ describe the presence of firm i's real activities in Europe, the U.K., Asia, Australia, Latin America and South Africa. Finally, $\gamma_{EU.t}, \gamma_{UK.t}, \gamma_{AS.t}, \gamma_{AU.t}, \gamma_{LA.t}, \gamma_{SA.t}$ measure the firm i's exchange risk exposure towards the euro, the U.K pound, Asian currencies, the Australian dollar, Latin American currencies and the South African Rand.	Trade-weighted world exchange rate index.	Results show that U.S. stock returns react asymmetrically to currency movements. Large currency fluctuations lead to stronger effect of asymmetries.

Table 2.7: Summary of empirical literature (continued).

Authors	Data		Period	Country	Model	Type of exchange rate	Key features
	industry level	firm level					
Rossi Jr (2009)		•	1999-2009	Brazil.	$R_{i,t} = \alpha + \beta_i^m * r_{m,t} + (\beta_i^s + \beta_i^{s'} * M_i(\gamma, c, z_{t-d})) * \Delta S_t + \varepsilon_{i,t}$ where $(\beta_i^s + \beta_i^{s'} * M_i(\gamma, c, z_{t-d}))$ represents firm's exchange rate exposure, which can be broken down into two terms. The first term indicates the linear portion of exposure and the second term represents the nonlinear part of the exchange rate exposure.	Bilateral exchange rate (BRLUSD).	The companies' exchange rate exposure is modelled in nonlinear approach. The results show that nonlinear model leads to an increase in the number of firms exposed to exchange rate fluctuations allowing more accurate analysis of the impact of exchange rate fluctuations on the value of firms.
Lin (2011)		•	1997-2010	Asian emerging markets.	$R_{m,t} = \beta_0 + \beta_1 R_{w,t} + (\beta_x + \beta_{D,x} D_t) X_t + \varepsilon_t$ where $R_{m,t}$ is the local market portfolio return; $R_{w,t}$ is the world market portfolio return; X_t is the unanticipated exchange rate change in which $X_t > 0$ represents domestic currency appreciation; $D_t = 1$ if $X_t > 0$ and zero otherwise		Foreign exchange exposure became more during the 1997 Asian crisis and the 2008 global crisis periods, despite the frequent central banks' interventions during these periods. During the 1997 Asian crisis period and the tranquil period prior to the 2008 global crisis, in all of the significant exchange exposure cases, the domestic market portfolio damages from domestic currency depreciation were consistent with the phenomenon of "liability dollarization" in emerging markets.
Aggarwal et al. (2011)		•	2005-2006	China.	$R_{i,t} = \beta_{i,0} + \beta_{1,x} R_{x,t} + \beta_{i,m} r_{m,t} + \varepsilon_{i,t}$	Yuan/foreign currency.	Find that some firms benefited from CNY appreciation.

2.3 Background on Exchange Rate Regimes in China

The Chinese Yuan[2] (CNY) first came effective in 1949 after the establishment of People's Republic of China in October 1949. The value of CNY was then pegged to the US Dollar (USD) at 2.46 CNY per 1 USD. Until the Chinese economic reform in 1978, CNY had gradually appreciated to 1.50 CNY per 1 USD in 1980. But in order to promote the competitiveness of Chinese exporters, the PBOC managed to undervalue the CNY to 8.27 CNY per 1 USD and pegged at the level until June 2005. The most recent reform includes the switch from the dollar-peg to a managed floating exchange rate regime, based on market supply and demand with reference to a basket of currencies on 21 July 2005. The Chinese authority also announced that it would allow the CNY to trade within a wide band of 0.3 percent per business day for the first time. Since then the CNY has appreciated in nominal terms by over 25 percent against the US dollar between 2005 and 2011. According to the Bank for International Settlements, over the past two years, the CNY has appreciated by 9.4 percent against the US dollar, and the real effective exchange rate of the CNY has appreciated by 6.3 percent.

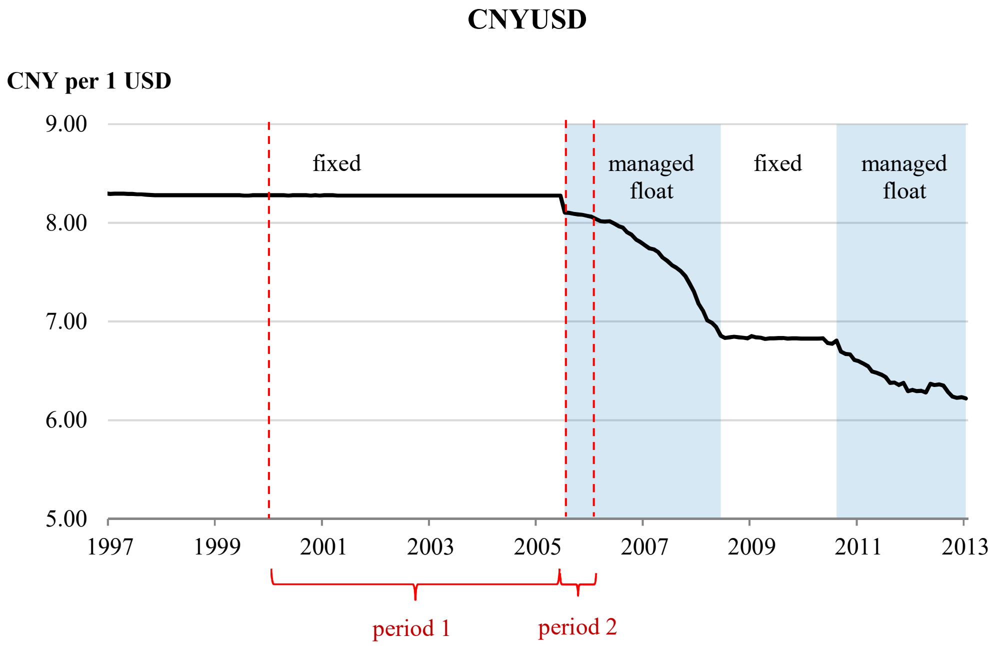
Considering the exchange rate regime in China, Figure 2.1 represents the exchange rate of Yuan against the US dollar. There are surprise changes in exchange rate policy during the sample period. We can separate exchange rate into four different regimes. Before 2005, the value of Yuan was pegged to the US dollar. But in order to promote the competitiveness of Chinese exporters and boost the economic growth, the People's bank of china (PBOC) managed to devalue the Yuan and pegged it at 8.27 Yuan per US dollar until 2005. Then in 21 July 2005, Chinese government decided to adopt the managed float regime in which the Yuan is tied to a basket of foreign currencies which is largely dominated by the US

[2] The "People's Currency" of China, or literally known in Chinese as "Renminbi" has a unit denominated in "Yuan". Both names can be used interchangeably as a currency unit in trade and transaction. They are often abbreviated as RMB and CNY respectively. To avoid ambiguity, this study uses "Chinese Yuan" or CNY as a proxy of official currency of China.

dollar, Yen, Euro and Korean Won. Since an introduction of the new regime, the CNY began to dramatically appreciate during that period and we will study such impact in our study. Another interesting period is during the sub-prime crisis 2008, Chinese government returned to fix the Chinese Yuan to the US dollar again. After that, in June, 2010 China unpegged its currency, the Yuan then began to appreciate and was traded around 6.30 Yuan per US dollar by the end of 2012. Although China adopted the managed float exchange rate, in the perspective of China trading‘s partners especially the US, the Yuan is still considered undervalued by 30-40 percent according to Lipman (2011). And also there is the debate that the part of China's growth has resulted from an artificially devalued currency that makes Chinese firms more competitive than they actually have. Hence, the result of the study during these different periods will also give new insight about the impact of policy shocks on firms' stock returns as well. We can therefore see whether or not Chinese firms are affected by the change of exchange rate regime. This can be considered as an evaluation of the PBOC's policies.

According to the managed float system, PBOC continually intervene the CNY to keep it undervalued. Knowing that exchange rate fluctuation directly affects firms' future cash flows, cost of capital and their accounting valuations (Aggarwal et al. (2011)), the Chinese central bank has been buying foreign currencies to prevent the CNY from appreciation. Consequently, China's foreign exchange reserves has grown remarkably to over 3 trillion US dollars by now and become the world's largest holder of foreign exchange reserves. This policy helps exporters keep their edge in selling prices and overcome any declining global demand or rising transportation costs. Chinese labors are also protected by the policy in which labor-intensive manufacturing firms can retain their profitability from export. As a result, labor costs in China can remain significantly low. This has induced many multinational enterprises to start up their businesses in China.

Figure 2.1: Exchange rate of Chinese Yuan per US dollar.



Note: Period 1 represents the fixed exchange rate regime (January 2000 - July 2005) and Period 2 is the managed float exchange rate regime (August 2005 to December 2006).

2.4 Theoretical Framework

We adopt the exchange rate exposure model from Allayannis and Ihrig (2001). The theoretical exchange rate exposure literature supports the common belief that exchange rate changes should impact firms that import from foreign markets, export to foreign markets, or face foreign competition. Their theoretical framework is analyzed how to properly specify and test for factors affecting exchange rate exposure. They report that industry markup and competition play key roles in exposure and show that US industries with low markup have high exchange rate exposure. Furthermore, the theoretical model is developed explicitly to identify the three channels of exposure. The first channel measures the competitive structure of the markets where the final output is sold. The second channel captures export share and industry structure, and the last channel measures imported input share and imported input competitive structure. A partial equilibrium model of a firm to scrutinize the effect of exchange rate changes on the firm's rate of return is discussed as follows.

Firm's rate of return at time t $(R_t)$is defined as

$$R_t = \frac{V_t - V_{t-1}}{V_{t-1}} \tag{2.1}$$

where V_t is the expected present discounted value of the firm at time t . Given the definition above, this is directly linked with how the exchange rate affects the firm's return (R_t) .

The expected present discounted value of the firm is based on the expected present discounted value of the firm's profit steam. Profit is a function of the firm's final goods, which it sells both domestically and abroad, as well as imported intermediate inputs and capital using in production. The firm starts a period with a given capital stock (K), the current exchange rate (e or ER) in home currency per unit of foreign currency, and current price of capital (r). The firm then chooses imports (M), and its capital stock for the following period ($K^{'}$), to maximize the expected discounted value of its profit. The firm's value function can be written as follows:

$$\begin{aligned} V(K,e,r) = \max[&pq(e,p) + ep^*q^*(e,p^*) - r(K-(1-\delta)K) \\ &- p_M M(e,p_M) + \rho EV(K^{'},e^{'},r^{'})|e,r] \end{aligned} \tag{2.2}$$

where $q(q^*)$ is the output of the final goods sold domestically (aboard); the firm uses M and K to produce its total output $q+q^*$; $p(p^*)$ is the price of the output good in domestic (foreign) currency; p_M is the domestic price of imported intermediate inputs; δ is the depreciation rate of capital; ρ is the discount factor; and prime ($^{'}$) denotes date $t+1$ values. All output or demand functions depends on the respective price in each market and on the exchange rate.

The expected profitability responded to exchange rates relies on these following three main channels, namely, domestic market revenues, export market revenues and imported intermediate input costs. To see the effect of exchange rate movements on the rate of return of the firm, consider a Taylor series expansion of V_t around $t-1$ date state variables. Equation (2.1) becomes

$$R_t = \frac{V_{e^*}(e_t - e_{t-1})}{V_{t-1}} + \frac{V_{r^*}(r_t - r_{t-1}) + V_{K^*}(K_t - K_{t-1})}{V_{t-1}}. \tag{2.3}$$

The first term presents the effect of exchange rate movements on the rate of return. The second term captures the effect of the capital stock and price of capital (the remaining state variables) on the rate of return. The envelope theorem is applied to our value function to investigate the effect of exchange rate movements on the rate of return. The movements in the exchange rate are assumed to be permanent and uncorrelated over time and that expectations of the other state variables are equal to their current level.

From equation (2.2), by using the envelope theorem, we get

$$\frac{\partial V}{\partial e} = p\frac{\partial q}{\partial e} + p^* q^* + ep^*\frac{\partial q^*}{\partial e^*} - p_M\frac{\partial M}{\partial e} + \rho E\frac{\partial V(K^{'}, e^{'}, r^{'})}{\partial e^{'}}\frac{\partial e^{'}}{\partial e}. \tag{2.4}$$

This equation solves for V_e . It is a function of the current state variables(K, e, r). If $E_t K_{t+1} = K_t$, $E_t r_{t+1} = r_t$ and $E_t e_{t+1} = e_t$ (the exchange rate follows a random walk), then by iterative substitution this reduces to

$$\frac{\partial V}{\partial e} = \frac{1}{1-\rho}\left[p\frac{\partial q}{\partial e} + p^* q^* + ep^*\frac{\partial q^*}{\partial e^*} - p_M M - p_M\frac{\partial M}{\partial e}\right]. \tag{2.5}$$

Given that $\frac{\partial q}{\partial e} = -\frac{\partial q}{\partial p}\frac{\partial p}{\partial e}$ by definition of the demand function, and $\frac{\partial p}{\partial e}\frac{e}{p} = \frac{\partial p*}{\partial e}\frac{e}{p^*} + 1$ since we assume domestic and export markups are equal and their costs are the same (we have $p = ep^*$; taking the derivative of $p = ep^*$ with respect to the exchange rate, they have $\frac{\partial p}{\partial e} = e\frac{\partial p*}{\partial e} + p^*$; multiplying through by $\frac{e}{p} = \frac{1}{p^*}$ obtains our desired result), and simplifying the marginal value of the firm with respect to movement in the exchange rate, they get this following equation

$$V_e = \frac{1}{1-\rho}\left(\frac{pq+ep^*q^*}{e}\right)\xi\phi + \frac{1}{1-\rho}\left(\frac{ep^*q^*}{e}\right)[1+\xi] - \frac{1}{1-\rho}\left(\frac{p_M M}{e}\right)\xi_M\phi_M \quad (2.6)$$

where

$\xi = \frac{\partial q}{\partial p}\frac{p}{q}$ represents the elasticity of demands for the domestic output,

$\xi_M = \frac{\partial M}{\partial p_M}\frac{p_M}{M}$ is the elasticity of demands for the imported intermediate input,

$\phi = -\frac{\partial p}{\partial e}\frac{e}{p}$ is exchange rate pass through for the domestic output, and

$\phi_M = -\frac{\partial p_M}{\partial e}\frac{e}{p_M}$ captures exchange rate pass through for the imported intermediate input.

The elasticity of demand is related to the firm's markup as defined by Domowitz et al. (1986). Specifically, the elasticity is the negative reciprocal of the price cost margin. The exchange rate pass-through coefficients are comparable to pricing-to-market estimates in the literature. Their values determine whether changes in the local currency prices amplify or dampen the effect of an exchange rate movement. Theory suggests that pass-through coefficients should be positive ($\phi > 0$ and $\phi_M > 0$).

The second term of equation (2.3) can be proxied by the market return. Since exchange rate may have little effect on the market return (e.g. Jorion (1991)), we can assume that the market return is only affected by our other state variables (r and k). If we assume that the effect of a change of the price of capital and capital stock affects a firm proportionally to that of the market as a whole, then $R_t^m = V_{r^*}(r_t - r_{t-1}) + V_{K^*}(K_t - K_{t-1})$.

Combining the above expression with equation (2.3) and (2.6), results in an equation links exchange rate movements with a firm's rate of return. The estimate equation is

$$\begin{aligned} R_t &= a_0 + a_1 R_t^m + \frac{\phi}{1-\rho}\frac{p_t q_t + e_t p_t^* q_t^*}{V_{t-1}}(\xi_t)\triangle e_t + \frac{1}{1-\rho}\frac{e_t p_t^* q_t^*}{V_{t-1}}(1+\xi_t)\triangle e_t \quad (2.7)\\ &+ \left(\frac{-\phi_M}{1-\rho}\right)\frac{p_{M_t} M_t}{V_{t-1}}(\xi_{Mt})\triangle e_t,\\ R_t &= a_0 + a_1 R_t^m + a_2\frac{p_t q_t + e_t p_t^* q_t^*}{V_{t-1}}(\xi_t)\triangle e_t + a_3\frac{e_t p_t^* q_t^*}{V_{t-1}}(1+\xi_t)\triangle e_t \quad (2.8)\\ &+ a_4\frac{p_{M_t} M_t}{V_{t-1}}(\xi_{Mt})\triangle e_t. \end{aligned}$$

where $a_0 = 0$, $a_1 > 0$ is the constant of proportionality between the market and the firm, $a_2 = \frac{\phi}{1-\rho}$, $a_3 = \frac{1}{1-\rho} > 0$, $a_4 = \frac{-\phi_M}{1-\rho}$, and $\triangle e_t$ is the percentage change in the exchange rate between dates $t-1$ and t .

Equation (2.8) shows that exchange rate movement affects a firm's size of the rate of return through trade shares, pass-through and markups. Firstly, we expect that on average, the share of domestic sales ($\frac{p_t q_t}{V_{t-1}}$) and the share of foreign sales ($\frac{e_t p_t^* q_t^*}{V_{t-1}}$) should positively affect the size of the rate of return, while the share of imported intermediate inputs ($\frac{p_{M_t} M_t}{V_{t-1}}$) should negatively affect the size of the rate of return. The larger the nominal value of trade shares, the larger the effect of exchange rate movements on the size of the rate of return. Secondly, since, on average, pass through (ϕ and ϕ_M) is found to be positive and less than unity (see, e.g., Knetter (1992)), pass through dampens the effect of exchange rate movements on the size of the rate of return. This also implies that we expect, on average, $a_2 > 0$ and $a_4 < 0$. Lastly, markups ($\frac{1}{\xi}$ and $\frac{1}{\xi_M}$) allow the firms to dampen the effect of exchange rate movement on their rate of return. The larger the markup, the smaller the effect exchange rate movements have on the size of the rate of return. Equation (2.8) shows how exchange rate exposure is related to trade shares and markups. Exposure is measured as $a_2\frac{p_t q_t + e_t p_t^* q_t^*}{V_{t-1}}(\xi_t) + a_3\frac{e_t p_t^* q_t^*}{V_{t-1}}(1+\xi_t) + a_4\frac{p_{M_t} M_t}{V_{t-1}}(\xi_{Mt})$. This is the elasticity of the firm's value with respect to the exchange rate. These three terms represent their three channels of exposure. The first channel measures the competitive structure of the markets where the final goods is sold. The second channel captures export share and industry structure, and the last channel measures imported input share and imported input competitive structure.

They assume that an industry's total sales (at home and abroad) proxy for the value of the industry and define, therefore, trade shares relative to total sales. This is simply a normalization, similar in spirit to Campa and Goldberg (1995). This normalization, along with the common final goods markup and exchange rate variable, may increase the collinearity in the third and fourth terms of equation (2.8), which represents exposure through the final output good side. To address this issue they combine those two channels in the estimation. Their estimation equation is therefore as follows:

$$R_{i,t} = \beta_{0,i} + \beta_{1,i} R_t^m + \beta_{2,i} \left[\left(\frac{1}{MK\hat{U}P_{i,t}} \right) + \left(\frac{X_{i,t}}{V_{i,t}} \right) \left(1 + \frac{1}{MK\hat{U}P_{i,t}} \right) \right] \Delta e_t \quad (2.9)$$
$$+ \beta_{3,i} \left[\left(\frac{M_{i,t}}{V_{i,t}} \right) \left(\frac{1}{IMK\hat{U}P_{i,t}} \right) \right] \Delta e_t + \varepsilon_{i,t}$$

where $R_{i,t}$ is the rate of return on the i th industry's common stock adjusted for inflation at date t; R_t^m is the rate of return on the market portfolio adjusted for inflation at date t; Δe_t is the rate of return on a real dollar exchange rate index; $MK\hat{U}P_{i,t}$ is the price cost markup[3] of the final output good market of industry i at time t; $IMK\hat{U}P_{i,t}$ is the imported input price cost markup of industry i at time t ; $\frac{M_{i,t}}{V_{i,t}}$ is the share of imported inputs in industry i at time t and $\frac{X_{i,t}}{V_{i,t}}$ is the share of exports in industry i at time t.

From equation (2.9), an industry's exchange rate exposure is affected by its competitive structure in the market where it sells its total production, by the interaction of the competitive structure of the export market and the export share, and by the interaction of competitive structure of the imported input market and its imported input share. The model predicts that markups have a positive effect through the total sales and exports ($\beta_2 > 0$) and a negative

[3] In their paper, the final goods markup is the price-cost margin (PCM) proxying for industry competitiveness in the final goods sector. They follow the methodology developed by Domowitz et al. (1986) to calculate PCM at the four-digit SIC level, as follows: $PCM = \frac{Value\,of\,output - payroll - cost\,of\,materials}{value\,of\,output}$

effect through imports ($\beta_3 < 0$). According to Allayannis and Ihrig (2001), incorporating markups in the estimates of exposure improves the precision of the exposure estimates. Therefore, our study will consider this variable in our analyses.

2.5 Data and Variables

2.5.1 Database Construction

In our study, we use five data sources to construct a firm-level data set. Subsequently, we construct the variables such as firm-specific exchange rate index, firm-specific markups, imported-input markups and other financial variables for each Chinese firm.

2.5.1.1 Bloomberg

This data source provides all Chinese listed companies in Shanghai or Shenzhen stock exchanges. As of 2013, there are in total 2,574 firms from the two markets; 996 firms from Shanghai stock exchange and 1,578 firms from Shenzhen stock exchange. We particularly retrieve stock prices and foreign exchange rates against the CNY. However, the number of firms with stock prices available varies from year to year as shown in Table 2.8 . All foreign exchange rates against the CNY corresponding to our trading partner countries are collected and the number of currencies with foreign exchange rates available is also shown in Table2.8.

2.5.1.2 Chinese Customs Trade Statistic (CCTS)

The second data source is a sample data covering 654 Chinese trading firms[4] participating in international trade from the Chinese Customs Trade Statistic (CCTS) during year 2000-

[4]It should be noted that the firms in this study are sample of population from Chinese Customs Trade Statistic.

2006. These monthly data contain information on Chinese firm names, export and import values[5] , export and import quantities, destination countries of export, origin countries of import, type of trades (e.g. ordinary trade and processing trade), IPO dates and product codes (a 8-digit Harmonized System Classification) of each firm. Specifically, the data specify firm-level trade values (in US dollar) by products and trade partners for 221 destination or source countries and 6,582 different products in the 8-digit HS Classification. The source is useful since it provides information on the type of trades (e.g., ordinary trade and process with imported materials) which allows us to explore the existence of heterogeneous effects on type of trades. Another advantage is the availability of high frequency (monthly) destination-specific data on exports and imports would allow one to make a more detailed and nuanced analysis of the exchange rate-firm value nexus. The number of firms and the number of trading partner countries (engaged in export, import or both) of Chinese firms in the CCTS data are shown in Table 2.8.

2.5.1.3 China's Annual Survey of Industrial Firms (CASIF)

China's Annual Survey of Industrial Firms (CASIF) provides yearly firm-level data covering year 2000 - 2006. Firms in CASIF data set are identified with 10-digit Enterprise Customs Coding system as used in CCTS data set[6]. There are in total 398 firms with 1,721 observations in the CASIF data set which are part of 654 firms in CCTS data set. This data source is mainly used for calculating firm-level markups. The key variables we retrieve from CASIF are therefore nominal output, wage and cost of materials.

[5] The export and import values were collected monthly which can be tracked down to the export destination and import origin countries of each firm.

[6] More details of CASIF data are elaborated in Wang and Yu (2012).

2.5.1.4 World Input Output Database (WIOD)

The database has been developed to analyze the effects of globalization on trade patterns, environmental pressures and socio-economic development across a wide set of countries. It covers 27 EU countries and 13 other major countries in the world for the period from 1995 to 2009. Further details of WIOD can be found in Timmer et al. (2012). In our study, we retrieve a national Input-Output Table (IO Table) of China to construct the weights for calculating imported-input markups. Data provided by WIOD are at industry-level providing information on sources of supply (from other industries) each industry needs in order to produce its final products. The import values from other industries that each industry needs are therefore calculated accordingly as weights of imported-input values to each industry. Since the result calculated from IO Table is industry-specific, firms in CCTS which are categorized as the same industry group are assumed to share the same imported-input weights.

2.5.1.5 China Stock Market and Accounting Research (CSMAR)

The China Stock Market and Accounting Research (CSMAR) database is developed by GTA Information Technology, one of major providers of Chinese data. CSMAR covers quarterly data on the Chinese stock market, financial statements and China Corporate Governance of Chinese listed firms. We retrieve financial data of each firm such as total assets, total liabilities, and financial ratios in order to explore factors determining the exchange rate exposure. Each firm in CSMAR is identified with the same ID as in Bloomberg. Therefore, this data source can be easily merged with Bloomberg.

2.5.2 Merging Data Sources

Data from five data sources are collected to construct variables to be used in the regression models. Some variables need data from more than one source, details of data sources integration are described as follows.

2.5.2.1 Merging Bloomberg and CCTS

The main purpose for merging these two sources is to consolidate all data necessary for constructing firm-specific exchange rate index. The sample firms in the CCTS data are listed companies and each firm in Bloomberg and CCTS has a common listed code, so it is possible to find all firms in CCTS stock prices and foreign exchange rates to their trading partner countries. The number of firms[7] with available stock prices is shown in Table 2.8. Next, we map countries trading with Chinese firms (their export destination countries and import origin countries) to their corresponding exchange rates. The number of countries matched with their currencies is shown in Table 2.8. Note that the number of countries mapped with their currencies is less than the number of countries as some countries share the same currencies, e.g., countries in the Eurozone.

In addition, we find some errors in the 3-digit code of countries recorded in Chinese Custom Trade Statistic in which some 3-digit codes cannot be identified to any existing country such as a destination labelled as "Other Europe, nes and Other Asia, nes". We therefore drop these observations from our sample data. The matched data are defined as firms from Chinese Customs Trade Statistic dataset that can be mapped to their stock prices from Bloomberg dataset. The unmatched data in our study are therefore from the rest of the companies in Shanghai and Shenzhen stock markets which does not appear in our Chinese

[7] The number of those companies with available stock prices is, however, less than the number of firms in original data (Chinese Customs Trade Statistic) since stock prices data of some Chinese firms are missing from Bloomberg database.

Customs Trade Statistic dataset during 2000 - 2006. Therefore, information on export, import values and export destinations or import origins are not available for the unmatched firms. Although we organize both the matched and unmatched data, only the matched data are used to run regression on Model 1 and Model 2 in later section.

2.5.2.2 Merging Bloomberg, CCTS and CASIF

The CASIF data source, is added to the merged data of CCTS and Bloomberg in order to integrate additional variables to calculate firm-specific markups used in Model 3. Chinese manufacturing firms in CASIF data are part of firms in CCTS and have the 10-digit Enterprise Customs Coding system in common. After merging Bloomberg and CCTS with CASIF, the total number of matched firms is reduced to 398 firms as shown in Table 2.8. This merged database is later used for running on Model 3 in later section.

Table 2.8: Summary of the data sources.

Data Source	Type	Number							
		2000	2001	2002	2003	2004	2005	2006	2000-2006
Bloomberg	Number of firms (with stock prices available)	1,091	1,172	1,239	1,307	1,406	1,419	1,485	1,485
	Currencies	175	177	187	188	189	189	189	189
CCTS	Number of firms	304	380	439	496	537	529	527	654
	Number of countries	179	188	186	199	195	208	204	221
CASIF	Number of firms	148	196	222	258	326	286	285	398
CSMAR	Number of firms	144	67	70	67	98	15	71	532
CCTS merged with Bloomberg	Number of firms mathced (with stock prices available)	218	269	309	365	426	428	447	654
	Number of countries matched with currencies	149	160	167	174	173	178	181	200
CCTS merged with Bloomberg and CASIF	Number of firms	148	196	222	258	326	286	285	398

Source: Our own calculation from the sample.

2.5.3 Variables

In what follows, the variables used in the estimated models are defined as follows,

2.5.3.1 Firm Return ($R_{i,t}$)

$R_{i,t}$ is a monthly logarithmic rate of returns of each Chinese sample firm computed from change in natural logarithmic value of stock price at time t relative to its previous month's price or $R_{i,t} = \ln(stock\,price_{i,t}) - \ln(stock\,price_{i,t-1})$ where $stock\,price_{i,t}$ is the stock price of firm i in month t.

2.5.3.2 Stock Market Index Return (R_t^m)

R_t^m is a monthly logarithmic rate of returns of a market index calculated by change in natural logarithmic value of a market index (Shanghai or Shenzhen market) at time t relative to its previous month's index value or $R_t^m = \ln(market\,index_t) - \ln(market\,index_{t-1})$ where $market\,index_t$ is the market index in month t. We use Shanghai stock index if firms are registered in Shanghai stock market and use Shenzhen stock index if they are registered in Shenzhen stock exchange.

2.5.3.3 Trade-Weighted Exchange Rate Index (Δe_t)

Δe_t is defined as the summation of the product of the weight associated to China's trade value with country c in month t and the return of exchange rate between the CNY and a currency of country c in month t as described below,

$$\Delta e_t = \sum_c w_{c,t} FX_{c,t} \tag{2.10}$$

where

c is an index of countries.

t is an index of time.

$w_{c,t}$ is an average weight associated to China's trade value of country c at time $t-2$ to t according to the following formula: $w_{c,t} = \frac{T_{c,t}+T_{c,t-1}+T_{c,t-2}}{\sum_c(T_{c,t}+T_{c,t-1}+T_{c,t-2})}$ in which $T_{c,t}$ is the trade value (in CNY) between China and a country c.

$FX_{c,t}$ is a logarithmic return of exchange rate between the CNY and country c at time t. The number is quoted in an amount of CNY per one unit of foreign currency.

In this study, we assume that currencies used in trade settlement are corresponding currencies of firm's trading partners. For instance, if a Chinese firm trades with firms in Australia, we assume that Australian dollar is used in settlement although US dollar could also be used. It is noted that every firm in each month will have the same trade-weighted exchange rate index. The average of current, one-month lagged and two-month lagged of trade values is employed to take into account settlement delay which could occur in actual trading.

2.5.3.4 Firm-Specific Exchange Rate Index ($\Delta e_{i,t}$)

$\Delta e_{i,t}$ is the summation of the product of the weight of net export value of firm i with country c from time $t-2$ to t and the return of exchange rate between CNY and country c at time t. And the weight of firm i is calculated from the share of net export value between firm i and country c at time t.

$$\Delta e_{i,t} = \sum_c w_{i,c,t} FX_{c,t} \tag{2.11}$$

in which

$$w_{i,c,t} = \frac{|NX_{i,c,t}| + |NX_{i,c,t-1}| + |NX_{i,c,t-2}|}{\sum_c(|NX_{i,c,t}| + |NX_{i,c,t-1}| + |NX_{i,c,t-2}|)} \tag{2.12}$$

$$= \frac{\sum_{s=0}^{2} |NX_{i,c,t-s}|}{\sum_c \sum_{s=0}^{2} |NX_{i,c,t-s}|} \tag{2.13}$$

where

i	is an index of firms.
s	is an index of time lags.
c	is an index of countries.
t	is an index of months.
$w_{i,c,t}$	is the average share of net export value of firm i to country c from time $t-2$ to t over the total net export value of firm i from time $t-2$ to t. $0 \leq w_{i,c,t} \leq 1$ and $\sum_c w_{i,c,t} = 1$.
$X_{i,c,t}$	is the export (in CNY) of firm i to country c in month t .
$M_{i,c,t}$	is the import (in CNY) of firm i to country c in month t.
$NX_{i,c,t}$	or $(X_{i,c,t} - M_{i,c,t})$ is the net export value of firm i to country c in month t.
$FX_{c,t}$	is the logarithmic return of exchange rate between China and country c in month t .

The number is also quoted in an amount of the CNY per one unit of foreign currency. The positive values of $FX_{c,t}$ denote the CNY depreciation while the negative values represent the CNY appreciation. Likewise, this firm-specific exchange rate index is the product of a row vector of net export weight (measured as the ratio of an absolute value of net export in a particular country over the sum of its absolute value of net export of each firm) and a column vector of the returns of the respective bilateral CNY-foreign currency exchange rate at time t . We take the average of current, one-month lagged and two-month lagged of net export values to take into account settlement delay which could occur in actual trading. In addition, we also assume that currencies used in trade settlement are corresponding currencies of firm's trading partners.

Notice that the weight $w_{i,c,t}$ in equation (2.12) is calculated using the net export values $|NX_{i,c,t}|$ rather than ordinary net export values $NX_{i,c,t}$. Th e reason is to avoid the denominator taking zero value (it is possible that $\sum_c (NX_{i,c,t} + NX_{i,c,t-1} + NX_{i,c,t-2}) = 0$ which leaves the weight undefined). An interpretation of absolute net export values remains identical to that of ordinary net export values, i.e., the difference between export and import which constitutes exposure to a trading partner's currency.

2.5.3.5 Markup ($MKUP_{i,t}$)

$MKUP_{i,t}$ is the markup price of the final output in good market of firm i at time t. The markups in our analysis are constructed based on firm-level production data from China's Annual Survey of Industrial Firms[8] (CASIF) compiled by the National Bureau of Statistics in China (NBS). The total number of firms with data available for markups calculation is 398, resulting from matching the Bloomberg, CCTS and CASIF data.

Since CASIF provides only yearly data, the markups can be calculated on yearly basis. This study assumes that monthly markups are constant throughout each year equal to their yearly markups.

The yearly firm level markup is constructed by using the methodology developed by Do-

[8]Further details of CASIF data can be found in Wang and Yu (2012).

mowitz et al. (1986) as follows,

$$MKUP_{i,t} = \frac{Value\,of\,output - Payroll - Cost\,of\,materials}{Value\,of\,output} \quad (2.14)$$

Where $MKUP_{i,t}$ is a firm's markup, $Value\,of\,output$ is an output value of firm i, $Payroll$ is the wage of firm i and $Cost\,of\,materials$ is represented by total intermediate inputs for production of firm i. In order to reduce the impact of extreme values of markup calculation, the markups are winzorized at the 10^{th} and 90^{th} percentiles. Furthermore, in order to avoid endogeneity problems that might occur, we use a one-month lagged markup in the estimation model.

2.5.3.6 Imported Input Markup ($IMKUP_{i,t}$)

$IMKUP_{i,t}$ is a weighted average of industry markups that each industry requires from other industries in order to produce its goods. We calculate the imported input markups for each firm according to Allayannis and Ihrig (2001) as follows,

$$IMKUP_{k,t} = \sum_{j} w_{k,j} MKUP_{j,t} \quad (2.15)$$

where $IMKUP_{k,t}$ is the imported input markup of industry k at time t. $MKUP_{j,t}$ is the markup of industry j at time t and $w_{k,j}$ is the percentage of industry k's input costs that comes from industry j constructed by using data from Input-Output Table. In our study, the imported input industry markups are calculated by using the Chinese data from World Input-Output Database[9](WIOD). Based on this data, we calculate the ratio representing

[9]For China, WIOD provides data from 1995 to 2011. Industry groups in the Input-Output Table are categorized into 35 sectors. Each row of the table indicates how much input (in current prices) from other sectors is needed to generate output for each of 35 industry sectors.

percentage contribution of input from 35 different industries on the output of one industry. The imported input markups are also winsorized at 10^{th} and 90^{th} percentiles to reduce the effect of possibly spurious outliers.

Note that, in equation (2.15), there requires markup by industry $MKUP_{j,t}$ to work with $w_{k,j}$ at an industry-level. We extend the firm-level markup exhibited earlier in eqution (2.14) for indusrty-level markup as follows:

$$MKUP_{j,t} = \sum_{i} MV_{i,t} MKUP_{i,t} \quad \text{for each industry } j \tag{2.16}$$

where $MV_{i,t}$ is the market value of firm i at time t and $MKUP_{i,t}$ is the markup of firm i at time t as defined in (2.14). The summation in equation (2.16) is treated over all firms in an industry. Thus $MKUP_{j,t}$ is the same for all firms in the same industry. The resulting imported input markup $IMKUP_{k,t}$ is therefore equal to all firms in the same in an industry k. Consequently, we can find $IMKUP_{i,t}$ (imported input markup for each individual firm i) for each firm in an industry k by referring to $IMKUP_{k,t}$.

Next, we merge firms with corresponding annual imported input markup to the CCTS dataset (matched data). Because WIOD dataset is industry-level, the imported input markups information cannot be merged to the CCTS dataset (matched data) directly. We refer to the Global Industry Classification Standard (GICS) classification in Bloomberg which categorizes all Chinese firms in CCTS dataset into 63 different industry sectors. The 63 industry groups from GICS are then mapped to 35 industry sectors of WIOD dataset[10]. In order to avoid probable endogeneity problems, a one-month lagged imported input markup is used in the regression model.

[10] See Table A.2.

2.5.3.7 Share of Exports ($\frac{X_{i,t}}{V_{i,t}}$)

$\frac{X_{i,t}}{V_{i,t}}$ is measured by smoothed export values over smoothed total sales ($V_{i,t}$) of firm i at time t. The series of export and sales are smoothed using 6-month moving average.

2.5.3.8 Share of Imported Input ($\frac{M_{i,t}}{V_{i,t}}$)

$\frac{M_{i,t}}{V_{i,t}}$ is the 6-month moving average of total imported input over the 6-month moving average of total sales ($V_{i,t}$) of firms in industry j at time t . The imported input ($M_{j,t}$) represents a weighted average value of imports from each industry j in order to produce the final goods according to the following formula,

$$M_{k,t} = \sum_{j} w_{k,j} IMPORTS_{j,t} \tag{2.17}$$

where $w_{k,j}$ is the percentage of industry k's input costs that comes from industry j (same as defined in equation (2.15)), $IMPORTS_{j,t}$ is the total value of imports of final goods of industry j at time t . Note that all firms in an industry k have the same share of imported input, hence we can find the share of imported input for each individual firm, $M_{i,t}$, in an industry k by referring to $M_{k,t}$.

The summary statistics such as mean, standard deviation and number of observations of the key variables are shown in Table 2.9.

Table 2.9: Summary for variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
Firm return ($R_{i,t}$)	12,748	-0.00644	0.096922	-1.27595	0.814494
Market return (Shanghai, R_t^m)	108	0.003775	0.084719	-0.28266	0.242758
Market return (Shenzhen, R_t^m)	108	0.003766	0.091536	-0.26517	0.254912
Trade weighted exchange rate index (Δe_t)	70,632	-0.00031	0.002421	-0.0051	0.007663
Firm-specific exchange rate index ($\Delta e_{i,t}$)	18,860	0.000593	0.013673	-0.26033	0.197085
Imported input markup ($IMKUP_{i,t}$)	18,860	0.153624	0.020036	0.03512	0.193565
Industrial markup ($MKUP_{j,t}$)	18,860	0.212364	0.065196	0.11339	0.361665
Markup ($MKUP_{i,t}$)	18,860	0.209185	0.109686	0.05622	0.456652

2.6 Models

2.6.1 The Standard Two Factor Model (with Trade-Weighted Exchange Rate Index, Δe_t)

As a starting point, this study uses a simple two factor model which was used in many previous studies such as Jorion (1990) and He and Ng (1998). Initially, exchange rate exposure is estimated by regressing the individual firm's stock return on the market return and exchange rate change as given by

$$\textbf{Model 1} \quad R_{i,t} = \beta_{0,i} + \beta_{1,i} R_t^m + \beta_{2,i} \Delta e_t + \varepsilon_{i,t} \tag{2.18}$$

where $R_{i,t}$ is the monthly return of the firm i at time t , R_t^m is a monthly market index represented by Chinese stock market returns and Δe_t is the foreign exchange rate index which is trade-weighted exchange rate at time t. $\beta_{2,i}$ measures exchange rate exposure of firm i . If the null hypothesis that $\beta_{2,i}$ being zero is rejected, there is an evidence of exchange rate exposure.

A positive values of $\beta_{2,i}$ indicates that either firm's stock return is increased when CNY depreciates or firm's stock return is decreased when CNY appreciates. On the other hand, a negative value of $\beta_{2,i}$ signifies that firm's stock return is increased when CNY appreciates or firm's stock return is decreased when CNY depreciates.

2.6.2 The Standard Two Factor Model (with Firm-Specific Exchange Rate Index, $\Delta e_{i,t}$)

This model is used to answer whether or not the stock returns of firms are affected by changes in exchange rate proxy if we use a more representative, i.e., firm-specific exchange rate than trade-weighted exchange rate. Since the use of trade-weighted or any common exchange rate indices may, in fact, not reflect actual exchange rate exposure of each firm. There can be a chance that a firm has exposure on a currency it has never traded against which could lead to inaccurate result.

One alternative to resolve this problem is to develop a firm-specific exchange rate index ($\Delta e_{i,t}$) to represent the exchange rate index. In order to explore the effect of a transition from a trade-weighted exchange rate to a firm-specific exchange rate, initially, a weight is represented by a total trade at firm level. Specifically, the firm-specific exchange rate in equation (2.12) is expressed as

$$w^T_{i,c,t} = \frac{T_{i,c,t} + T_{i,c,t-1} + T_{i,c,t-2}}{\sum_c (T_{i,c,t} + T_{i,c,t-1} + T_{i,c,t-2})}$$

where $T_{i,c,t}$ is the total trade value of firm i to country c in month t which is calculated from $X_{i,c,t} + M_{i,c,t}$. Then the firm-specific trade exchange rate index is defined as

$$\Delta e^T_{i,t} = \sum_c w^T_{i,c,t} FX_{c,t}.$$

Accordingly, the first step in estimating exchange rate exposure is performed by regressing he individual firm's stock return on the market return and exchange rate change as given by

$$\textbf{Model 2.1} \qquad R_{i,t} = \beta_{0,i} + \beta_{1,i} R_t^m + \beta_{2,i} \Delta e_{i,t}^T + \varepsilon_{i,t} \tag{2.19}$$

where $R_{i,t}$ is the return of the firm i at time t , R_t^m is a market index represented by Chinese stock market returns and $\Delta e_{i,t}^T$ is a firm-specific exchange rate index based on destination-specific total trade value.

The weighted calculated from total trade $(X_{i,c,t} + M_{i,c,t})$, however, ignores the fact that exposure to a currency should represent an outstanding export value. That is, if at time t a firm exports and imports from a country c at the same values, $X_{i,c,t} - M_{i,c,t} = 0$, then the firm should not have exchange rate exposure to country's c currency. Therefore, the exchange rate exposure exists only when $X_{i,c,t} - M_{i,c,t} \neq 0$.

Thus, for the next step, the weight is changed from a total trade $(X_{i,c,t} + M_{i,c,t})$ to a net export value as proposed in equation (2.12). Consequently, the firm-specific exchange rate index is referred to what defined in equation (2.11). The following regression model is then proposed to investigate exchange rate exposure at firm-level:

$$\textbf{Model 2.2} \qquad R_{i,t} = \beta_{0,i} + \beta_{1,i} R_t^m + \beta_{2,i} \Delta e_{i,t} + \varepsilon_{i,t} \tag{2.20}$$

where $R_{i,t}$ is the return of the firm i at time t , R_t^m is a market index represented by Chinese stock market returns and $\Delta e_{i,t}$ is a firm-specific exchange rate index based on destination-specific export and import values. An interpretation on signs of $\beta_{2,i}$ for Model 2.1 and Model 2.2 is similar to what mentioned in the case of Model 1.

2.6.3 The Adjusted Allayannis and Ihrig's Model

As previously introduced in the theoretical framework section, we adopt the model developed by Allayannis and Ihrig (2001) and make some adjustments on the exchange rate exposure model. The industry-weighted exchange rate index which is formerly used in their version is replaced with our firm-specific exchange rate index. In accordance with the firm-specific exchange rates, we employ firm-level data for calculating necessary variables such as export values, import values and total sales. The adjusted version of Allayannis and Ihrig's model is as follows:

$$\textbf{Model 3} \quad R_{i,t} = \beta_{0,i} + \beta_{1,i} R_t^m + \beta_{2,i} \left[\left(\frac{1}{MKUP_{i,t-1}} \right) + \left(\frac{X_{i,t}}{V_{i,t}} \right) \left(1 + \frac{1}{MKUP_{i,t-1}} \right) \right] \Delta e_{i,t} + \beta_{3,i} \left[\left(\frac{M_{i,t}}{V_{i,t}} \right) \left(\frac{1}{IMKUP_{i,t-1}} \right) \right] \Delta e_{i,t} + \varepsilon_{i,t} \tag{2.21}$$

where $\left(\frac{1}{MKUP_{i,t-1}} \right) + \left(\frac{X_{i,t}}{V_{i,t}} \right) \left(1 + \frac{1}{MKUP_{i,t-1}} \right)$ represents competitive structure of final output goods and the export shares channels and $\left(\frac{M_{i,t}}{V_{i,t}} \right) \left(\frac{1}{IMKUP_{i,t-1}} \right)$ is the imported input channel. Interpretation on signs of $\beta_{2,i}$ and $\beta_{3,i}$ for Model 3 is similar to what mentioned in the case of Model 1.

The advantage of Model 3 is attributed to the theoretical framework which well mixes international trade and finance together. This also allows us capability to identify channels that mainly influence firms' exchange rate exposure.

We run all models over two sub-periods in order to inspect the effect of exchange rate exposure over different foreign exchange rate regimes in China. The two periods are defined as follows:

1. Period 1 - the first period ranges from January 2000 to July 2005 to cover the fixed exchange rate regime in China.

2. Period 2 - the second period spans from August 2005 to December 2006 to cover the managed float exchange rate regime.

2.7 Results

In this section, the results of different exchange rate exposure models are presented. We run the regression firm-by-firm in each period (period 1 and period 2) by using Newey-West standard error[11] and show the number of firms presenting significant result at 5% level. The signs of coefficients obtained from regression are also categorized as zero, positive and negative.

2.7.1 Results from The Standard Two-Factor Model (with Trade-Weighted Exchange Rate, Δe_t)

The regression results from Newey-West standard errors for Model 1 are shown in Table 2.11 and Figure 2.2. Focusing on the results from trade-weighted exchange rate indices in Model 1, 34 out of 654 firms (5.2%) significantly expose to exchange rates during the fixed exchange rate regime (period 1) while 16 out of 654 firms (2.4%) have significant exchange rate exposure at 5% significant level in managed float regime (period 2).

2.7.2 Results from The Standard Two-Factor Model (with Firm-Specific Exchange Rate, Δe_{it})

Model 2.1 and Model 2.2 aim to test whether or not the stock returns of Chinese firms are influenced by changes in foreign exchange rates if a more representative firm-specific

[11] Standard errors of the estimates are corrected for autocorrelation and heteroscedasticity with the Newey-West procedure.

exchange rate index is used as a proxy rather than trade-weighted exchange rates which were used in many previous studies.

The results exhibited in Table 2.11 and Figure 2.2 show similar results from the both models. For model 2.1, there are 63 out of 446 firms (14.2%) and 62 out of 397 firms (15.7%) showing significant exchange rate exposure during period 1 and period 2, respectively. For Model 2.2, 70 out of 446 firms (15.7%) and 66 out of 397 firms (16.6%) have significant exchange rate exposure during period 1 and period 2, respectively.

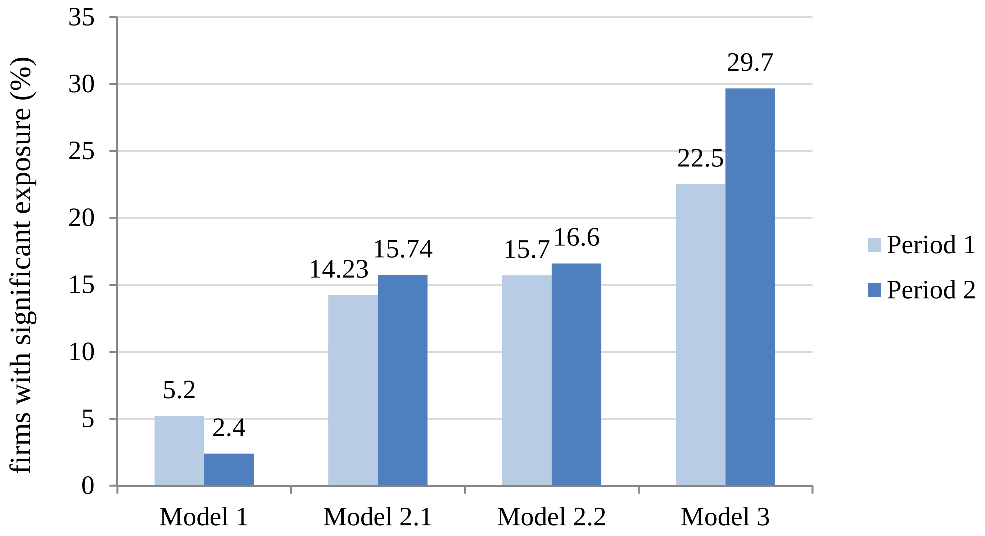
Interestingly, more firms are found exposed to changes in exchange rate index when changing from trade-weighted to firm-specific exchange rate index which is in line with our initial expectation. The change of weight representation from total trade $X_{i,c,t} + M_{i,c,t}$ to $\mid X_{i,c,t} - M_{i,c,t} \mid$ provides slightly gain in the number of firms showing significant exchange rate exposure. It can thus be concluded that the change from the trade-weighted exchange rate to firm-specific exchange rates substantially captures more number of firms with significant exchange rate exposure while changing a weight representation improves the performance of exchange rate exposure estimation marginally.

2.7.3 Results from The Adjusted Allayannis and Ihrig's Model

As mentioned earlier, There are two channels of exchange rate exposure in Model 3, i.e., export shares and imported input channels. In order to count the number of firms that are significantly exposed to exchange rate, firms that exhibit significant values of $\beta_{2,i}$ or $\beta_{3,i}$ are considered as firms having significant exchange rate exposure. Accordingly, the results shown in Table 2.11 and Figure 2.2 indicate that 52 out of 231 firms (22.5%) have significant exchange rate exposure during period 1 (fixed exchange rate regime).

During the managed float exchange rate system (period 2), 54 of 182 firms (29.7%) expose to exchange rate at 5% confidence level. It can be seen that Model 3 can capture more

Figure 2.2: Percentage of firms showing significant exchange rate exposure at 5 percent level.



Note: Period 1 = fixed exchange rate regime (January 2000 - July 2005). Period 2 = managed float exchange rate regime (August 2005 - December 2006).

percentage of firms showing significant exposure than Model 2 thanks to an integration of markups into the estimation model. Comparing between the fixed and float exchange rate regimes, it is found that more percentage of firms is found to be significantly exposed to exchange rates when China adopted the managed float exchange rate regime.

The benefit of incorporating markups into an exchange rate exposure estimation model (Model 3) is that, according to Allayannis and Ihrig (2001), channels of exchange rate exposure are identified. This establishes a linkage between the fall (rise) of industry's markups and an increase (decrease) of exchange rate exposure. Thus, the model reflects contemporaneous effects of exchange rate movements on returns in a more sensible way than a model that neglects markups. It is also claimed in Allayannis and Ihrig (2001) that the absence of markups leads to noise overstating and understating the significance of exchange rate exposure. An increase in the number of firms with significant exchange rate exposure when markups are included is in line with the findings in Allayannis and Ihrig (2001).

In addition, the transition matrix (see Table 2.10) investigates if firms' exchange rate ex-

Table 2.10: Transition matrix for the adjusted Allayannis and Ihrig's model.

		Period 2	
		significant	insignificant
Period 1	significant	7	27
	insignificant	45	83

Note: The transition matrix contains only firms that exist in both periods which are 162 firms in total.

posure is persistent over different exchange rate regimes. It is noted from Table 2.11 that the number of firms in the both periods are unequal due to data availability. The transition matrix contains only firms that exist in both periods which are 162 firms in total. The results in Table 2.10 show that firms with significant exposure in the fixed regime are most likely to have no exchange rate exposure when the regime is changed to managed float. In contrast, if firms initially have no exchange rate exposure, then it is most likely that they will stay unexposed when the regime changes. Interestingly, 45 out of 128 firms (35%) that have no exchange rate exposure in fixed exchange rate regime turn to have significant exchange rate exposure during the managed float exchange rate regime.

When comparing across the results of Model 1 to Model 3, it can be seen that representing exchange rate that firms experiencing by firm-specific exchange rate index instead of trade-weighted exchange rate index can detect more firms that have significant exchange rate exposure. Besides, comparing between the models that both employ the firm-specific exchange rate exposure, it is noticed that the percentage of firms found significantly exposed to exchange rate in the model with markups (Model 3) is higher than that of Model 2. Thus, including markups in the model may result in an increase of the percentage of firms that significantly expose to exchange rates.

We also observe that, for the models using the firm-specific exchange rate index (Model 2.1, Model 2.2 and Model 3), there are more firms exposed to exchange rate during the managed float exchange rate regime. This finding is deemed reasonable as firms trading with the US should expose to USDCNY fluctuation comparing to when China used the fixed exchange rate regime and that adds up to total exchange rate exposure that firms encountering in period 2.

Overall, although the introduction of firm-specific exchange rate index results in finding more firms exposed to exchange rates (comparing to trade weighted exchange rate index), the number of firms that have significant exchange rate exposure are considered small (under 30% of firms trading internationally). It is most likely that those firms could hedge their exchange rate exposure through derivatives such as FX forwards or FX futures.

Table 2.11: Significant results for Model 1-3.

		Period 1 % of firms showing significant coefficient			Period 2 % of firms showing significant coefficient		
		Positive	Negative	Total	Positive	Negative	Total
	Market return	50.6	0.0	50.6	52.9	0.0	52.9
Model 1	Trade-weighted index	1.5	3.7	5.2	1.5	0.9	2.4
	Total number of firms			654			654
Model 2.1	Market return	57.3	0.4	57.7	21.3	0.5	21.8
	Firm-specific index	13.4	0.8	14.2	14.2	1.5	15.7
	Total number of firms			446			397
	Market return	64.8	0.0	64.8	22.9	0.5	23.4
Model 2.2	Firm-specific index	13.0	2.7	15.7	7.3	9.3	16.6
	Total number of firms			446			397
	Market return	53.7	0.0	53.7	20.3	0.0	20.3
	Export share channel	13.4	7.4	20.8	13.2	10.4	23.6
Model 3	Imported input channel	6.5	9.5	16.0	9.3	13.2	22.5
	Firm-specific index			22.5			29.7
	Total number of firms			231			182

Note: Total number of firms indicates number of firms that are qualified (have all necessary data such as import-export values and markups) for firm-by-firm regression. Hence, the total number of firms varies by models. Nevertheless, some qualified firms are excluded from the counting if they have insufficient number of observations for running a regression. The total number of firms shown in the table is the number of firms that participate in the estimation.

2.8 Further Studies

After obtaining the exchange rate exposure, we conduct further studies to investigate further in particular issues. Firstly, the asymmetric exchange rate exposure is investigated. Dummy variables are added to the regression model to inspect whether firms' returns are impacted equally when the local currency appreciates and depreciates. Next, since it is known that outliers could subdue the reliability of regression results, we employ median regression to remove the outlier effects and explore if any additional insight is gained from this experiment. Lastly, we determine the factors that have impact on exchange rate exposure. The potential determinants relating to trade such as Herfindahl indices and volatility of trade are of our main interest.

2.8.1 Asymmetric Impact of Exchange Rates

Another possible explanation for these different empirical results is the presence of model misspecifications in the estimation of the sensitivity of stock returns to exchange rate changes (see Bartov and Bodnar (1994)) since most of the traditional studies assume that the impact of exchange rate fluctuations is symmetrical[12]. Such assumption has been investigated in studies that analyze asymmetric responses of stock prices to currency movements. Koutmos and Martin (2003) provide evidence that asymmetries are found significant in the financial and non-cyclical sectors. Many authors point out that sources of the asymmetric exposure are probably from pricing-to-market behavior (Froot and Klemperer (1988), Marston (1990) and Knetter (1994)), hysteresis (Ljungqvist (1994) and Christophe (1997)), and asymmetric hedging (Booth (1996)). Empirical study by Muller and Verschoor (2006) shows that US

[12]Asymmetric exchange rate exposure is found when exchange rate appreciation and depreciation affect firms' profit unequally.

stock returns react asymmetrically to currency movements for 935 US multinational firms.

Therefore, this section aims to investigate whether or not the effect of exchange rate changes on firms' stock returns in China is symmetric between currency appreciations and depreciations. The importance of this issue has the linkage on policy implication. For example, if asymmetries exist in the exchange rate exposure process, a firm may prefer to use financial instruments in hedging against the exposure. Then central bank has to issue appropriate policies to develop financial market.

In order to test if the impact of exchange rate changes on firm's stock return in China is symmetric when CNY appreciates and depreciates, dummy variables are added to the Model as follows:

Model 3a
$$\begin{aligned} R_{i,t} = {} & \beta_{0,i} + \beta_{1,i} R_t^m + \beta_{2,i} \left[\left(\frac{1}{MKUP_{i,t-1}} \right) + \left(\frac{X_{i,t}}{V_{i,t}} \right) \left(1 + \frac{1}{MKUP_{i,t-1}} \right) \right] \Delta e_{i,t} \\ & + \beta_{3,i} \left[\left(\frac{M_{i,t}}{V_{i,t}} \right) \left(\frac{1}{IMKUP_{i,t-1}} \right) \right] \Delta e_{i,t} \\ & + \beta_{4,i} D_{1,t} \left[\left(\frac{1}{MKUP_{i,t-1}} \right) + \left(\frac{X_{i,t}}{V_{i,t}} \right) \left(1 + \frac{1}{MKUP_{i,t-1}} \right) \right] \Delta e_{i,t} \\ & + \beta_{5,i} D_{2,t} \left[\left(\frac{M_{i,t}}{V_{i,t}} \right) \left(\frac{1}{IMKUP_{i,t-1}} \right) \right] \Delta e_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{2.22}$$

where $D_{1,t}$ is the dummy variable that takes a value of unity ($D_{1,t} = 1$) when $\left[\left(\frac{1}{MKUP_{i,t-1}} \right) + \left(\frac{X_{i,t}}{V_{i,t}} \right) \left(1 + \frac{1}{MKUP_{i,t-1}} \right) \right] \Delta e_{i,t} > 0$ and zero otherwise and $D_{2,t}$ is the dummy variable that takes a value of unity ($D_{2,t} = 1$) when $\left[\left(\frac{M_{i,t}}{V_{i,t}} \right) \left(\frac{1}{IMKUP_{i,t-1}} \right) \right] \Delta e_{i,t} > 0$ and zero otherwise.

The results from investigating the presence of asymmetric effect from Model 3a are shown in Table 2.12 . The results demonstrate that 14.1% and 10.3% of firms significantly expose to changes in exchange rates at 5% level in fixed and managed float exchange rate regime, respectively. Moreover, there are 9.5% (7.3%) and 8.9% (8.3%) of firms showing asymmetric impact when CNY appreciates and depreciates through the export share and imported

Table 2.12: Results from the asymmetric model.

		Period 1			Period 2		
		% of firm showing significant coefficient			% of firm showing significant coefficient		
		Positive	Negative	Total	Positive	Negative	Total
Model 3a	Dummy for export share channel	5.1	4.4	9.5	3.0	4.3	7.3
	Dummy for imported input channel	2.9	6.0	8.9	4.5	3.8	8.3
	Firm-specific exchange rate index			14.1			10.3
	Total number of firms			370			398

Note: Based on the model specification of Model 3a, 14.1% of firms are significantly exposed to exchange rate in period 1 and 10.3% of firms are significantly exposed to exchange rate in period 2.

input channel, respectively, in period 1 (period 2).

Overall, the empirical results point out that the majority of firms in our sample do not exhibit asymmetric exchange rate effect. That is, CNY appreciation and depreciation result in similar impacts on firms' stock returns.

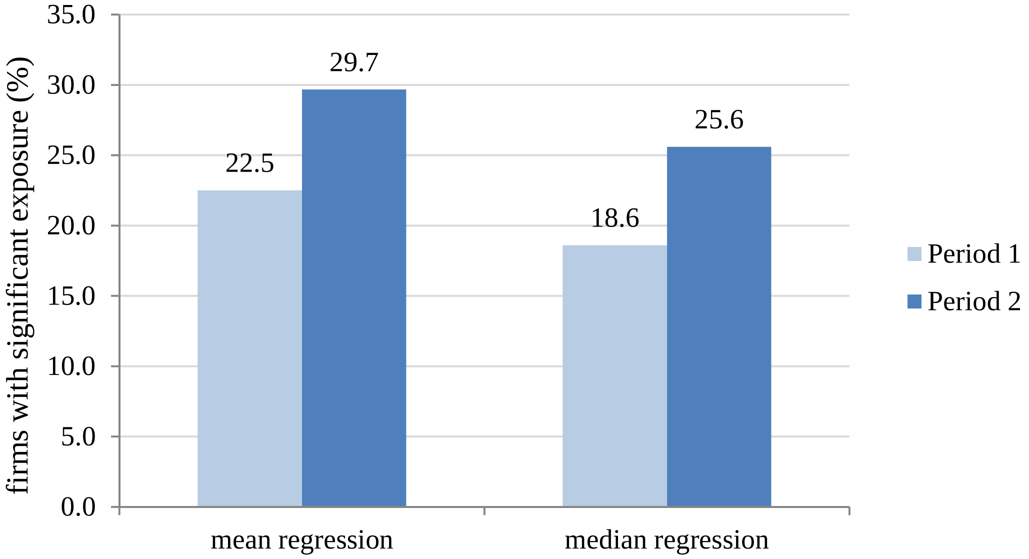
2.8.2 Median Regression

Linear regression normally estimates how, on average, returns of a firm are affected by firm-specific exchange rate index which thus unavoidably take into account the effect of outliers more or less. In such respect, we employ median regression to obtain results against those extreme observations.

We run the median regression and the results display in Figure 2.3. There is 18.6% (25.6%) of firms showing significant exposure when considering median of firms' returns at 5% level in period 1 (period 2). The results also agree with those obtained from standard regression in a way that the managed float exchange rate regime shows more number of firms having significant exchange rate exposure comparing to the fixed exchange rate regime.

When comparing to the results from median regression, there shows no clear difference on the number of firms showing significant exposure from the two regressions. This shows that outliers containing in the raw data might be only a few observations and their values are not so extreme to differ the results of mean and median regressions. Hence, the results initially obtained from standard (mean) regression are robust against outliers.

Figure 2.3: Percentage of firms showing significant exchange rate exposure when using median regression.



Note: Period 1 = fixed exchange rate regime (January 2000 - July 2005). Period 2 = managed float exchange rate regime (August 2005 - December 2006).

2.8.3 Determinants of Exchange Rate Exposure

In this section, we investigate what the factors determining the exchange rate exposure are. The existing studies find the potential variables are such as the level of a firm's foreign operations (Jorion (1990)), debt ratio (He and Ng (1998)) and the concentration of a firm's foreign operations network (Fraser and Pantzalis (2004)). The trade variables such as export over sales, import over sales, trade volatility and trade concentration are mainly focused in this study.

First, the significant relationship between exchange rate exposure and firms' foreign operations are reported in the study of US firms in Jorion (1990). He finds that dollar depreciation positively relates to the ratio of a firm's foreign sales to total sales. In our study, this variable is proxied by export over total sales. Given other things being equal, it is expected that CNY depreciation would make domestic goods relatively cheaper than foreign goods and hence benefit Chinese exporting firms in particular. Therefore, firms with high exports ratio should also have high positive exposure or low negative exposure for a given level of CNY depreciation. We conjecture a positive coefficient of export over total sales in our study. Furthermore, considering only export does not comprehensively cover international trade, thus import over total sales is introduced to test this issue since it could have some effects on exchange rate exposure and we hypothesize that import over total sales and exchange rate exposure could show a negative relationship.

Carter et al. (2001) document that firms with operations spread over many currencies and business areas are more insulated from foreign exchange exposure. Thus, the number of trading partners of each firm is introduced to our study as it primarily indicates an involvement of the firm to international trade. More number of trading partners tends to make firms more exposed to exchange rate changes. We thus expect a positive relationship between the number of trading partners and exchange rate exposure.

Fraser and Pantzalis (2004) use Herfindahl index to capture the concentration of a firm's foreign operations network. We apply this index to capture the concentration of trade. The index value approaching to 1 indicates that the firm trades with only a few countries while a value close to 0 indicates that the firm well diversifies its trades across various partners. In this study, we utilize three Herfindahl indices to capture the concentration of trade. First, $HI_{T_{i,t}}$ indicates the concentration of firm's total trade values across all its partner countries. Second, $HI_{X_{i,t}}$ represents the concentration of firm's export values to its export destination countries while $HI_{M_{i,t}}$ depicts the concentration of firm's import values from its import origin countries. Each Herfindahl index is calculated as follows,

$$HI_{T_{i,t}} = \frac{\sum_{j=1}^{N_i} (T_{i,j,t})^2}{\left(\sum_{j=1}^{N_i} (T_{i,j,t})\right)^2} \tag{2.23}$$

$$HI_{X_{i,t}} = \frac{\sum_{j=1}^{N_i} (X_{i,j,t})^2}{\left(\sum_{j=1}^{N_i} (X_{i,j,t})\right)^2} \tag{2.24}$$

$$HI_{M_{i,t}} = \frac{\sum_{j=1}^{N_i} (M_{i,j,t})^2}{\left(\sum_{j=1}^{N_i} (M_{i,j,t})\right)^2} \tag{2.25}$$

Where for each period,

i is index of firms.

j is index of trading partners.

t is index of time.

N_i is number of trading partners of each firm.

$T_{i,j}$ is value of total trade of firm i in country j.

$X_{i,j}$ is value of export of firm i in country j.

$M_{i,j}$ is value of import of firm i in country j.

In our study, we also examine the influence of volatility of trade, volatility of export and volatility of import on exchange rate exposure. To our knowledge, these factors have not been studied in the context of exchange rate exposure determinants before. Volatilities of trade, export and import are calculated as a 12-month rolling window of total trade, export and import values of each firm.

Moreover, we also explore other control variables such as firm size, firm age and firm leverage which are three of the most common variables for their role in explaining the exchange rate exposure. First, the relationship between firm size and exposure is ambiguous. Large firms are more likely to engage in international transaction and thus are vulnerable to exchange rate changes. However, it is also more likely for large firms to hedge against exchange rate risk which implies that smaller firms are more likely to expose to exchange rate changes. He and Ng (1998) report that larger firms generally have access to risk management expertise and are thus more likely to hedge than smaller firms. As a consequence, bigger firms should be less exposed to exchange rate risk. In contrast, Gruber and Warner (1977) argue that smaller firms have more incentive to hedge as they face greater bankruptcy costs. Based on existing indecisive results, the impact of firm size on exchange rate exposure is hence to be examined empirically.

Second, Solakoglu and Demir (2009) document the significant relationship between firm age and exchange rate exposure of Turkish firms. However, they also report that the sign is different across sectors. Bodnár et al. (2009) investigate Hungarian enterprises and find that the probability of having exchange rate exposures is a negative function of the quadratic form of firm age. We hypothesize that there is a negative relationship between firm age on exchange rate exposure.

In addition, debt to asset ratio is one of the other control variables. He and Ng (1998) study the probability of financial distress and a firm's leverage using long-term debt to asset ratio as a proxy. They find that firms with higher long-term debt to asset ratio are more likely to experience larger expected costs of financial distress and tend to engage in more hedging activities. Thus, it is expected that firms with higher leverage are more likely to hedge and are consequently less exposed to exchange rate risk.

Consequently, after studying the coefficients of foreign exchange variables, in the second stage of our analysis, we aim to examine potential determinants of any exposure. The estimated exposure coefficients of the firm-specific exchange rate (or marginal effect) in Model

3 are used as a dependent variable in a panel regression. The general panel regression takes the following form:

$$\textbf{Model 4} \quad \beta_{i,t}^{*} = \gamma_0 + \gamma_1 F_{i,t} + \gamma_2 Trade_{i,t} + f_i + \varepsilon_{i,t} \tag{2.26}$$

Where $\beta_{i,t}^{*}$ is the foreign exchange coefficients or marginal effect from Model 3, f_i is a firm fixed effects, $F_{i,t}$ are the control variables consisting of firm size ($Size_{i,t}$), firm age ($Age_{i,t}$) and debt to asset ($Debt_{i,t}$) and $Trade_{i,t}$ represents of export over sales ($X/S_{i.t}$), import over sales ($M/S_{i,t}$), number of trading partners ($Ntrade_{i,t}$), Herfindhal indices and trade volatilities ($Vol_{i,t}$).

The estimated exposure coefficients ($\beta_{i,t}^{*}$) derived from regressing Model 3 contain both significant and insignificant results. We assign a value of zero to insignificant exposure coefficients and keep the significant coefficients as they are for subsequent analyses[13].

We report the estimates of Model 4 with firm fixed effects in Table 2.14. We observe the negative relationship between firm age and exchange rate exposure (column (1) to column (10)) indicating that the longer the firm operates, the less exposure it has on exchange rate changes. Firm size, on the other hand, shows positive effect on exchange rate exposure (column (1) to column (8)) implying that large firms may have more tendency to hold more international assets than smaller firms but the coefficient is insignificant. Debt to asset is positively related to exchange rate exposure (column (1) to column (7)) but the coefficient is insignificant.

Export over sales ratio has a positive relation to exposure at 5% significant level. The positive sign is consistent with what we discussed earlier. The import over sales, as opposed to the export over sales, shows negative sign which is contrast with what we expected. However, the coefficient is insignificant. In addition, the number of trading partners positively

[13]The estimated exposure coefficients are winsorized at 10^{th} and 90^{th} percentiles.

affects the exchange rate exposure which is in line with our hypothesis (column (4) and column (9)); nonetheless, its effect is insignificant. Trade volatility (column (7)) and export and import volatilities (Column (8)) have no significant effect on exchange rate exposure. The influences of trade concentration displayed in column (9) and column (10) exhibit that only export concentration significantly shows positive relationship with exchange rate exposure at 10% level while import concentration does not. The positive sign of export concentration is also agreeing with our expectation, indicating that more export concentration leads to more exposure.

The estimation results over different model specifications (columns (1) to (10)) support that firm age, the ratio of export over sales and export concentration are the main determinants of firms' exchange rate exposure. Positive coefficient of export over sales signifies that firms whose revenues mainly come from export tend to have more exchange rate exposure than firms which are less export-oriented. Negative coefficient of firm age suggests that the longer the firms have been in the market, the less exchange rate exposure they have. Besides, positive coefficient of export concentration (Herfindahl index of export) indicates that firms that export to several destinations generally have lower exchange rate exposure than firms exporting to fewer countries. This could imply that exporting firms can divesify exchange rate risk by exporting to many export destination countries. Moreover, these two variables (firm age and Herfindahl index of export) imply that firms that are more export-competitive (in terms of experience and markets) tend to have lower exchange rate exposure than those who are new to export.

Table 2.13: Definition of variables in Model 4.

Variable	Definition
$X/S_{i,t}$	is exports over sales ratio of firm i in period t measured by dividing total export value of each firm by its total sales.
$M/S_{i,t}$	is imports over sales ratio of firm i in period t measured by dividing total import value of each firm by its total sales.
$Ntrade_{i,t}$	is the natural logarithm of total number of trading partners of firm i in period t.
$HI_{i,t}$	is Herfindahl index of firm i in period t. In each period, we construct three separate Herfindahl indices to characterise concentration of total trade, export and import values for each firm. The indices represent each firm the trade concentration based on the trading value of its partners.
$Vol_{i,t}$	is the natural logarithm of trade volatilities of firm i in period t . The variable indicates standard deviation of trading values of each firm in each period. Volatilities of export and import values of each firm are also calculated separately.
$Size_{i,t}$	is the size of firm i in period t calculated from dividing the average of total asset in each sub-period of each firm by the median of total asset of an industry the firm belongs.
$Age_{i,t}$	is the natural logarithm of age of firm (in year) i in period t from its IPO date until the end of period 1 and 2.
$Debt_{i,t}$	is the debt to asset ratio of firm i in period t calculated from dividing total long-term debt of each firm by its total assets.

Table 2.14: Determinants of exchange rate exposure.

Variable	Estimation results									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Firm age	-0.242***	-0.113*	-0.220***	-0.138**	-0.143**	-0.115**	-0.131**	-0.009	-0.230**	-0.231 ***
Firm size	0.001	0.003	0.002	0.002	0.003	0.004	0.003	0.002	-0.000	0.003
Debt to asset	0.160	0.298	0.214	0.310	0.0850	0.0208	0.239	-0.262	-0.779	-0.079
Export over sales	1.996**		2.101**						1.818*	1.950**
Import over sales		-0.374	-0.989						-0.265	
Number of trading countries				0.00988					0.061	
Herfindahl index (total trade)					0.403					
Herfindahl index (export)						0.282*			0.680*	0.266*
Herfindahl index (import)						0.0926			0.2340	0.074
Volatility of total trade							-0.0340			
Volatility of export								-0.104	-0.004	
Volatility of import								0.053	0.061	

Notes: *p<.0, **p<.05, ***p<.01. Dependent variable is the coefficient ($\beta^*_{i,t}$) from Model 3. All model specifications include firm fixed effects.

2.9 Conclusions

This study aims to investigate the exchange rate exposure in Chinese firms using firm-level dataset collected from CCTS, CASIF and CSMAR in 2000-2006. To this end, we are able to construct a firm-specific exchange rate index based on destination-specific export and import values.

We start our analysis with Jorion's two–factor model using trade-weighted exchange rate index. Using the firm-level dataset, we compare the results of Jorion's original model with its adaptation in which the exchange rate index is changed to firm-specific. Our findings show that more percentage of firms are found to significantly expose to exchange rates, suggesting that firm-specific exchange rate index may result in finding more firms having significant exchange rate exposure comparing to the use of trade-weighted exchange rate index.

However, Jorion's model does not well accommodate the firm-level study, the main drawback is that there is no linkage between firm return and firm-level factors such as export, import and markups. We thus adopt Allayanis and Ihrig's model which incorporates firm-level factors that explain stock returns to investigate exchange rate exposure of Chinese firms. The modification of Allayanis and Ihrig's model is made to improve the accuracy of exposure measurement. Thus, we replace the industry-level exchange rate index with firm-specific exchange rate index. The empirical results indicate that more percentages of firms are found significantly exposed to exchange rates comparing to the models used in earlier estimations. We also investigate the effect of changes in exchange rate regime from fixed to managed float on the number of firms having significant exposure. The results indicate that there are higher percentages of firms exhibiting significant exchange rate exposure in the managed float exchange rate regime. The possible explanation is due to additional exposure from USDCNY when China adopted the new exchange rate regime. The findings that there is larger portion of firms showing significant exchange rate exposure when the exchange rate regime is changed to managed float have important policy implications as they demonstrate that exchange rate stabilization could also help stabilize firm returns more or less.

Additionally, further analyses are conducted to explore the exchange rate exposure of Chinese trading firms in different aspects. In terms of asymmetric effects on firm returns due to local currency appreciation and depreciation, the findings suggest that CNY appreciation and depreciation affect most of Chinese firms similarly (no significant asymmetric effect). Also, we observe that estimation results obtained from median and standard regression are similar which imply that the results and interpretations obtained earlier are not affected by outliers containing in the raw data. Furthermore, we examine variables that could be determinants of exchange rate exposure. The empirical results show that high exchange rate exposure can be seen in firms having high export intensity (high export over sales) since their stock returns highly rely on export revenues. However, the exchange rate exposure of firms is lower if firms acquire longer experience and have diverse export markets. It is most likely that wisdom gained over years and different export destinations may result in knowledge for firms to effectively mitigate impacts of exchange rate on their stock returns.

Chapter 3

Decomposing The Risk Premium of Chinese Exporting Firms

3.1 Introduction

Typically, equity risk premium is decomposed, according to the Capital Asset Pricing Model (CAPM) developed by Jensen et al. (1972), into systematic risk (market risk) and idiosyncratic risk. The first component (systematic risk) is undiversifiable while the latter one is diversifiable. However, in order to decompose risk premia of exporting firms by country, this study is the first to decompose risk premium of exporting firms geographically which extends further on the diversifiable component to identify risk premium contributions from export destinations which is a direct benefit to the literature. The motivation is that if exporting were to produce risk premium to a firm, it should be worthwhile to identify how much each export destination contributes to overall risk premium. Having known country-specific risk premia benefits the firm in terms of risk management that it guides firms to choose to export to countries where additional risks are well compensated by additional returns (positive risk premium) and avoid undercompensated export destinations (negative risk premium). In addition, decomposition of risk premia to a country level gives an insight to risk-return evaluation of existing export activities and guides firms to sensibly adapt their export strategies to gain more stable profitability. In the perspective of investors, knowing risk premium of firm's export destinations helps diversify a portfolio to match with investors' risk preferences.

Export is generally perceived as a mean inducing economic growth and it can help protect companies against domestic market swings and business cycles (Bernard and Jensen (1999)). Firms choose to export by many reasons. The study by Clerides et al. (1998) reveals that firms decide to export because of being attracted by higher returns. It is widely accepted in the business literature that firms can increase their revenues by entering new markets or introducing new products as documented in Ansoff (1965) and Wickham (2006) and provide new opportunities for diversification. Although exporting means more opportunities, risks are entailed unavoidably. Risks associated to export are from, for example, exchange rates, political turmoil and counterparties credibility. These unanticipated shocks in foreign economies could adversely impair firms' earnings. This argument is supported by the study of Vannoorenberghe (2012) which states that export sales are considered to be even more volatile than domestic sales. Risk management thus becomes crucial tool to keep exporting firms competitive amidst ever-changing environments.

Investors or company executives generally take risk with the aim to reap extra return over their benchmark or risk-free investments. For companies listed in stock markets, good performance of stock returns attracts new investors and new funds to flourish its business and hence it is a commitment for company executives to ensure satisfactory equity returns. As a matter of fact, all investments necessarily involve some degrees of risk. Conventionally, risk on stock investment is commonly defined as a deviation from expected return. For exporting firms listed in stock exchanges in particular, risk associated to their stock values is assumed to emanate from uncertainty in different economies of export destinations and their home market. As such, risk can be determined by the degree of how much a home market react to shocks from each export destination and how much each individual firm reacts to economic shocks from each export market.

It is acknowledged that risk is generally attached to investment and that riskier investments should be compensated by higher return than low risk investments. The required return on the investment is generally the sum of the risk-free rate and the risk premium. The latter is a reward for the investor who takes risk. A riskier investment provides a higher reward in order to attract investors to take part in the investment. Risk premium is thus a suitable measure how much additional return is rewarded to stocks of exporting firms regarding their portfolio of export markets. The risk premium on equities reflects judgments how people perceive risk in an economy or a stock market and how much price they attach to that risk (Damodaran (2011)). It determines the expected return on risky investments and the value estimated of those investments. Risk premium thus makes difference on how we choose which assets or securities to invest and how money is allocated into each investment. If the risk premium is positive, it means that investors get some additional returns from risk taking. While the negative risk premium means there is no compensation for taking more risk. For these reasons, it is important and sensible for firms to keep their risk premia positive, this requires them to export to destinations that provide positive return reward. To filter out countries with negative risk premium, decomposing risk premium by country of export is hence the topic of our interest.

Exporting to a foreign market provides both risk and opportunity to firm's growth and profit. Entering into foreign markets means expanding market shares, increasing sales and increasing profits due to lower unit costs. Additionally, it is one way to overcome unfavorable growth or business cycles in the home country and this gives rise to the idea of diversifying export destinations. To evaluate risk and return gained from exporting to one destination, risk premium could be one single number that summarizes the trade-off between risk and return. A positive value is preferable, stating that return (net of risk-free borrowing cost) exceeds the risk taken (from uncertainty in economic condition of a destination country and cost of entry).

Apart from existing export markets, it is most likely that most firms have a plan to expand their export destinations to seek higher sales and earn more diversification benefits. Decision to export to new markets always bears uncertainty which hinders effectiveness of firm's capital budgeting and differs projected cash flows from what planned. In other words, new markets can introduce new risk but can also provide new opportunities for diversification. Under such uncertain circumstances, considering future investment as real options brings more flexibility to the firms as addressed in Bowman and Hurry (1993), Trigeorgis (1996) and McGrath et al. (2004). Real options investments refer to physical or human assets investments as opposed to financial options instrument (Kogut and Kulatilaka (2001)). Real options provide flexibility for firms to select the most appropriate courses of action on unfold future. Importance of real options in multinational firm valuation is addressed in Fillat et al. (2015). They incorporate options to enter new markets in calculating risk premium of US multinational enterprises (MNEs). In our study, we apply their idea on Chinese exporting companies so that plans to export to new export destination countries (or potential markets) involve in valuation of the firms in stock market. Consequently, our objective is to find the risk premium contribution from both current export destination and potential export destination countries of Chinese exporting firms during 2000-2006.

In the work of Fillat et al. (2015), the risk premia of US multinational companies are broken down to domestic market and countries of affiliates. Stationary covariance of GDPs between foreign market and the US is an indicator how much risk is contributed by each affiliate. Firm-specific elasticity derived from regressing stock prices with respect to GDP values characterizes how much a firm individually responses to shocks in each country and helps distinguish risk exposures when different firms set up their affiliates in same countries. The product of country's covariance and firm-specific elasticity thus indicates the risk each MNE is exposed to each of its affiliates. The decomposed risk premium by country is computed subsequently using covariance, elasticity and coefficients obtained from regressing firms' risk premia with respect to total risk from corresponding affiliates.

The first contribution of this study is that, to the best of our knowledge, this study is the first to decompose risk premium of exporting firms geographically. Other contributions are made on the improvement of risk representation. In Fillat et al. (2015), time-invariant covariance is a measure of risk concerning GDP co-movement between the US and other countries. As a matter of fact, both volatility and correlation between countries vary over time making stationary risk measure underestimates actual risk. In addition, instead of GDP, stock returns are selected as uncertainty representative of each export destination. The relationship between stock returns of firms that trade internationally and shocks from global stock markets is studied in Brooks and Del Negro (2006) which explores factors influencing stock returns of 1,239 firms in 20 countries and discover that, for companies which are globally engaged in terms of sales, assets or income, global shocks are an important source of return variation. Empirically, a firm that raises its international sales by 10 percent raises the exposure of its stock returns to global shocks such as global stock markets by 2 percent and reduces the exposure to domestic shocks by 1.5 percent. In the same study, the authors also elaborate that shocks that returns of globally engaged firms exposed to are in fact shocks from domestic and foreign stock markets.

The advantage of using stock return is that economic expectations always reflect in stock prices which make a time series of stock returns reflecting forward outlook of economy more instantly than GDP (Comincioli (1996)). Furthermore, the calculation of the time-varying covariance requires sufficiently long time series for each export destination country. Since GDP data are updated most frequently at quarterly basis while stock prices are updated monthly. For a study period of seven years, GDP time series are insufficient to provide estimation for time-varying covariance. Stock prices are therefore preferred to GDP in this respect.

The rest of this chapter is organized as follows. Section 3.2 reviews the related literatures. Section 3.3 exhibits the theoretical model for empirical specification. Section 3.4 describes the data and variables. Section 3.5 provides the empirical results and robustness checks and Section 3.6 presents the conclusions.

3.2 Literature Review

We present a review of literature in separate topics. Subsection 3.2.1 examines past studies to understand the motive of firms to export to several markets and what are determinants in selecting export destinations. Subsection 3.2.2 reviews strengths and drawbacks of the existing methods employed in decomposing equity risk premium.

3.2.1 Export Diversification

Expanding export destinations has been a key strategy for exporting firms to mitigate risks from export prices volatility, sudden closure of export markets (as a result of regulatory changes), entry of new competitors and domestic supply shocks. The recent economic turmoil provides additional support for a firm to diversify its export geographically. Geographical diversification, by its mechanism, works as a form of portfolio diversification which helps minimize risk for a given level of return (Brainard et al. (1970)). This leads to a more stable flow of export income, in addition to other gains such as learning about foreign market conditions and technologies through exporting experience.

On the key determinant encouraging how much firms is willing to diversify, many empirical works find that distance from home market affects diversity of destination markets. Supporting evidence is documented in, for instance, Amurgo-Pacheco (2008), Tamberi (2008), Dutt et al. (2008) and Cadot et al. (2013). The economic intuition behind this is that the set of foreign markets entered by exporters is determined by the entry costs which can vary across countries. Only the most productive firms can enter the most costly (least accessible) foreign markets. This leads to the fact that most firms specifically export to some particular markets but not others.

Evenett and Venables (2003) examine the export growth of 23 developing countries to 93 foreign markets over the period 1970–1997. They find that the probability of exporting to a given destination is generally decreasing in distance, but increasing in market size. Eaton et al. (2004) use a database of French firms to analyze the determinants of export behavior. They find that bigger firms (i.e., those with higher levels of sales) in France tend to export to a larger number of foreign markets. Using similar data, Koenig (2009) finds that distance (a proxy for trade cost) and foreign market size have significant effects at the extensive margin. Shepherd (2010) shows that export costs, tariffs, and international transport costs are all robustly associated with geographical export diversification in a sample of 117 developing countries where a reduction on each of them by one standard deviation could lead to increases in the number of export destinations of 12%, 3% and 4%, respectively.

In our study, attention is paid on the effects of diversity of export destinations on equity risk premium of firms. In contrast with what predicted in "diversification hypothesis" that foreign investments should help diversify away total risk of firms, previous studies such as Jacquillat and Solnik (1978), Senchack and Beedles (1980) and Rowland and Tesar (2004) find limited evidence of diversification benefits for firms with foreign affiliates. Fillat et al. (2015) point out that such "puzzle" could be explained by introducing fixed and sunk cost channels. They study how the geographic structure of a US multinational corporation impacts its risk premium in the stock market and discover that foreign activities do not necessarily result in diversification and could contrarily be a source of risk premium to investors.

Their findings show that positive correlation of GDP between foreign and domestic markets in tandem with sunk entry costs is accounted for higher risk premium.

3.2.2 Risk Premium Decomposition

Decomposing risk premium geographically is a technique providing insight to an exporting firm how much risk premium is contributed by each of its export markets. Prior to geographical decomposition, several approaches are applied to decompose the components of risk premium. The first stream established on the concept of Gordon and Shapiro (1956) states that equity risk premium is composed of discounted flows of dividend, known as Dividend Discount Models (DDM). The basic intuition is that the value of a stock is determined by projected cash flows. Current stock price should be the sum of all expected future cash flows discounted at an appropriate rate to take into account their riskiness and time value of money. The advantages of DDM are forward looking and consistent with no arbitrage condition. Moreover, they are easy to implement. However, a drawback is that the results are sensitive to expectations of future dividend.

The second stream originated from the work of Ibbotson and Sinquefield (1976) decomposes historical returns of a stock index into a risk-free rate and a stationary equity premium. The easiest approach to estimate the equity risk premium is to use the historical mean of realized market returns in excess of the contemporaneous risk free rate. This model is simple for implementation but its out-of-sample predictability performance is unconvincing. The important shortcomings are that it is purely backward looking and assumes that the future behaves similarly to the past. For instance, it assumes that mean of excess returns is either constant or slowly moving over time, giving very little time-variation in the equity risk premium. Another drawback is that the appropriate length of data required to compute historical mean is unknown. This approach thus loses its popularity by the renowned paper of Mehra and Prescott (1985) and hence begins the last stream.

Mehra and Presscott's article discovers the failure of standard "general equilibrium" or "macroeconomic" asset-pricing models in explaining excessively high historical equity risk premium of around 7% annually during the period of 1889 – 1978. Many attempts have been put to explain why the realized equity premium was so large which can be categorized into two groups. The first group led by Brown et al. (1995), Dimson et al. (2006), McGrattan and Prescott (2001, 2003), Arnott and Bernstein (2002) and Siegel (2005) aims to find bias in historical data due to the effects of transaction costs, taxes, unanticipated repricing of equities and unanticipated poor historical bond returns. Another group, on the other hand, focuses on improvement of theoretical models used in Mehra and Prescott (1985). For instance, Bansal and Yaron (2004) exhibit that risks related to varying growth prospects and fluctuating economic uncertainty, combined with separation between the intertemporal substitution and risk aversion, can help to resolve the equity risk premium puzzle. In addition, Brav et al. (2002) show that the equity premium can be explained with a stochastic discount factor calculated as the weighted average of the individual households' marginal rate of substitution with low and economically plausible values of the rate of risk aversion coefficient.

For the approach decomposing risk premium by country, to the best of our knowledge, Fillat et al. (2015) are the first group of authors introducing this idea to study geographical risk premium across affiliates of US multinational companies. We apply their approach on exporting firms to decompose risk premium by export destination so as to facilitate firms on making decision which export markets worth entering in the sense of equity risk-return reward. In Fillat et al. (2015), risk of establishing affiliates in each country is represented by fixed costs and GDP covariance between that country and the US. As opposed to GDP covariance in original paper, we select stock market covariance to represent risk of each export destination market.

The advantage of using stock return over GDP is that economic expectations reflected in stock prices are more responsively than those of GDP (Comincioli (1996)). There is a broad consensus that stock market performance impacts the economy and this influence is more pronounced over the years. Persistent stock market declines lower consumer confidence and business outlook which consequently lead to lower consumption and investment spending. Rise or fall of stock prices can increase or diminish wealth of private households which directly impacts consumption more or less. For instance, a 100 euro decline in the value of stock holdings decreases private consumption in Germany by 1 to 2 euros[1]. As a predictive indicator of stock markets, a study by Barro and Ursúa (2009) reports interesting result that the likelihood of a depression increases by 20% if there is a stock market crash. This well supports the use of stock market covariance to proxy the risk exposed in each destination country. Another advantage to the selection of stock indices rather than GDPs is that stock market returns offer time series sufficiently long to construct time-varying covariance. This improvement is made to circumvent a rigid assumption in Fillat et al. (2015) that the covariance is constant over time.

3.3 Methodology

In this section, to illustrate how the stock returns of exporting firms depend on variables related to their international activities across countries, we adapt the model developed by Fillat et al. (2015) to estimate and decompose risk premium of exporting firms.

The model is a multi-country extension of the framework developed by Fillat et al. (2015). The economy is composed by N+1 countries: a home counry, that is denoted by d, and N potentially asymmetric foreign countries, that are denoted by $j = 1, \ldots, N$. Time is continuous. Each country is hit by aggregate shocks to its GDP growth rate, which are described

[1]Deutsche Bundesbank Monthly Report, March 2003, p.40.

by the following geometric Brownian motions:

$$\frac{dY_i}{Y_i} = \mu_i dt + \sigma_i dz_i \quad for\, i = d, j and\ j = 1, ...N \tag{3.1}$$

where $\mu_i \geq 0, \sigma > 0$. Y_i denotes the GDP level in country i and dz_i is an increment of a standard Wiener process. GDP growth processes may be correlated across countries: let $\rho_j \in [-1, 1]$ denote the correlation between GDP growth of the home country and the one of country j.

International markets are incomplete: changes in aggregate consumption in each country is equal to changes in GDP, and there is no possibility of consumption smoothing over time or across countries. We assume complete home bias in the asset markets, in the sense that firms are owned by agents in country d, who discount cash flows with the following discount factor (M_d)

$$\frac{dM_d}{M_d} = -r_d dt - \gamma \sigma_d dz_d \tag{3.2}$$

where r_d denotes the risk-free rate in the home country, γ denotes risk-aversion and dz_d is the aggregate shock for the home country. This is a partial equilibrium model where aggregate quantities are taken as given. Thus, equilibrium in the goods and asset markets is determined by adjustment in prices.

Aggregate output in each country Y_i is produced by domestic firms and by the affiliates of multinational firms located in country i. Each firm chooses its optimal production level in each country as a share of total output Y_i.

Let v denote the value of a firm. v depends on both firm-specific characteristics like productivity, size, employment, etc., and on country-specific characteristics such as the GDP growth processes of the countries where the firm oprates, entry cost, and other operating costs. For this reason, we write $v = v(a, \bar{Y}, \bar{X})$, where a denotes firm-specific characteristics and $\overline{Y} = (Y_d, Y_1, \ldots, Y_N)$ denotes a vector whose entries are the realizations of GDP described by 3.1 and $\overline{X} = (X_d, X_1, \ldots, X_N)$ denotes a vector whose entries are other country-specific characteristics affecting firm value. Consistent with the literature on selection into multinational activity and with the empirical evidence on firms' international dynamics, fixed-operating costs of production and sunk costs of entry into a market are particularly relevant among the variables entering the vector $\bar{X}$. Depending on its characteristics a, each firm self-selects into the set of countries where its operations are profitable. Given demand for each firm's product in each country, a drives both the intensive margin of production in each country and the extensive margin of entry in different countries.

Regarding firm valuation, we assume that firms' activities are independent across countries, i.e. each firm makes entry and production decisions country-by-country. Since the decision of setting up a foreign affiliate is endogenous and affected by uncertainty through the country-specific GDP growth shocks, we must consider the fact that a firm's valuation is affected both by its assets currently in place in variuos countries, and by the possibility of entering new countries (its option value). For these reasons, the value of the firm is written as:

$$v(a,\overline{Y},\overline{X}) = V_d(a,Y_d,X_d) + \sum_{j\in A} V_j(a,Y_J,X_J) + \sum_{j\notin A} V_j^o(a,Y_j,X_j) \tag{3.3}$$

where $V_d(a,Y_d,X_d)$ is the firm's value of domestic sales. $V_j(a,Y_J,X_J)$ denotes the value of firm's affiliate sales in country j if the firm has an affiliate there and $V_j^o(a,Y_j,X_j)$ denotes the option value of the firm's affiliate sales in country j if the firm does not have an affiliate there. A denotes the endogenous set of countries where the firm has affilates ($A \subseteq \{1,2,\ldots,N\}$).

We assume that all firms sell in the home country. Conversely, firms' entry and exit into foreign markets are endogenous. For these reasons, over a generic time interval (Δt), the components of a firm's value function are expressed as:

$$V_d(a,Y_d,X_d) = \pi_d(a,Y_d,X_d)M\Delta t + E[M\Delta t \cdot V_d(a,Y_d^{'},X_d|Y_d)], \tag{3.4}$$

$$V_j(a,Y_j,X_j) = \max\{\pi_j(a,Y_j,X_j)M\Delta t + E[M\Delta t \cdot V_j(a,Y_j^{'},X_j|Y_j)];\ V_j^o(a,Y_j,X_j)\}, \tag{3.5}$$

$$V_j^o(a,Y_j,X_j) = \max\{E[M\Delta t \cdot V_j^o(a,Y_j^{'},X_j|Y_j)];\ V_j(a,Y_j,X_j) - F_j\} \tag{3.6}$$

where $\pi_i(a,Y_i,X_i)$ denotes the profit flows of the firm in country i (for $i = d, j$ and $j = 1,\dots.N$), F_j denotes the sunk entry cost that a firm has to cover to open an affiliate in country j, and the terms in expectations indicate the firm's continuation value in the event in which its status in a country does not change (i.e. it does not enter or exit the country).

Equation (3.4) represents the present value of firm operating in the domestic market for an interval of Δt. Equation (3.6) represents the decision-making process of a firm on its potential affiliations. If the expected value of opening an affiliation in a potential country in the future is greater than doing it today, a firm decides to set up an affiliation in country j at later time, and vice versa. Equation (3.5) denotes the value of firm's affiliates from its existing destinations. However, if the option value of setting up an affiliation in that destination is greater than the expected value of current affiliation, it implies that a firm could be better off to defer its operation and return to the market at later time. The sunk entry costs in equation (3.5) and (3.6) involve in the values of both existing and potential affiliates. Given all else being equal, the lower sunk cost increases the values of V_j^o and V_j hence raising overall value of the firm.

Fillat et al. (2015) show that in the continuation regions, the three value functions above satisfy the following no-arbitrage conditions:

$$\pi_d - r_d V_d + (\mu_d - \gamma\sigma_d^2) Y_d V_{dY}^{'} dt + 1/2\sigma_d^2 Y_d^2 V_{dY}^{''} = 0, \tag{3.7}$$

$$\pi_j - r_d V_j + (\mu_j - \gamma\rho_j\sigma_d\sigma_j) Y_j V_{jY}^{'} dt + 1/2\sigma_j^2 Y_j^2 V_{jY}^{''} = 0, \tag{3.8}$$

$$-r_d V_j^o + (\mu_j - \gamma\rho_j\sigma_d\sigma_j) Y_j V_{jY}^{o'} dt + 1/2\sigma_j^2 Y_j^2 V_{jY}^{o''} = 0. \tag{3.9}$$

Since $(dv) = E[dv_d] + \sum_{j\in A} E[dv_j] + \sum_{j\notin A} E[dv_j^o]$, by combining equations (3.7) to (3.9), one can obtain the following expression for a firm's expected returns:

$$\begin{aligned} E[ret] &= \frac{\pi_d + \sum_{j\in A}\pi_j + E[dv]}{v}, \\ &= r_d + \gamma\left(\frac{\sigma_d^2 Y_d V_{dY}^{'}}{v} + \sum_{j\in A}\sigma_d\sigma_j\rho_j\frac{Y_j V_{jY}^{'}}{v} + \sum_{j\notin A}\sigma_d\sigma_j\rho_j\frac{Y_j V_{jY}^{o'}}{v}\right). \end{aligned} \tag{3.10}$$

Equation (3.10) summarizes the implications of the model for the dependence of firm level returns (and hence of the risk premium, $E[ret] - r_d$) on country-specific variables, and is the theoretical foundation of our empirical specifications. The risk aversion (γ) captures the price of risk for the representative agent, or how much does he need to be rewarded for additional exposure to risk incurred by the firms. The terms in the parentheses capture the three sources of risk that a firm is exposed to which are domestic risk, risk from the countries where the firm has an affiliate, and risk from the countries where the firm has the option of opening an affiliate, respectively. The first term of the expression describes the contribution of domestic activities to the returns. The last term captures the option value of entry in new countries. They focus on the second term, which they refer to as "assets in place". This term captures the exposure of multinational firms to the risk that arises from having affiliates in foreign countries.

From the structural model in equation (3.10), it is applied to decompose risk premium of Chinese exporting firms into individual contribution of each of its export destinations. Furthermore, contribution of risk premia contributed by existing and potential export destinations can also be quantified with the structural model. Recall equation (3.10) which can be re-written as

$$E[ret_i] - r_d = \gamma \left(\sigma_d^2 \varepsilon_{id} + \sum_{j \in A} \sigma_d \sigma_j \rho_j \varepsilon_{ij} + \sum_{j \notin A} \sigma_d \sigma_j \rho_j \varepsilon_{ij}^o \right) \tag{3.11}$$

where

$E[ret_i] - r_d$	is risk premium of each exporting firm,
γ	is a risk aversion coefficient,
$\varepsilon_{id} = \frac{Y_d V_{dY}'}{v}$	is the elasticity of firm's value with respect to stock market returns in the domestic market (China),
$\varepsilon_{ij} = \frac{Y_j V_{jY}'}{v}$	is the elasticity of the firm's value with respect to stock market returns in current export destination country $j \in A$,
$\varepsilon_{ij} = \frac{Y_j V_{jY}^{o\prime}}{v}$	is the elasticity of the firm's value with respect to stock market returns in a potential export destination country $j \notin A$.

The terms in the parenthesis represent the three sources of risk that a firm is exposed to. Specifically,

$\sigma_d^2 \varepsilon_{id}$	is risk from domestic sales (in China),
$\sum_{j \in A} \sigma_d \sigma_j \rho_j \varepsilon_{ij}$	is risk from current export destination countries the firm is exporting to,
$\sum_{j \notin A} \sigma_d \sigma_j \rho_j \varepsilon_{ij}^o$	captures the option values of exporting to new countries.

3.4 Data and Variables

This section aims to provide descriptions of all data sources and key variables used in our study. First, we give details of what are retrieved from each data source and how they are subsequently merged to create the final database. Afterwards, the variables appearing in estimation models are described. There are two main data sources selected in this study, namely Chinese Customs Trade Statistics (CCTS) and Bloomberg.

3.4.1 Data Sources

3.4.1.1 Chinese Customs Trade Statistics (CCTS)

This data source provides monthly firm-level data of Chinese exporting firms listed in Shanghai and Shenzhen stock markets. Our sample contains 654 Chinese exporting firms with varied number of observations across firms in 2000-2006. It contains firm's information such as firm identifiers, export and import values, export destination countries and import origin countries. More details for the key variables are as below

1. Firm identifiers: we use this to merge CCTS to other data sources of the same identification system such as Bloomberg.
2. Export destination countries: 199 countries are originally identified with CCTS country codes along with corresponding country names which are later used to merge country-level data from Bloomberg such as distances between China and other countries.

3.4.1.2 Bloomberg

This vast data source provides a wide range of financial data at various frequencies. The key variables collected from this provider such as firm's stock returns, stock market indices, China's risk-free rate and distance between China and other countries are described as follows.

1. Stock returns: Bloomberg supplies stock returns including market values of all firms registered in Shanghai and Shenzhen stock markets while we need only 654 firms

appearing in CCTS. Stock returns are collected at monthly frequency covering the period of January 2000 to December 2006.

2. Stock market indices: we collect monthly stock index returns of 199 export destination countries in CCTS data during 2000-2006.

3. China's risk-free rate: The 3-month treasury bill index of China is used as a proxy of China's risk-free rate of return. This variable is used for calculating risk-premium of firms in model.

4. Distance between China and other countries: distance in kilometers from China to export destinations represents the sunk costs.

Listed firms in CCTS and Bloomberg are identified with the same stock codes system which allows merging data across databases. The data collected from these two sources are all in monthly frequency so the observations can be mapped firm-to-firm and month-to-month. In terms of the number of firms, Bloomberg contains all listed companies in Shanghai and Shenzhen stock markets while there are 654 firms in our CCTS sample. The final merged database is therefore limited to 654 available firms as appearing in the CCTS dataset.

3.4.2 Variable Definitions and Constructions

In this section, we describe the variables used in the model in Section 3.3 and how they are constructed. If not locally specified elsewhere, all the following equations comply with these notations

i is an index of firms.

j is an index of export destination countries.

t is an index of months.

C_{it} is a number of export destination of firm i in month t.

3.4.2.1 Firm Returns (ret_{it})

The firm returns are the monthly logarithmic rates of return of each Chinese exporting firm computed from change in natural logarithmic value of stock price at time t relative to its previous month's price or $ret_{it} = \ln(stockprice_{it}) - \ln(stockprice_{it-1})$ where $stockprice_{it}$ is the stock price of firm i in month t. For the average firm stock return in our sample, the average stock return is -0.68% per month during 2000-2006.

3.4.2.2 China's Risk-Free Rate (r_{dt})

In this study, the 3-month treasury bill of China is used as a proxy of China's risk free rate. China's risk-free rate is computed by $r_{dt} = \ln(TB_t) - \ln(TB_{t-1})$ where TB_t is the three month treasury bill index at time t. On the average, China's risk-free rate is around 0.15% per month during our sample period (see Table 3.1).

3.4.2.3 Time-Varying Variance of Chinese Stock Market (σ^2_{dt})

The time-varying variance or conditional variance of stock market in China is computed from a time series of Shanghai composite stock index at monthly frequency. The generalized autoregressive conditionally heteroskedastic (GARCH) model is introduced to estimate variance of domestic stock returns that changing over time. We employ GARCH (1,1) to estimate the variance of Chinese stock market returns.

The underlying reason of employing GARCH model is that the covariance structure of returns is widely accepted to change through time (Starica (2004)) . The non-stationary framework that assumes the unconditional variance to be the main time varying feature of returns can be traced back to Officer (1973), Hsu et al. (1974), Merton (1980) and French et al. (1987). As a starting point of our analysis, we focus on the GARCH(1,1) process presented in Bollerslev (1986) and French et al. (1987) since it is widely used, highly regarded in practice and in the academic discourse. From Table 3.1, on the average, the time-varying variance of Chinese stock market is 0.04% per month during 2000-2006.

3.4.2.4 Time-Varying Covariance between Chinese Stock Market Return and Actual Export Destination Return ($\sigma_{dt}\sigma_{jt}\rho_{jt}$ where $j \in A$)

The covariance between stock market of China and actual export destination countries represents the risk from co-movement of two stock market returns. The distinction from covariance used in Fillat et al. (2015) is that our version allows the covariance varies over time rather than a stationary (time-invariant covariance). The multivariate GARCH with dynamic conditional correlation model (DCC-GARCH) is employed in our study to estimate the trivariate covariance. Thorough details of DCC-GARCH are provided in Section B.5 of Appendix B while the estimation of time-varying covariances is outlined below.

At time t, given an $n \times n$ conditional covariance matrix (H_t), it can be decomposed to

$$H_t = D_t R_t D_t = \rho_{ij}\sqrt{h_{iit}h_{jjt}} \tag{3.12}$$

where i and j denote indices of row and column of a covariance matrix respectively, ρ_{ij} is an element in a positive definite time-varying conditional correlation matrix (R_t) and $D_t = diag\left(\sqrt{h_{11t}}, \ldots, \sqrt{h_{nnt}}\right)$. The conditional variances (h_{iit}) are estimated using a GARCH(p,q) model which can be written in a vector form as

$$h_t = \omega + \sum_{i=1}^{p} A_i \varepsilon_{t-i} \odot \varepsilon_{t-i} + \sum_{i=1}^{q} B_i h_{t-i} \tag{3.13}$$

where ω is a constant, A_i and B_i are $n \times n$ diagonal matrices of coefficients, ε_t is a residual of the process and $\odot$ is the Hadamard operator. The coefficients in A_i and B_i can be obtained by maximizing the log-likelihood of equation (3.13).

The trivariate time-varying covariance is employed in the regression model to compute the decomposed risk premium. The reason why trivariate time-varying covariance is used in this study is when a Chinese firm exports to the US, its stock price is basically influenced not only directly from Chinese and the US stock markets but also indirectly from stock markets of other countries which trade with China and the US. Assuming risk associated to exporting to one country is merely from domestic market and an export destination could misestimate actual risk and hence inaccurate decomposed risk premium. Accordingly, to complement the covariance components, a set of other countries except for China and an export destination is introduced in time-varying covariance estimation.

The details of the resulting trivariate covariance are given as follows. Suppose that C is a set of all countries that Chinese firms are exporting to (there are 199 countries in our sample), then we denote j as a export destination country and T as a set of other countries that does not include country j, defined as $T = C \setminus \{j\}$. A composite stock return index representing pooled return of stock markets in the set T is created by weighting each stock index return by its corresponding market capitalization. The trivariate GARCH model subsequently takes the time series of stock returns from the three components i.e., China, export destination country j and the set of other countries T to calculate the time-varying covariance.

To exemplify, the trivariate covariance of China, the US and other countries are estimated using the following composite index. Suppose that there are n export destinations in the set C, then other export destinations excluding the US are expressed by the set $T = C \setminus \{US\}$ with the number of elements of $n-1$. Denote $x_{it} = x_{1t}, \ldots, x_{(n-1)t}$ as stock index returns of $n-1$ export destinations corresponding to elements of set T at time t and denote $m_{it} = m_{1t}, \ldots, m_{(n-1)t}$ as the contemporaneous market capitalizations denominated in US dollar of x_i. The weight (w_{it}) for the composite index is constructed with the following formula:

$$w_{it} = \frac{m_i}{\sum\limits_{i \in T} m_i} \tag{3.14}$$

and the subsequent composite index at time t is created by

$$y_t = \sum_{i \in T} w_{it} x_{it}. \tag{3.15}$$

The conditional covariance matrix (H_t) of dimension 3×3 in equation (3.12) is constructed by the time series of stock index returns of China, the US and the composite index, and is subsequently used to estimate the dynamic conditional correlation multivariate GARCH model.

From Table 3.1, during our sample period, the average of time–varying covariance between returns of Chinese stock index and those of actual export destinations is 0.14% per month. The positive values of covariance indicate that, on the average, stock markets in export destinations co-move with Chinese stock markets and vice versa. The covariance value of 0.14% monthly signifies that if a firm exporting to all actual destinations constantly over the studied period, apart from fluctuation of individual stock markets the firm exporting to, the co-movement between those markets accounts for additional risk to the firm's stock value by 0.14% per month.

3.4.2.5 Time-Varying Covariance between Chinese Stock Market Return and Potential Export Destination Return ($\sigma_{dt}\sigma_{jt}\rho_{jt}$ where $j \notin A$)

We perform a two-step approach to estimate time-varying covariance between returns of potential export markets (or option value of a firm) and China. We begin the first-step estimation with probit regression to find predicted probability of a firm to export to each of its potential destinations. According to the export decision model developed by Das et al. (2007), the decision to export depends on firm sizes, sunk costs and whether or not the firm already exports to that destination. Additionally, skilled labor measured by the ratio of labor that completed tertiary graduation from World Bank is included in firm's export decision which formulates the estimating equation as

$$D_{ijt} = \alpha + \beta_1 \ln(size_{it}) + \beta_2 \ln(cost_j) + \beta_3 D_{ijt-1} + \beta_4 \ln(L_{jt}) + \delta_t + \varepsilon_{ijt} \tag{3.16}$$

where D_{ijt} is a dummy variable that equals one if firm i exports to country j at time t and 0 otherwise. $size_{it}$ is a firm size proxied by market values of firm i, $cost_j$ is sunk cost proxied by the distance from China to country j and D_{ijt-1} is a dummy variable that equals one if firm i exports to a country j at time $t-1$ and 0 otherwise. L_{jt} represents a percentage of skilled labors in country j at time t, δ_t is year fixed effect and ε_{ijt} is an error term. We expect that firms with larger market values, more experience are more likely to export to the foreign market (or a country j) whereas firms with higher sunk costs are less likely to export to the country j. Besides, exporting to a country with high percentage of skilled labors is more likely than exporting to a country with scarce skilled labors. Therefore, β_1, β_3 and β_4 are expected to be positive while β_2 should be negative.

We calculate the probability to export using a probit model. From Table 3.2, all coefficients of the variables determining whether or not a firm will export to a given country are significant at least at the 10 percent level. In particular, firm sizes, skilled labors and past experience of export are positively and significantly related to a firm's export decision while the sunk costs affect the decision of export negatively.

Next, the probabilities that each firm will export to each countries are estimated by using cumulative normal distribution function. The resulting estimated β's are subsequently used to compute the firm-specific predicted probability that a firm will export to each of its destination countries in the future. The predicted probabilities are given as:

$$prob_{ijt} = \Phi\left(\alpha + \hat{\beta}_1 \ln(size_{it}) + \hat{\beta}_2 \ln(cost_j) + \hat{\beta}_3 D_{ijt-1} + \hat{\beta}_4 \ln(L_{jt})\right) \tag{3.17}$$

where Φ is the cumulative normal distribution function and $prob_{ijt}$ denotes the predicted probability that firm i will export to destination j in month t. The average value of probability that each firm will export to each export destination is given in Table 3.3. Note that, due to data availability, some countries with low trading activities with China have insufficient observations. Hence, probabilities to export to those countries cannot be calculated and they are not shown in Table 3.3. Eventually, we obtain probabilities to export for 59 export destination countries for each firm. The resulting probabilities suggest that Chinese exporting firms are more likely to export to more regional than distant destinations. Additionally, countries that are major trading partners with China in terms of export values such as the US, South Korea and Singapore attract Chinese exporters more than those with lower values of export.

After we obtain the probability that firm i will export to destination j in month t ($prob_{ijt}$), we next construct the time-varying covariance between China and the potential countries in which the firm will export in the future by multiplying the predicted probabilities with corresponding covariances as $\sum_{j \notin A} \sigma_{dt} \sigma_{jt} \rho_{jt} prob_{ijt}$. From Table 3.1, the average of time-varying covariance between returns of Chinese stock market and potential export destinations is -0.001% per month.

3.4.2.6 Firm elasticity (ε_{id}, ε_{ij} and ε_{ij}^{o})

Recall equation (3.11), ε_{id} is the elasticity of the firm's value with respect to China's stock market returns, ε_{ij} is the elasticity of the firm's value with respect to stock market returns in current export destination country $j \in A$ and ε_{ij}^{o} is the elasticity of the firm's value with respect to stock market returns in a potential export destination country $j \notin A$. In practice, to estimate the equation (3.11), we need to compute the elasticities (ε_{id}, ε_{ij} for $j \in A$ and ε_{ij}^{o} for $j \notin A$). Elasticity of firm values with respect to stock market returns of China or those of other export destination countries take crucial part in calculating risk exposure arising from domestic and export activities. It signifies how much firm returns individually response to local and global stock market shocks. We proxy the true elasticity (ε_{ij}) as the product of the approximated elasticity ($\widetilde{\varepsilon}_{ij}$) and a country-specific unobserved component (ζ_j) (Fillat et al. (2015)) as follows,

$$\varepsilon_{ij} = \widetilde{\varepsilon}_{ij}\zeta_j. \tag{3.18}$$

As an adaptation on exporting firms, the approximated elasticity ($\widetilde{\varepsilon}_{ij}$) is estimated from regressing log-market values of firm i ($\ln(mv_i)$) on log-stock market returns of export destination j ($\ln(stock_j)$) as follows:

$$\ln(mv_{it}) = a + \widetilde{\varepsilon}_{ij}\ln(stock_{jt}) + \mu_{it}. \tag{3.19}$$

For the elasticity of the option value (ε^o_{ij}), we assume that

$$\varepsilon^o_{ij} \approx \zeta^o_j prob_{ijt}\widetilde{\varepsilon}_{ij} \tag{3.20}$$

where $prob_{ijt}$ is the predicted probability that firm i will export to country j obtained from probit regression in equation (3.17). The term ζ^o_j accounts for other country-specific factors that may impact the value of firms in potential market j.

According to equations (3.18) to (3.20), the risk premium of firm can be expressed as

$$RP_{it} = \psi_d\sigma^2_{dt}\widetilde{\varepsilon}_{id} + \sum_{j\in A}\psi_j\sigma_{dt}\sigma_{jt}\rho_{jt}\widetilde{\varepsilon}_{ij} + \sum_{j\notin A}\psi^o_j\sigma_{dt}\sigma_{jt}\rho_{jt}prob_{ijt}\widetilde{\varepsilon}_{ij} + \nu_{it} \tag{3.21}$$

where RP_{it} represents risk premium of each firm, $\psi_d = \gamma\zeta_d$, $\psi_j = \gamma\zeta_j$, $\psi^o_j = \gamma\zeta^o_j$ and ν_{it} is an error term. Recall that, on the right hand side, the first term or $\sigma^2_{dt}\widetilde{\varepsilon}_{id}$ is risk from domestic sales representing risk from sales in China, while the second term $\sigma_{dt}\sigma_{jt}\rho_{jt}\widetilde{\varepsilon}_{ij}$ for $j \in A$ is risk from the current export destination countries where the firm has already exported to. Moreover, the last term $\sigma_{dt}\sigma_{jt}\rho_{jt}prob_{ijt}\widetilde{\varepsilon}_{ij}$ for $j \notin A$ is risk from the potential export destination countries where the firm has the option of export. ψ_d, ψ_j and ψ^o_j are the coefficients to be estimated. Note that the baseline model in equation (3.21) is our time-varying extension to the time-invariant geographical risk premium decomposition model of Fillat et al. (2015) as earlier explained in equation (3.11).

Table 3.1: Descriptive statistics of variables associated to the sample of 654 exporting firms from CCTS during 2000-2006.

	Mean	Std. Dev.	Min	Max
Firm stock return (monthly)	-0.68%	9.08%	-78.59%	81.45%
Risk-free rate (monthly)	0.15%	0.09%	0.11%	0.19%
Market value of firms (million CNY)	31,186	436,700	6,597	20,200,000
Shanghai stock index return (monthly)	0.80%	6.51%	-14.41%	24.25%
Time-varying Varinace of Shanghai stock index returns	0.04%	0.06%	-0.13%	0.16%
Covariance between China and actual export destination j (monthly)				
- bivariate	0.13%	0.86%	-0.43%	12.83%
- trivariate	0.14%	0.75%	-0.17%	8.40%
Covariance between China and potential export destination j (monthly)				
- bivariate	-0.002%	0.145%	-0.327%	0.132%
- trivariate	-0.001%	0.036%	-0.690%	0.112%
Number of export destinations for each firm	9.50	12.47	1	91
Distance from China to country j	9,130	3,809	797	19,246
Firm Elasticity	-0.15	0.45	-5.00	10.92

Note: This table presents summary statistics including means, standard deviations, minimum and maximum of variables such as monthly firm stock returns, market value of firms in million CNY, monthly risk free rate and monthly time-varying covariance between returns of China and other countries. In our sample, the market value is around 31,186 million CNY on the average. Exporting firms export to around 10 different countries over 2000-2006 period. However, the extreme contrast between minimum and maximum numbers of destination countries and market values is observed. Furthermore, there are 199 export destination countries. The fixed cost is proxied by distances in kilometer from China to country j. The average of distance is around 9,130 kilometers.

Table 3.2: Estimation results of a probit regression.

Variable	Coefficient
$D_{i,jt-1}$	2.093***
$\ln(mv_{ijt})$	0.088***
$\ln(L_{jt})$	0.107***
$\ln(cost_j)$	-0.174***
constant	-1.109*
no. of observations	798,783

Notes: the model specification includes year fixed-effect and * $p < 0.1$, **$p < 0.5$, ***$p < 0.01$.

Table 3.3: Predicted probability that an exporting firm will export to each destination country in each month.

Country	Predicted probability	Country	Predicted probability
South Korea	0.38	Saudi Arabia	0.09
Japan	0.27	Switzerland	0.08
Vietnam	0.16	Iran	0.08
Philippines	0.15	Greece	0.08
Thailand	0.14	Sri Lanka	0.08
Bangladesh	0.13	New Zaland	0.08
singapore	0.13	Mexico	0.08
India	0.13	Poland	0.08
Myanmar	0.12	Ukraine	0.08
Canada	0.12	Turkey	0.08
Australia	0.12	Egypt	0.08
Malysia	0.12	Kuwait	0.07
Israel	0.12	Hungary	0.07
Russia	0.12	Syria	0.07
Germany	0.12	South Africa	0.07
Cambodia	0.12	Panama	0.06
UK	0.11	Peru	0.06
Pakistan	0.11	Argentina	0.06
Belgium	0.11	Sudan	0.06
Netherlands	0.11	Algeria	0.06
Spain	0.11	Romania	0.06
France	0.10	Libya	0.06
Findland	0.10	Nigeria	0.06
USA	0.10	Malta	0.05
Denmark	0.09	Benin	0.05
Norway	0.09	Colombia	0.05
Sweden	0.09	Brazil	0.05
UAE	0.09	Chile	0.05
Indonesia	0.09	Venezuela	0.05
Italy	0.09		

3.5 Results

The model estimation presented in this section allows us to decompose the risk premium into the separate contributions of each export destination country. As mentioned earlier, the risk premium can be positive or negative or zero. Furthermore, we are able to quantify the contribution of actual export destination countries versus potential export markets to the risk premium.

We present the results from estimating equation (3.21) in two parts. First, we decompose the risk premium of the firm into the contributions of each export destination country. Second, we aggregate the risk premia across countries to give an estimate of the total risk premium.

3.5.1 Decomposed Risk Premium by Country

In this study, we use the monthly data of Chinese exporting firms during 2000-2006 to estimate equation (3.21). When considering the potential countries in which a firm may export in the future, we define the sample to the top 50 countries that account for 95% of total export value of our Chinese sample during 2000-2006. We assume that each firm has 50 choices of export destinations which helps simplify the model formulation.

First, we estimate equation (3.21) without controlling for potential export markets as follows:

$$RP_{it} = \psi_d \sigma_{dt}^2 \widetilde{\varepsilon}_{id} + \sum_{j \in A} \psi_j \sigma_{dt} \sigma_{jt} \rho_{jt} \widetilde{\varepsilon}_{ij} + v_{it}. \tag{3.22}$$

Since the relationship in the above equation should hold within industry, the industry and year fixed effects are added in this specification. Note that the baseline model of risk premium decomposition as defined in equation (3.21) is firm-specific, i.e., decomposed risk premium of each firm is different. In order to present the results of all firms collectively, in what follows, we report all the estimation results in terms of average decomposed risk premium which averages decomposed risk premia over all exporting firms. Any following interpretations based on the average decomposed risk premium demonstrate impacts on all exporting firms on the average.

The empirical results of estimating equation (3.22) by using fixed effects regression are presented in column (1) of Table 3.4. For brevity of presentation, in Table 3.4, we present only the estmation results of export destinations that are either statistically significant or belonging to top-10 export destinations for our Chinese firms (e.g., Germany, France and India). The complete estimation results are reported in Table 3.5. The results reported in Table 3.5 show that 25 out of 48 export destinations (ψ_j) are statistically significant at least at the 10 percent level. Of these 25 significant coefficients, 13 are associated with a positive risk premium while 12 actual export destination countries have negative risk premium.

As mentioned earlier, the previous results do not take into account the contribution to the risk premium of potential export destinations which could cause the estimated coefficients (ψ_j) bias. To address this concern, the potential export markets are included into the model and hence the baseline model is established as shown in equation (3.21). Each country-specific risk premium can be interpreted as the additional return required to induce investors to hold shares of firms that export to that country. The values of risk premium ($\psi_j \sigma_{dt} \sigma_{jt} \rho_{jt} \widetilde{\varepsilon}_{ij}$ and $\psi_j^o \sigma_{dt} \sigma_{jt} \rho_{jt} prob_{ijt} \widetilde{\varepsilon}_{ij}$) can be positive or negative. Positive risk premium means that when investors buy the stock, they receive positive return over risk-free rates. On the other hand, the negative risk premium can be interpreted that when investors buy the stock, they earn stock return lower than risk-free rates although taking more risk, which is irrational. It should be noted that negative risk premium does not imply that the investment carries lower risk than risk-free investments but it means that such risky investment pays off unexpectedly worse than risk-free cases.

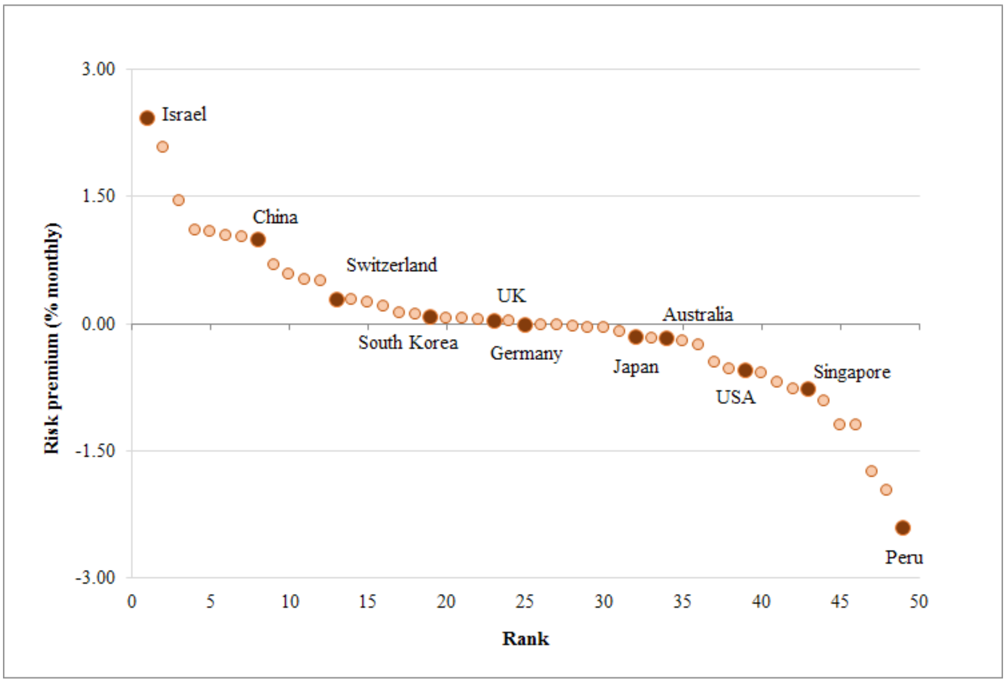
When including the potential export destinations into the model, the results for the baseline model in Table 3.6 indicate that 25 out of 48 estimated coefficients of actual export markets

(ψ_j) are statistically significant at least at the 10 percent level. When considering the values of risk premium, the results present that there are 13 of actual export destination countries associated with a positive risk premium while the rest have negative risk premium. There is one estimated coefficient of potential destinations (ψ_j^o) significant which provides positive risk premium.

The monthly risk premium results of Chinese domestic firms ($\psi_d \sigma_{dt}^2 \widetilde{\varepsilon}_{id}$) that only sell the products only in China is 0.99% monthly. It can be interpreted in the sense of investors that when they buy a stock of these firms, they expect excess stock return 0.99% per month over the risk-free investments. To exemplify an interpretation of the resulting decomposed risk premia from actual export destinations, suppose that a firm now exports to only Belgium and has no domestic sales. From column (2) of Table 3.4, the risk premium from actual exports to Belgium (0.28% per month) indicates that, on the average, the shares of the firm exporting to Belgium have monthly expected excess return 0.28 percentage points higher than if this firm does not export to Belgium. For investors who buy a stock of this firm, they get monthly stock return 0.28% higher than risk free rates. Consider the case of the US which is the largest export destination of Chinese firms (column (2) of Table 3.4), exporting to the US earns a negative risk premium of -0.55% per month. This means that investors buying a share of a firm whose business has already exported to the US only receive the expected return of 0.55% a month lower than the risk-free rates although bearing higher risk.

Another component of firm's risk premium is from exporting to potential export destinations. The potential destinations are countries that firms never export to but have a plan to export there in the future. From investors' perspective, a risk premium from potential export destinations suggests how stock buyers expect the future exports of firm could contribute to the stock returns today. Export postponement sometimes helps evade from unfavorable environment in the current period and subsequently deliver better risk premium than existing

Figure 3.1: Scatter plot of decomposed risk premia by current export destinations.



Note: Labelled data points are for the highest, lowest risk premium and the important export destination countries for Chinese firms.

exports. For example, from column (2) of Table 3.4, the current export to India provides a negative risk premium of 0.59% monthly and exporting to India in the future (column (3) of Table 3.4) pays off a positive risk premium of 0.01% monthly. Had the firm known that, it should defer its export to India. In contrast, South Korea posts an actual risk premium of 0.08% and a potential risk premium of -0.01% monthly which demonstrates that current export to South Korea contributes a positive risk premium to a firm and exporting to South Korea in the future gives lower return than the risk-free rate.

Figure 3.1 plots the estimated country-level contributions to the risk premium from column (2) (risk premia from current export destinations) of Table 3.4. We label data points for the highest, lowest risk premium and for the important export destination countries. The top 3 countries with the highest risk premia are Israel, Sri Lanka and Ukraine where those with lowest risk premia are Peru, Pakistan and Chile.

In addition, we are interested in the aggregate country risk premium because most firms generally export to multiple destinations. The aggregate risk premia[2] are calculated by summing over 48 country-specific risk premia in our sample. Table 3.7 displays the aggregate country-risk premia for the case of excluding potential export markets and for the case of including potential export destinations. When the potential export markets are excluded (column (1) of Table 3.7), domestic market contributes a positive risk premium to a firm by 0.95% a month. The aggregate risk premium from actual export destinations is about -0.99% per month. This implies that an investor who owns a share of firms currently exporting to all 48 export destinations in our sample would have expected monthly risk premium 0.99% lower than that of a domestic firm.

[2]The model assumes that firms take the decision to exporting to a country independently of their existing exports to other countries.

Table 3.4: Decomposed risk premium by country estimated from different model specifications.

	Case 1	Case 2		Case 3		Case 4		Case 5		Case 6		Case 7	
	Actual	Actual	Potential	Actual	Potential	Actual	Potential	Actual	Potential	Actual	Potential	Actual	Potential
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Domestic market	0.95	0.99	n/a	1.1	n/a	1.04	n/a	0.82	n/a	11.88	n/a	-4.51	n/a
Belgium	0.28	0.28	0.00	0.25	-	0.37	0.00	0.35	0.00	3.36	0.00	-4.89	0.02
Brazil	-1.20	-1.20	0.00	-0.99	-	-1.21	0.00	-1.02	0.01	-14.40	0.00	0.87	0.12
Chile	-1.80	-1.74	0.00	-1.45	-	-1.55	0.00	-1.22	0.00	-20.88	0.00	4.20	-0.09
Colombia	1.07	1.08	0.00	0.76	-	0.86	0.00	0.79	0.00	12.96	0.00	9.95	0.00
Denmark	-0.54	-0.54	0.00	-0.36	-	-0.86	0.00	-0.75	-0.01	-6.48	0.00	-6.29	-0.06
France	-0.01	-0.02	0.00	-	-	-0.15	0.01	-0.09	0.01	-0.24	0.00	0.39	0.06
Germany	-0.01	-0.01	0.00	-	-	-0.02	0.00	-0.02	0.00	-0.12	0.00	0.03	0.00
India	-0.62	-0.59	0.01	-	-	-0.50	0.03	0.41	0.00	-7.08	0.12	-4.39	0.09
Indonesia	0.46	0.50	0.01	0.3	-	0.73	0.02	0.45	0.02	6.00	0.12	-6.44	-0.05
Israel	2.34	2.41	0.00	2.33	-	1.39	0.00	1.76	0.01	28.92	0.00	-10.18	-0.09
Italy	0.05	0.06	0.00	0.06	-	0.04	0.00	0.04	0.00	0.72	0.00	0.09	0.00
Japan	-0.16	-0.16	0.00	-0.2	-	-0.10	0.00	-0.04	0.00	-1.92	0.00	-0.16	-0.02
Malaysia	0.66	0.69	0.02	-	-	0.36	0.01	0.07	0.01	8.28	0.24	1.35	0.00
New Zealand	-0.47	-0.45	0.00	-0.74	-	-0.58	0.00	-0.35	0.00	-5.40	0.00	4.80	0.00
Nigeria	0.12	0.12	0.00	0.18	-	0.07	0.00	0.03	0.01	1.44	0.00	-0.73	0.02
Pakistan	-1.85	-1.98	0.01	-2.06	-	-1.61	0.00	-0.95	0.01	-23.76	0.12	5.36	-0.04
Panama	1.12	1.10	0.00	0.94	-	0.91	-0.01	0.54	0.01	13.20	0.00	2.67	0.03
Peru	-2.42	-2.41	0.00	-3.06	-	-1.80	0.00	-2.15	0.00	-28.92	0.00	-27.96	0.00
Philippines	0.55	0.58	-0.01	0.56	-	0.64	0.01	0.39	0.00	6.96	-0.12	0.27	0.03
Saudi Arabia	-0.72	-0.78	0.00	-0.88	-	-0.61	-0.01	-0.71	0.00	-9.36	0.00	23.96	0.08
Singapore	-0.75	-0.78	0.00	-0.73	-	-0.74	0.00	-0.49	0.00	-9.36	0.00	-1.04	-0.04
South Korea	-0.15	0.08	-0.01	-	-	0.71	0.00	0.75	-0.01	0.96	-0.12	-1.97	-0.17
Spain	-0.86	-0.91	0.00	-0.81	-	-1.11	0.00	-0.90	0.00	-10.92	0.00	-0.34	0.08
Sri Lanka	2.11	2.07	0.01	-	-	2.01	0.00	1.27	0.01	24.84	0.12	-6.89	-0.03
Switzerland	0.27	0.29	0.00	0.27	-	0.40	0.00	0.31	0.00	3.48	0.00	2.00	0.00
Taiwan	1.00	1.01	0.00	0.85	-	0.90	0.00	0.65	0.00	12.12	0.00	-0.13	0.00
Thailand	1.02	1.04	-0.03	-	-	1.90	-0.01	1.10	-0.02	12.48	-0.36	1.97	-0.17
Turkey	-0.60	-0.69	-0.02	-0.22	-	-0.55	-0.01	-0.26	-0.01	-8.28	-0.24	4.43	-0.04
UK	0.03	0.03	0.00	0.01	-	0.03	0.00	0.02	0.00	0.36	0.00	0.54	0.01
Ukraine	-0.57	1.45	0.00	1.86	-	0.53	0.00	0.84	-0.01	17.40	0.00	-0.78	-0.01
USA	1.33	-0.55	-0.01	-0.51	-	-0.63	0.01	-0.36	-0.01	-6.60	-0.12	-0.63	-0.07

Note: Export destinations shown are either statistically significant or belonging to top-10 export destinations for our Chinese firms. All decomposed risk premia presented in this table are thus statistically significant at least at 10 percent level. For estimation results under Case 3, "-" indicates that decomposed risk premium with respect to an export destination is not statistically significant at least at 10 percent level.

Case 1 = model without potential markets (%monthly), Case 2 = Baseline model (%monthly), Case 3 = Baseline model excluding insignificant countries (%monthly), Case 4 = Baseline model for median regression (%monthly), Case 5 = Baseline model with winsorized data (%monthly), Case 6 = Annualizd risk premia of Case 2 (% yearly) and Case 7 = Baseline model with yearly data (% yearly)

Actual = $\psi_j \sigma_d \sigma_j \rho_j \tilde{\varepsilon}_{ij}$ and Potential =$\psi_j \sigma_d \sigma_j \rho_j prob_{ij} \tilde{\varepsilon}_{ij}$.

When consider a case where potential countries are taken into account in column (2) of Table 3.7, exporting to all actual exporting markets in our sample does not pay off in extra return over risk-free rates; the equity risk premium of exporting firms in our sample is lower than that of domestic firm by 1.1% a month on average. It is noted that the aggregate risk premium from actual export markets decreases when including the potential markets. By contrast, the aggregate risk premium from potential export destinations is 0.07% per month. This means that if domestic firms that have not currently exported to any countries in our sample and plan to export to all our countries in the future, they will get extra return over risk-free investments by 0.07% per month on the average. The results clearly show how future exports of firms affect their stock returns in the present and selective exports to countries with positive potential risk premia even more improve firms' current equity returns over risk-free rates.

The aggregate results mentioned above illustrate the risk premium for an average firm exporting to all 48 export destination countries. Nevertheless, the estimation results in Table 3.4 can be used to estimate the expected risk premium for a firm with any combination of export destination countries. For instance, suppose that a Chinese firm exports to three countries which are Indonesia, Switzerland and the UK. The expected contribution of three actual export destinations to the firm's risk premium would be 0.50+0.29+0.03 = 0.82% monthly while the contribution to the risk premium from the potential export markets would be the summation of potential risk premia of all countries except for Indonesia, Switzerland and the UK which yields a value of 0.060% monthly. Including the risk premium for domestic market, the total risk premium for a firm that exports to Indonesia, Switzerland and UK would be 0.99+0.82+0.06 =1.87% monthly, on the average. Therefore, an investor holding a stock of this firm could expect the stock return 1.87 % per month higher than risk free rate.

Table 3.5: Estimation results of decomposed risk premia by actual export destinations (potential export destinations are not considered).

Country	Coefficient	Risk premium (% monthly)	(95% confidence interval)	
Domestic market	15.72***	0.95	0.54	1.36
Argentina	-2	0.02	-0.91	0.95
Australia	1.45	-0.08	-0.86	0.70
Belgium	-20.98**	0.28	0.06	0.50
Brazil	-1590.5***	-1.20	-1.60	-0.81
Canada	0.47	-1.05	-3.23	1.12
Chile	36.63***	-1.80	-2.23	-1.36
Colombia	-145.17***	1.07	0.74	1.40
Denmark	106.79***	-0.54	-0.87	-0.21
Egypt	-15.96	0.07	-0.53	0.67
Finland	-21.47	-0.10	-0.28	0.08
France	-11.06	-0.01	-0.18	0.16
Germany	-13.67	-0.01	-0.05	0.02
Greece	-12.34	0.09	-0.14	0.33
Hungary	-1.13	0.02	-0.68	0.72
India	87.19	-0.62	-1.71	0.48
Indonesia	91.15**	0.46	0.07	0.84
Israel	-130.75***	2.34	1.37	3.30
Italy	84.31**	0.05	0.01	0.10
Japan	43.64***	-0.16	-0.25	-0.07
Malaysia	-19.79	0.66	-0.16	1.48
Malta	17.1	-0.03	-0.12	0.06
Netherlands	6.81	0.03	-0.20	0.26
New Zealand	42.91***	-0.47	-0.75	-0.19
Nigeria	-591.25**	0.12	0.00	0.25
Norway	-18.41	0.20	-1.05	1.45
Pakistan	539.03***	-1.85	-2.58	-1.13
Panama	-111.14***	1.12	0.67	1.57
Peru	358.03**	-2.42	-4.37	-0.46
Philippines	-111.99***	0.55	0.27	0.84
Poland	9.9	-0.10	-0.60	0.41
Romania	-29.57	0.47	-0.26	1.19
Russia	-9.17	0.09	-0.54	0.71
Saudi Arabia	217.99***	-0.72	-1.07	-0.36
Singapore	82.68***	-0.75	-1.25	-0.25
South Africa	-7.69	0.22	-0.64	1.07
South Korea	4.72	-0.15	-1.29	1.00
Spain	66.88***	-0.86	-1.35	-0.37
Sri Lanka	-359.24***	2.11	1.35	2.88
Sweden	21.27	-0.04	-0.13	0.04
Switzerland	-97.85***	0.27	0.11	0.44
Taiwan	-153.53***	1.00	0.57	1.43
Thailand	-104.68	1.02	-0.28	2.32
Turkey	68.21*	-0.60	-1.29	0.08
UK	-60.44**	0.03	0.00	0.05
USA	18.86***	-0.57	-0.80	-0.33
Ukraine	-153.84**	1.33	0.04	2.63
Venezuela	14.81	-0.24	-1.44	0.96
Vietnam	38.91	-0.24	-0.69	0.21

Note: * $p < .1$; ** $p < .05$; *** $p < .01$. This specification includes industry and year fixed effects.

Table 3.6: Estimation results of decomposed risk premia for the baseline model.

Country	Coefficient: Actual export destination	Coefficient: Potential export destination	Risk premium (% monthly): Actual export destination expected	(95% confidence interval)		Risk premium (% monthly): Potential export destination expected	(95% confidence interval)	
Domestic market	16.35***	n/a	0.99	0.58	1.40	n/a	n/a	n/a
Argentina	5.25	186.15	-0.05	-0.99	0.89	-0.02	-0.05	0.01
Australia	3.19	6.07	-0.18	-0.95	0.59	0.00	-0.01	0.01
Belgium	-20.84**	-22.01	0.28	0.06	0.51	0.00	-0.01	0.01
Brazil	-1592.62***	199.94	-1.20	-1.60	-0.81	0.00	-0.03	0.03
Canada	0.54	-0.3	-1.19	-3.41	1.03	0.01	-0.01	0.02
Chile	35.52***	4.69	-1.74	-2.18	-1.31	0.00	-0.03	0.02
Colombia	-146.34***	0	1.08	0.75	1.41	0.00	0.00	0.00
Denmark	105.42***	22.11	-0.54	-0.87	-0.20	0.00	-0.02	0.01
Egypt	5	-200.93	-0.02	-0.61	0.57	0.03	-0.03	0.09
Finland	-22.12	93.77	-0.10	-0.29	0.08	0.01	0.00	0.03
France	-14.71	306.26	-0.02	-0.19	0.16	0.00	0.00	0.01
Germany	-13.31	-28.34	-0.01	-0.05	0.02	0.00	-0.01	0.00
Greece	-14.47	0	0.11	-0.12	0.34	0.00	0.00	0.00
Hungary	-1.96	-23.04	0.04	-0.68	0.75	0.01	-0.01	0.02
India	83.18	-54.6	-0.59	-1.69	0.51	0.01	-0.02	0.04
Indonesia	99.25**	110.73	0.50	0.11	0.89	0.01	-0.01	0.03
Israel	-135.08***	2.61	2.41	1.43	3.40	0.00	-0.02	0.02
Italy	89.11***	-280.19	0.06	0.01	0.10	0.00	-0.01	0.00
Japan	44.58***	1.68	-0.16	-0.26	-0.07	0.00	-0.01	0.01
Malaysia	-20.66	-15.73	0.69	-0.15	1.52	0.02	-0.01	0.05
Malta	19.18	2.22	-0.04	-0.13	0.06	0.00	-0.01	0.01
Netherlands	11.98	-294.71	0.05	-0.18	0.29	-0.01	-0.03	0.01
New Zealand	41.62***	0	-0.45	-0.74	-0.17	0.00	0.00	0.00
Nigeria	-552.13*	256.3	0.12	-0.01	0.24	0.00	-0.01	0.01
Norway	-23.38	0	0.26	-1.02	1.53	0.00	0.00	0.00
Pakistan	574.89***	-37.36	-1.98	-2.70	-1.25	0.01	-0.02	0.03
Panama	-108.62***	-4.18	1.10	0.64	1.55	0.00	-0.01	0.02
Peru	357.14**	0	-2.41	-4.42	-0.40	0.00	0.00	0.00
Philippines	-116.86***	34.09	0.58	0.28	0.87	-0.01	-0.03	0.01
Poland	18.01	-47.4	-0.18	-0.69	0.33	0.01	-0.01	0.02
Romania	-32.3	0	0.51	-0.22	1.23	0.00	0.00	0.00
Russia	-2.63	-168.12***	0.03	-0.60	0.65	0.05	0.02	0.09
Saudi Arabia	236.95***	-11.08	-0.78	-1.14	-0.41	0.00	-0.03	0.03
Singapore	86.16***	6.47	-0.78	-1.28	-0.28	0.00	-0.02	0.01
South Africa	-6.87	5.29	0.19	-0.68	1.07	0.00	-0.05	0.05
South Korea	-2.67	8.71	0.08	-1.03	1.19	-0.01	-0.04	0.02
Spain	70.5***	-3.66	-0.91	-1.41	-0.41	0.00	-0.01	0.01
Sri Lanka	-351.92***	-59.42	2.07	1.30	2.84	0.01	-0.02	0.04
Sweden	22.51	-26.61	-0.05	-0.13	0.04	0.00	0.00	0.00
Switzerland	-102.9***	0	0.29	0.12	0.46	0.00	0.00	0.00
Taiwan	-155.8***	0	1.01	0.57	1.45	0.00	0.00	0.00
Thailand	-106.74	73.98	1.04	-0.26	2.34	-0.03	-0.08	0.01
Turkey	78.63**	153.43	-0.69	-1.37	-0.02	-0.02	-0.03	0.00
UK	-60**	-30.66	0.03	0.00	0.05	0.00	0.00	0.00
USA	18.27***	8.55	-0.55	-0.79	-0.31	-0.01	-0.04	0.02
Ukraine	-166.95**	-3.97	1.45	0.13	2.77	0.00	-0.04	0.05
Venezuela	16.26	0	-0.26	-1.48	0.96	0.00	0.00	0.00
Vietnam	33.66	6.59	-0.20	-0.66	0.25	0.00	-0.03	0.02

Note: * $p < .1$; ** $p < .05$; *** $p < .01$. This specification includes industry and year fixed effects. Potential export to China is specified as "n/a" as it is a home country.

Table 3.7: Aggregate risk premia.

	Aggregate risk premium (% monthly)	
	Case 1	Case 2
	(1)	(2)
From domestic market	0.95	0.99
From actual export destinations	-0.99	-1.10
From potential export destinations		0.07

Note: Case 1 = the model without potential markets and Case 2 = the baseline model.

3.5.2 Robustness

In this section, we include a number of robustness tests to ensure that our empirical results are not sensitive to changes in variable definitions. Specifically, robustness checks are generally conducted to examine how regression coefficient estimates behave when the model specification is altered by adding or removing regressors. The goal of the checks is to investigate if parameters of interest are sensitive to the exact specification introduced. Leamer (1983) addresses that "fragility" of regression coefficient estimates is indicative of specification error and hence sensitivity analyses (or robustness checks) should be routinely conducted to help diagnose misspecification. The first robustness check then explores if we remove insignificant export destinations from the baseline model specification and run the regression again, will the remaining export destinations still significantly determine the risk premium?

In addition to robustness in the model specifications, we are also interested in distributional robustness. Following Huber (2011), robustness is interpreted as insensitivity to small deviations from the assumptions the model imposes on the data. The distributional robustness mainly deals with the impact of skewed distributions or outliers on regression estimates. In such respect, we then perform the median regression and regression on winsorized data to attest the distributional robustness of our model.

3.5.2.1 Removing Statistically Insignificant Export Destinations

This test is a supplementary analysis to ascertain the validity of significant coefficients obtained from the baseline model regression in Table 3.6. From the results in Table 3.6, we can see that the coefficients of some countries are not significant at the 10 percent level. In this study, the insignificant coefficients are excluded and we run the same regression on the remaining countries. For the baseline model , only the part that demonstrates significant coefficient will involves in the later-stage regression. For example, countries with insignificant actual and potential exports like Canada will be excluded in the second-time regression. While, for a country like Colombia whose only actual export coefficient is significant, the future export to Colombia will be excluded from the model in the second-stage regression but the actual export to Colombia remains.

The results[3] of the robustness check are shown in columns (4) and (5) of Table 3.4 for selected export destinations. It is observed in Table 3.4 that when excluding the countries with insignificant coefficients, most of export destinations present the same signs on the estimated coefficients and the values of expected risk premia are close to the estimations of the baseline model (i.e., comparing column (2) to column (4) in Table 3.4) in terms of sign and magnitude. Nevertheless, in the second-round regression, only Russia is statistically significant at least at 10 percent level (see Table 3.11). It could thus be concluded that the estimation results of the baseline model is robust, particularly for the results of actual export destinations.

3.5.2.2 Median Regression

Generally, outliers are defined as observations that are numerically different from the majority of data. Outliers could be a result from measurement error or they are just a part

[3]The complete estimation results are shown in Table 3.11.

of a heavy-tailed distribution. Graphically, data density or a box plot could help identify outliers. Alternatively, there are several statistical tools (which are beyond the scope of our study) that are used to detect outliers such as Cook's D, standardized residuals and leverage statistics. For the purpose of visualization, we plot the empirical distribution using kernel density method and the box plots to illustrate distribution of firm-level excess returns (risk premia) and potential outliers.

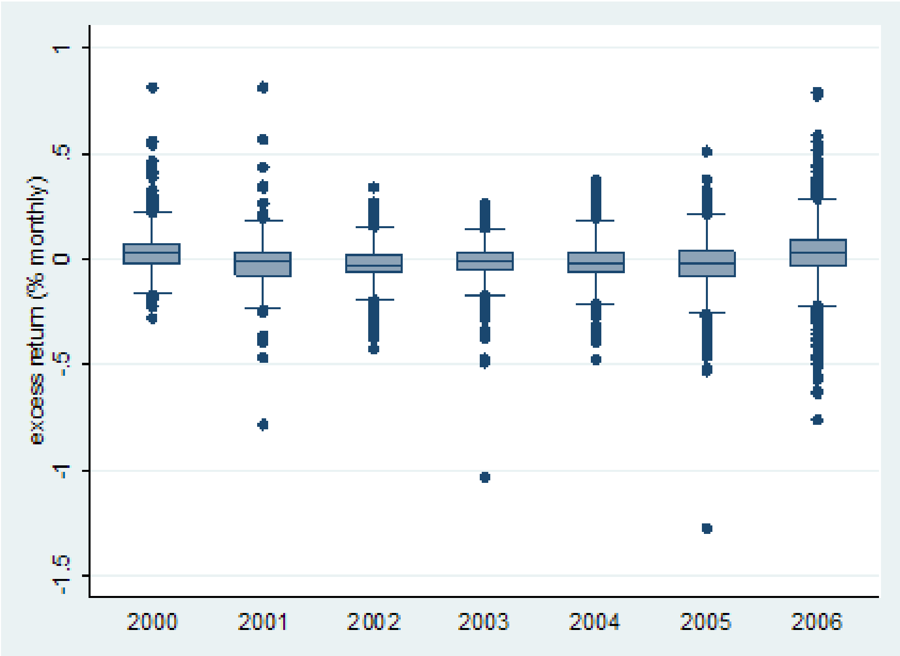
The mean and median are measures of data center. The mean, however, is sensitive to outliers and can be shifted from central location if there presents extreme outliers while the median is not. In other words, median is robust to the shapes of distribution. For normally-distributed data where the mean and median are commonly located, the results from median and standard (mean) regression should be similar. The comparison of estimates from median and standard regression therefore signifies if our model is robust on data distributions.

The box plots in Figure 3.2 provide an evidence of extreme negative excess returns which can be seen in year 2001, 2003 and 2005. Such values challenge the validity of normal distribution assumption held in standard regression. If our regression model is robust to outliers, the decomposed risk premia obtained from median regression and mean regression should be similar.

The results from median regression[4] are presented in columns (6) and (7) of Table 3.4. We compare the estimated risk premia of actual export destinations from the baseline model and median regression in Figure 3.3. It is observed that the decomposed risk premia of actual export destinations and potential export destinations (comparing column (2) against column (6) and column (3) against column (7) in Table 3.4) from standard regression and median regression for most countries demonstrate the same sign and similar magnitude. This implies that, under our given data, the model that decomposes firm's risk premium geographically is robust and the existence of extreme outliers does not considerably affect

[4]The full estimation results are given in Table 3.12.

Figure 3.2: Year-by-year box plots of excess returns (over risk-free rate) of Chinese exporting firm equities.



the estimation results.

3.5.2.3 Winsorized Data

One way to alleviate impacts from outliers is by winsorizing data. Winsorizing or Winsorization is the transformation of statistics by limiting extreme values in the statistical data to reduce the effect of possibly spurious outliers[5]. The treatment of outliers is basically keeping the outliers, replace the outliers (winsorizing) and eliminate the outliers (trimming). Generally, common procedure for winsorizing data is to replace any data value above 90^{th} percentile of the sample data by 90^{th} percentile and any value below 10^{th} percentile by 10^{th} percentile. The underlying assumption is that the outliers are erroneous observations and estimates will be improved if the outliers are replaced with more plausible values.

[5]Hansen et al. (1983) propose the rule of thumb that an outlier is any observation whose removal from the sample changes the estimate of a parameter of interest by 10 percent or more.

We therefore winsorize the 10^{th} and 90^{th} percentiles of each firm's returns and estimate the baseline model again. The estimation results[6] are reported in columns (8) and (9) of Table 3.4. The empirical results show that, using the winzoried data, risk premium from domestic market and most of actual and potential export destinations are similar to the risk premia obtained from the estimation using original data (columns (2) and (3) of Table 3.4). The comparison of the decomposed risk premia from both specifications is exhibited in Figure 3.4. In addition, the ranks of highest and lowest risk premia are still the same. This could imply that values of outliers in our original data are not so extreme to deviate the results of original data from the winsorized one and thus the estimation model is considered to be robust against existing outliers.

3.5.2.4 Data Frequency

We also investigate whether frequency of data affects the estimation of risk premium. Generally, regression models assume that each observation depends only on contemporaneous values of explanatory variables. This structure implies that all of the interactions among the variables of the model are assumed to take place immediately or taking into account the frequency, within the same time period (Wooldridge (2000)). For a study on exporting firms, since stock returns would not be fully reflected by revenues or sales from exports in the same month that it took effect, quarterly or annually data could be alternatives. It might therefore be reasonable to apply estimating equations on longer-frequency such as annually data to see if data frequency affects estimation results. We thus compare risk premia estimated using yearly data with the annualized values of risk premia estimated from monthly data obtained earlier.

Generally, investments over a long time span generate lower fluctuation of returns and hence long-term investments demand lower compensation on the risk taken. The study of Derrig

[6] The complete estimation results are given in Table 3.13.

and Orr (2004) demonstrates that equity risk premium is dependent on investment horizons. Their comparison of short, intermediate and long investment horizons of the US equity risk premia over 1926-2002 shows that the longer the investment horizon, the lower the equity risk premium. Thus, in our comparison of monthly and yearly decomposed risk premia, it is expected that the risk premia from yearly data are lower than those estimated with monthly data.

In preparing the yearly data, monthly observations are needed to be transformed from monthly to yearly. The monthly firm-level excess returns are aggregated to yearly. For covariances between China and other export destinations, although yearly covariance can be estimated from aggregated monthly data by multivariate GARCH but with a time span of seven years (2000-2006), available data are insufficient for covariance estimation. Therefore, the yearly covairances are an aggregation of monthly covariance assuming that covariance in each month is uncorrelated. For the firm-level market value elasticity of stock index, we estimate the yearly elasticity using yearly data of stock market indices and Chinese firm market values.

The estimation results[7] using the constructed yearly data are reported in columns (12) and (13) of Table 3.4. To compare the estimated risk premia from yearly data with estimated risk premia from monthly data, the monthly-frequency risk premia (in columns (2) and (3) of Table 3.4) are multiplied with 12 to produce an annualized risk premia as shown in columns (10) and (11) of Table 3.4. It is observed that risk premia estimated with yearly data differ from annualized risk premia (from monthly data) in most export destinations. Many countries demonstrate large deviation of risk premia estimated from two data frequencies such as Brazil, Israel and Sri Lanka. Besides, it is not obvious that risk premia from yearly data are lower than those estimated with monthly data which contradicts with our prior expectation. The findings suggest that risk premia estimated from monthly and yearly data

[7]The complete estimation results are given in Table 3.14.

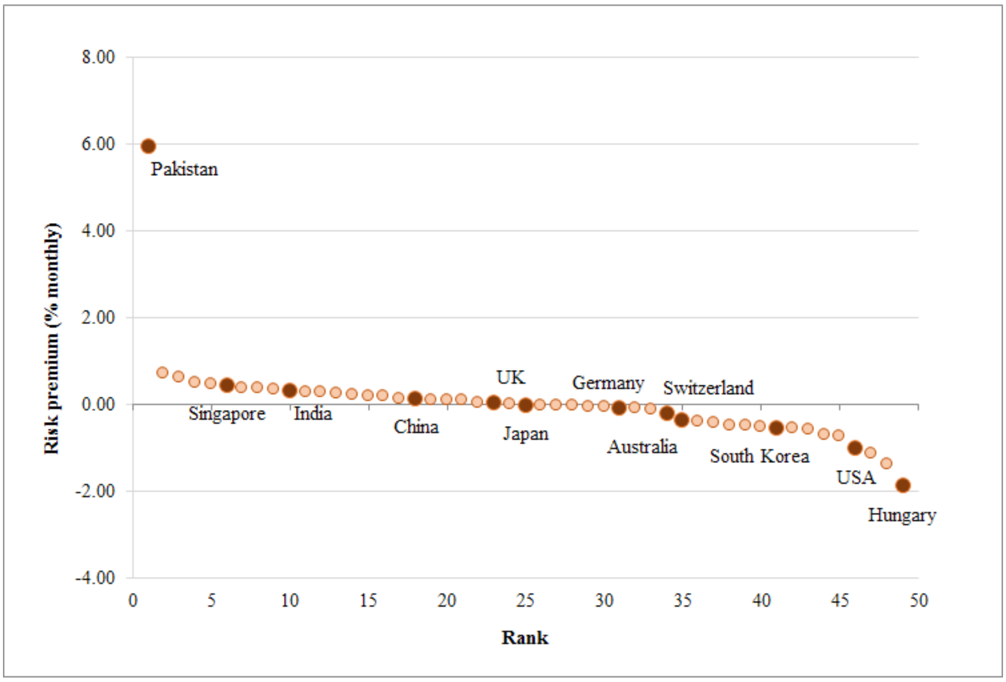
yield different results. The disagreement between estimated risk premia from two data frequencies indicates that stock returns (and hence risk premium) of Chinese exporting firms are influenced by exporting to foreign markets differently when the return horizon changes. Consequently, the estimation model is not robust on different data frequencies.

3.5.2.5 Bivariate Covariance

Essentially, the variables that influence the value of decomposed risk premium are the covariance and elasticity. Thus the accuracy of covariance calculation is crucial in determining decomposed risk premia. Previously, the trivariate time-varying covariance is employed in the regression model to estimate the decomposed risk premia. Ideally, the covariance estimated from multivariate GARCH is a preferred option for covariance construction as the underlying assumption is that a stock market of one country is related to the rest of the world. However, with too many countries engaged in export activities of Chinese firms, computation is intractable. One way too reduce computational complexity, we hence estimate the time-varying covariance with three components (trivariate covariance) in earlier analyses.

Alternatively, the time-varying covariance can be produced from bivariate GARCH model which supposes that only two countries are interrelated where the rest of the world is independent from those two countries. The time-varying bivariate covariance takes into account market dynamics in such a way that the magnitude and direction of stock markets between China and another country j can be varied over time. The bivariate covariance assumes that risk exposed to export to destination j is only from the co-movement of returns of Chinese stock market and the stock index in country j while returns of other countries are uncorrelated. The resulting decomposed risk premia estimated using bivariate covariance could give some clues on how much the decomposed risk premia are affected from using different specifications of covariance.

Table 3.9: Scatter plot of decomposed risk premia estimated using bivariate covariance.



Note: Labelled data points are for the highest, lowest risk premium and the important export destination countries for our Chinese firms.

Table 3.8: Summary statistics of bivariate and trivariate covariances.

Covariance	Mean	Std. Dev.	Min	Max
bivariate	0.0013	0.0086	-0.0043	0.1283
trivariate	0.0014	0.0075	-0.0017	0.0840

The summary statistics of trivariate and bivariate covariances estimated are given in Table 3.8. The values shown are the averages of the covariances between China and each export destination. The means and standard deviations of the two covairances are similar but the minimum and maximum of the bivariate case demonstrate more extreme values than those of the trivariate covariance.

The decomposed risk premia estimated under baseline specification using bivariate and trivariate covariances are presented in Table 3.10 while the estimation results of regressing the baseline model using bivariate covariance is given in Table 3.15. A scatter plot of decomposed risk premia by country is illustrated in Figure 3.9. In terms of the magnitude, the decomposed risk premia derived from bivariate are generally smaller (either less positive or less negative) than those obtained from trivariate covariance although some extreme estimation results are observed from the bivariate case; for instance, the risk premia from Pakistan and Hungary. Overall, it could be presumed that regression using bivariate covariance may result in underestimation of decomposed risk premia. Most possibly, it points out that the assumption that trades between China and another country is explained by merely two economies while ignoring other countries prevents capturing risks associated thoroughly. The findings also suggest that the estimation of decomposed risk premia can be further improved if data availability suffices to estimate the time-varying covariance from multivariate GARCH rather than the existing three components, i.e., China, another export destination and the rest of export destinations.

Table 3.10: Comparison between decomposed risk premia estimated from baseline specification using trivariate and bivariate covariances.

	trivariate		bivariate	
	Actual	Potential	Actual	Potential
Domestic market	0.99	n/a	0.13	n/a
Argentina	-0.05	-0.02	-0.74	-0.03
Australia	-0.18	0.00	-0.35	0.01
Belgium	0.28	0.00	-0.57	0.01
Brazil	-1.20	0.00	0.03	0.01
Canada	-1.19	0.01	0.37	0.00
Chile	-1.74	0.00	-0.59	0.00
Colombia	1.08	-	0.19	-
Denmark	-0.54	0.00	0.14	-0.01
Egypt	-0.02	0.03	0.70	0.02
Finland	-0.10	0.01	0.61	-0.01
France	-0.02	0.00	-0.05	0.00
Germany	-0.01	0.00	-0.09	0.00
Greece	0.11	-	0.10	-
Hungary	0.04	0.01	-1.89	0.01
India	-0.59	0.01	0.30	0.01
Indonesia	0.50	0.01	0.27	0.00
Israel	2.41	0.00	0.36	0.00
Italy	0.06	0.00	-0.12	0.00
Japan	-0.16	0.00	-0.02	0.00
Malaysia	0.69	0.02	-0.04	0.00
Malta	-0.04	0.00	-0.49	0.00
Netherlands	0.05	-0.01	0.47	0.00
New Zealand	-0.45	-	-0.07	-
Nigeria	0.12	0.00	-1.14	-0.01
Norway	0.26	-	0.18	-
Pakistan	-1.98	0.01	5.93	0.00
Panama	1.10	0.00	0.10	0.00
Peru	-2.41	-	-0.40	-
Philippines	0.58	-0.01	-0.01	0.00
Poland	-0.18	0.01	-0.10	0.00
Romania	0.51	-	0.27	-
Russia	0.03	0.05	-1.40	0.05
Saudi Arabia	-0.78	0.00	-0.49	0.00
Singapore	-0.78	0.00	0.44	0.00
South Africa	0.19	0.00	0.34	-0.01
South Korea	0.08	-0.01	-0.57	-0.01
Spain	-0.91	0.00	0.50	0.00
Sri Lanka	2.07	0.01	-0.05	0.00
Sweden	-0.05	0.00	-0.04	0.00
Switzerland	0.29	-	-0.21	-
Taiwan	1.01	-	0.23	-
Thailand	1.04	-0.03	-0.72	0.00
Turkey	-0.69	-0.02	-0.52	-0.02
UK	0.03	0.00	0.02	0.00
Ukraine	1.45	0.00	0.10	-0.01
USA	-0.55	-0.01	-1.02	0.00
Venezuela	-0.26	-	-0.43	-
Vietnam	-0.20	0.00	0.24	0.01

Note: Actual = $\psi_j \sigma_d \sigma_j \rho_j \widetilde{\varepsilon}_{ij}$, Potential =$\psi_j \sigma_d \sigma_j \rho_j prob_{ij} \widetilde{\varepsilon}_{ij}$.

Table 3.11: Estimation results of decomposed risk premia by actual and potential export destinations when statistically insignificat export destinations are removed.

Country	Coefficient		Risk premium (% monthly)					
	Actual export destination	Potential export destination	Actual export destination			Potential export destination		
			expected	(95% confidence interval)		expected	(95% confidence interval)	
Domestic market	18.21***	n/a	1.10	0.76	1.45	n/a	n/a	n/a
Belgium	-18.53***	-	0.25	0.06	0.44	-	-	-
Brazil	-1302.42***	-	-0.99	-1.24	-0.73	-	-	-
Chile	29.54***	-	-1.45	-1.78	-1.12	-	-	-
Colombia	-102.73***	-	0.76	0.50	1.02	-	-	-
Denmark	71.83***	-	-0.36	-0.54	-0.19	-	-	-
Indonesia	60.34***	-	0.30	0.08	0.52	-	-	-
Israel	-130.37***	-	2.33	1.67	2.98	-	-	-
Italy	86.49***	-	0.06	0.03	0.08	-	-	-
Japan	54.49***	-	-0.20	-0.27	-0.13	-	-	-
New Zealand	67.91***	-	-0.74	-0.96	-0.53	-	-	-
Nigeria	-869.97***	-	0.18	0.10	0.27	-	-	-
Pakistan	599.16***	-	-2.06	-2.50	-1.62	-	-	-
Panama	-92.88***	-	0.94	0.63	1.24	-	-	-
Peru	452.71***	-	-3.06	-3.97	-2.14	-	-	-
Philippines	-113.87***	-	0.56	0.35	0.78	-	-	-
Russia	-	-160.73***	-	-	-	0.05	0.02	0.08
Saudi Arabia	267.09***	-	-0.88	-1.16	-0.59	-	-	-
Singapore	80.62***	-	-0.73	-1.05	-0.42	-	-	-
Spain	62.64***	-	-0.81	-1.08	-0.53	-	-	-
SriLanka	-427.14***	-	2.51	1.88	3.14	-	-	-
Switzerland	-98.18***	-	0.27	0.19	0.36	-	-	-
Taiwan	-130.18***	-	0.85	0.52	1.17	-	-	-
Turkey	25.49	-	-0.22	-0.68	0.23	-	-	-
UK	-26.85	-	0.01	-0.01	0.03	-	-	-
USA	17***	-	-0.51	-0.69	-0.33	-	-	-
Ukraine	-214.14***	-	1.86	1.43	2.28	-	-	-

Note: * $p < .1$; **$p < .05$; *** $p < .01$. This specification includes industry and year fixed effects. Potential export to China is specified as "n/a" as it is a home country.

Table 3.12: Estimation results of decomposed risk premia from median regression.

Country	Coefficient		Risk premium (% monthly)					
	Actual export destination	Potential export destination	Actual export destination			Potential export destination		
			expected	(95% confidence interval)		expected	(95% confidence interval)	
Domestic market	17.15***	n/a	1.04	0.63	1.44	n/a	n/a	n/a
Argentina	-78.45	177.6	0.77	-0.20	1.73	-0.02	-0.05	0.01
Australia	12.55*	12.87	-0.71	-1.53	0.12	0.00	-0.02	0.01
Belgium	-27.11***	-4.31	0.37	0.14	0.59	0.00	-0.01	0.01
Brazil	-1594.99***	39.17	-1.21	-1.61	-0.81	0.00	-0.04	0.04
Canada	0.48	0.02	-1.06	-3.41	1.28	0.00	-0.02	0.02
Chile	31.56***	0.04	-1.55	-2.02	-1.08	0.00	-0.03	0.03
Colombia	-116.26***	-	0.86	0.43	1.29	0.00	0.00	0.00
Denmark	170.27***	45.41	-0.86	-1.23	-0.50	0.00	-0.02	0.01
Egypt	-32.96	85.05	0.14	-0.40	0.67	-0.01	-0.06	0.03
Finland	1.79	88.52	0.01	-0.18	0.19	0.01	-0.01	0.03
France	-140.25*	403.72	-0.15	-0.33	0.02	0.01	0.00	0.01
Germany	-28.06	-105.94	-0.02	-0.07	0.02	0.00	-0.01	0.00
Greece	5.59	-	-0.04	-0.26	0.18	0.00	0.00	0.00
Hungary	9.42	-61.02**	-0.17	-0.87	0.52	0.01	0.00	0.03
India	71.01	-109.72*	-0.50	-1.58	0.57	0.03	0.00	0.05
Indonesia	146.29***	257.28	0.73	0.35	1.12	0.02	-0.01	0.04
Israel	-77.75***	5.11	1.39	0.38	2.40	0.00	-0.02	0.02
Italy	62.86*	-372.38	0.04	0.00	0.08	0.00	-0.01	0.00
Japan	26.31**	-5.64	-0.10	-0.19	0.00	0.00	-0.01	0.01
Malaysia	-10.89	-9.37	0.36	-0.54	1.26	0.01	-0.02	0.05
Malta	2.88	17.62	-0.01	-0.10	0.09	0.00	-0.01	0.01
Netherlands	23.8	-139.92	0.10	-0.14	0.35	-0.01	-0.03	0.02
New Zealand	53.26***	-	-0.58	-0.87	-0.30	0.00	0.00	0.00
Nigeria	-335.75	335.18	0.07	-0.06	0.20	0.00	-0.01	0.01
Norway	-84.17	-	0.92	-0.57	2.41	0.00	0.00	0.00
Pakistan	469.32***	-23.48	-1.61	-2.32	-0.91	0.00	-0.02	0.03
Panama	-90.39***	42.02	0.91	0.48	1.34	-0.01	-0.02	0.01
Peru	266.74*	-	-1.80	-3.84	0.24	0.00	0.00	0.00
Philippines	-129.81***	-56.97	0.64	0.32	0.96	0.01	-0.01	0.04
Poland	9.77	-75.92	-0.10	-0.63	0.44	0.01	0.00	0.02
Romania	24.64	-	-0.39	-1.08	0.30	0.00	0.00	0.00
Russia	4.91	-148.26***	-0.05	-0.68	0.58	0.05	0.02	0.08
Saudi Arabia	184.83***	54.04	-0.61	-1.00	-0.21	-0.01	-0.03	0.02
Singapore	81.49***	13.85	-0.74	-1.24	-0.23	0.00	-0.02	0.02
South Africa	8.13	9.83	-0.23	-1.12	0.66	-0.01	-0.06	0.04
South Korea	-22.95	2.75	0.71	-0.40	1.82	0.00	-0.03	0.03
Spain	85.78***	-46.49	-1.11	-1.63	-0.58	0.00	-0.01	0.02
Sri Lanka	-342.66***	0.48	2.01	1.18	2.84	0.00	-0.02	0.02
Sweden	54.13**	17.46	-0.11	-0.21	-0.02	0.00	0.00	0.00
Switzerland	-143.94***	-	0.40	0.24	0.56	0.00	0.00	0.00
Taiwan	-138.98***	-	0.90	0.43	1.38	0.00	0.00	0.00
Thailand	-195***	28.01	1.90	0.51	3.29	-0.01	-0.05	0.03
Turkey	62.05	67.52	-0.55	-1.30	0.20	-0.01	-0.03	0.02
UK	-57.36*	-60.15	0.03	0.00	0.05	0.00	0.00	0.00
USA	20.97***	-11.88	-0.63	-0.88	-0.38	0.01	-0.02	0.04
Ukraine	-61.1	-8.18	0.53	-0.85	1.91	0.00	-0.04	0.05
Venezuela	16.14	-	-0.26	-1.50	0.98	0.00	0.00	0.00
Vietnam	-8.02	11.16	0.05	-0.41	0.50	0.00	-0.03	0.02

Note: * $p < .1$; **$p < .05$; *** $p < .01$. This specification includes industry and year fixed effects. Potential export to China is specified as "n/a" as it is a home country.

Table 3.13: Estimation results of decomposed risk premia from winsorized data.

Country	Coefficient		Risk premium (% monthly)					
	Actual export destination	Potential export destination	Actual export destination			Potential export destination		
			expected	(95% confidence interval)		expected	(95% confidence interval)	
Domestic market	13.54***	n/a	0.82	0.51	1.13	n/a	n/a	n/a
Argentina	-48.63	179.92**	0.47	-0.18	1.13	-0.02	-0.04	0.00
Australia	7.8	-3.22	-0.44	-1.04	0.16	0.00	-0.01	0.01
Belgium	-25.69***	31.15	0.35	0.18	0.51	0.00	-0.01	0.00
Brazil	-1342.42***	815.05	-1.02	-1.31	-0.72	0.01	-0.02	0.03
Canada	0.89**	-0.22	-1.98	-3.70	-0.25	0.00	-0.01	0.02
Chile	24.77***	-0.75	-1.22	-1.55	-0.88	0.00	-0.02	0.02
Colombia	-107.14***	-	0.79	0.53	1.06	-	-	-
Denmark	147.12***	68.86	-0.75	-1.01	-0.49	-0.01	-0.02	0.00
Egypt	-7.51	-5.98	0.03	-0.36	0.42	0.00	-0.03	0.03
Finland	-15.06	139.67***	-0.07	-0.20	0.06	0.02	0.01	0.03
France	-79.07	352.49	-0.09	-0.21	0.04	0.01	0.00	0.01
Germany	-18.16	-92.04	-0.02	-0.05	0.01	0.00	-0.01	0.00
Greece	-15.46	-	0.12	-0.04	0.28	-	-	-
Hungary	43.17***	-45.13**	-0.79	-1.31	-0.28	0.01	0.00	0.02
India	-57.29	-17.51	0.41	-0.40	1.21	0.00	-0.01	0.02
Indonesia	91.02***	267.23*	0.45	0.18	0.73	0.02	0.00	0.04
Israel	-98.56***	-21.48	1.76	1.01	2.51	0.01	0.00	0.02
Italy	59.7**	30.97	0.04	0.01	0.07	0.00	0.00	0.01
Japan	10.38	39.33	-0.04	-0.11	0.03	0.00	-0.01	0.00
Malaysia	-2.15	-9.37	0.07	-0.57	0.71	0.01	-0.01	0.04
Malta	24.43	31.29	-0.05	-0.12	0.03	0.00	-0.01	0.00
Netherlands	17.52	-77.32	0.08	-0.10	0.25	0.00	-0.02	0.01
New Zealand	31.72***	-	-0.35	-0.55	-0.14	-	-	-
Nigeria	-156.45	-1736.23**	0.03	-0.06	0.13	0.01	0.00	0.01
Norway	-54.77	-	0.60	-0.41	1.61	-	-	-
Pakistan	277.45***	-67.29	-0.95	-1.45	-0.46	0.01	-0.01	0.02
Panama	-53.31***	-33.02	0.54	0.22	0.85	0.01	0.00	0.02
Peru	318.19***	-	-2.15	-3.67	-0.62	-	-	-
Philippines	-78.48***	-4.31	0.39	0.17	0.61	0.00	-0.01	0.02
Poland	-1.2	-27.44	0.01	-0.37	0.39	0.00	0.00	0.01
Romania	5.06	-	-0.08	-0.57	0.41	-	-	-
Russia	2.97	-97.55***	-0.03	-0.47	0.42	0.03	0.01	0.05
Saudi Arabia	215.53***	-11.49	-0.71	-0.99	-0.42	0.00	-0.02	0.02
Singapore	53.91***	-23.77	-0.49	-0.86	-0.12	0.00	-0.01	0.02
South Africa	11.7	-22	-0.33	-0.96	0.30	0.02	-0.02	0.05
South Korea	-24.5*	5.6	0.75	-0.03	1.53	-0.01	-0.03	0.01
Spain	69.85***	-36.29	-0.90	-1.27	-0.53	0.00	-0.01	0.01
Sri Lanka	-216.56***	-51.62	1.27	0.69	1.86	0.01	-0.01	0.02
Sweden	51.17***	-141.04**	-0.11	-0.18	-0.04	0.00	0.00	0.00
Switzerland	-111.95***	-	0.31	0.19	0.44	-	-	-
Taiwan	-100.16***	-	0.65	0.30	1.00	-	-	-
Thailand	-112.53**	37.51	1.10	0.15	2.04	-0.02	-0.05	0.01
Turkey	29.1	133.88**	-0.26	-0.76	0.25	-0.01	-0.03	0.00
UK	-38.12*	-154.7	0.02	0.00	0.04	0.00	0.00	0.00
USA	12.12***	8.91	-0.36	-0.56	-0.17	-0.01	-0.03	0.02
Ukraine	-97.33*	14.42	0.84	-0.14	1.82	-0.01	-0.04	0.02
Venezuela	-5.63	-	0.09	-0.84	1.02	-	-	-
Vietnam	-76.32***	56.96***	0.46	0.13	0.80	-0.02	-0.03	-0.01

Note: * $p < .1$; ** $p < .05$; *** $p < .01$. This specification includes industry and year fixed effects. Potential export to China is specified as "n/a" as it is a home country.

Table 3.14: Estimation results of decomposed risk premia from yearly data.

Country	Coefficient: Actual export destination	Coefficient: Potential export destination	Risk premium (% yearly): Actual export destination: expected	(95% confidence interval)		Potential export destination: expected	(95% confidence interval)	
Domestic market	6.97***	n/a	-4.51	2.62	6.40	n/a	n/a	n/a
Argentina	-96.99**	-29.62	8.36	1.53	15.19	0.03	-0.16	0.22
Australia	3.38	2.02	-1.68	-10.82	7.46	-0.01	-0.10	0.09
Belgium	41.08	-17.21	-4.89	-13.34	3.56	0.02	-0.05	0.10
Brazil	130.87	1209.45	0.87	-5.86	7.61	0.12	-0.07	0.31
Canada	-0.01	-0.18	0.26	-5.08	5.60	0.03	-0.10	0.17
Chile	-9.7	10.41	4.20	-3.63	12.03	-0.09	-0.27	0.10
Colombia	-152.89	-	9.95	-1.96	21.85	-	-	-
Denmark	140.74*	74.38	-6.29	-13.24	0.66	-0.06	-0.18	0.06
Egypt	36.14	-45.79	-1.33	-8.93	6.28	0.06	-0.20	0.33
Finland	15.75	31.01	0.65	-1.70	3.01	0.03	-0.13	0.19
France	40.74	427.89*	0.39	-1.35	2.12	0.06	0.00	0.12
Germany	3.94	-2.08	0.03	-0.58	0.64	0.00	-0.06	0.06
Greece	18.73	-	-1.26	-5.64	3.12	-	-	-
Hungary	-0.49	-6.33	0.08	-6.10	6.26	0.01	-0.07	0.10
India	69.17	-43.39	-4.39	-10.89	2.11	0.09	-0.03	0.21
Indonesia	-144.61***	-86.25	-6.44	-11.06	-1.82	-0.05	-0.24	0.14
Israel	64.75	25.09	-10.18	-24.74	4.38	-0.09	-0.21	0.02
Italy	15.19	-29.87	0.09	-0.63	0.80	0.00	-0.04	0.04
Japan	4.73	30.57	-0.16	-1.20	0.88	-0.02	-0.06	0.02
Malaysia	-4.55	-0.2	1.35	-2.84	5.55	0.00	-0.16	0.16
Malta	-6.56	30.4	0.11	-1.81	2.02	-0.02	-0.07	0.03
Netherlands	-13.76	-152.14	-0.53	-4.01	2.94	-0.06	-0.26	0.13
New Zealand	-49.88**	-	4.80	0.54	9.07	-	-	-
Nigeria	393.03	-371.33	-0.73	-2.63	1.16	0.02	-0.06	0.09
Norway	-154.31*	-	14.81	-1.48	31.11	-	-	-
Pakistan	-175.19*	33.29	5.36	-0.94	11.65	-0.04	-0.22	0.14
Panama	-30.12	-19.6	2.67	-5.35	10.69	0.03	-0.10	0.15
Peru	470.16***	-	-27.96	-43.23	-12.70	-	-	-
Philippines	-6.16	-11.42	0.27	-3.94	4.48	0.03	-0.14	0.19
Poland	38.58	-90.06**	-3.34	-13.15	6.47	0.10	0.02	0.17
Romania	64.96	-	-9.00	-25.47	7.47	-	-	-
Russia	99.17***	-26.29	-8.43	-13.34	-3.53	0.07	-0.15	0.30
Saudi Arabia	-828.49***	-80.49	23.96	16.10	31.81	0.08	-0.15	0.31
Singapore	12.85	23.62	-1.04	-4.76	2.67	-0.04	-0.16	0.08
South Africa	5.28	0.85	-1.32	-13.97	11.33	-0.01	-0.30	0.29
South Korea	7.06	20.43*	-1.97	-5.13	1.18	-0.17	-0.35	0.00
Spain	3	-94.55*	-0.34	-3.30	2.62	0.08	-0.01	0.18
Sri Lanka	133.03	17.83	-6.89	-16.38	2.59	-0.03	-0.20	0.15
Sweden	89.03***	-51.75	-1.63	-2.61	-0.65	0.00	-0.01	0.00
Switzerland	-81.42**	-	2.00	0.24	3.76	-	-	-
Taiwan	4.57	-	-0.13	-0.37	0.11	-	-	-
Thailand	-22.81	42.78**	1.97	-5.45	9.40	-0.17	-0.34	0.00
Turkey	-56.93	41.53	4.43	-11.35	20.21	-0.04	-0.21	0.13
UK	-135.08**	332.14*	0.54	0.11	0.96	0.01	0.00	0.03
USA	2.83	1.44	-0.78	-2.46	0.91	-0.01	-0.18	0.16
Ukraine	8.27	15.21	-0.63	-15.04	13.78	-0.07	-0.31	0.16
Venezuela	-77.32**	-	10.92	0.50	21.33	-	-	-
Vietnam	-100.92***	-23.69	5.45	2.32	8.57	0.07	-0.03	0.17

Note: * $p < .1$; ** $p < .05$; *** $p < .01$. This specification includes industry and year fixed effects. Potential export to China is specified as "n/a" as it is a home country.

Table 3.15: Estimation results of decomposed risk premia from using bivariate covariance.

Country	Coefficient		Risk premium (% monthly)					
	Actual export destination	Potential export destination	Actual export destination			Potential export destination		
			expected	(95% confidence interval)		expected	(95% confidence interval)	
Domestic market	5.77	n/a	0.13	-0.24	0.50	n/a	n/a	n/a
Argentina	841.86***	2576.76**	-0.74	-1.02	-0.46	-0.03	-0.05	0.00
Australia	156.63***	-197.27	-0.35	-0.50	-0.20	0.01	0.00	0.01
Belgium	92.98**	-181.46***	-0.57	-1.13	0.00	0.01	0.00	0.02
Brazil	-1.05	-20.53	0.03	-2.27	2.32	0.01	-0.03	0.04
Canada	-42.23	-46.02	0.37	-0.51	1.24	0.00	-0.01	0.01
Chile	27.32	3.46	-0.59	-1.32	0.14	0.00	-0.02	0.02
Colombia	-16.86**	-	0.19	0.01	0.36	-	-	-
Denmark	-15.66	53.31	0.14	-0.17	0.45	-0.01	-0.03	0.01
Egypt	-143.16***	-100.97	0.70	0.22	1.19	0.02	-0.02	0.06
Finland	243.9***	-184.87	0.61	0.29	0.94	-0.01	-0.03	0.01
France	-29.85	198.33	-0.05	-0.18	0.08	0.00	0.00	0.01
Germany	-463.93***	-576.92	-0.09	-0.13	-0.04	0.00	-0.01	0.00
Greece	-84.38	-	0.10	-0.04	0.24	-	-	-
Hungary	87.1***	-43.19	-1.89	-2.54	-1.25	0.01	0.00	0.03
India	-21.02	-26.26	0.30	-0.86	1.47	0.01	-0.02	0.04
Indonesia	-78.15***	-43.49	0.27	0.09	0.45	0.00	-0.01	0.01
Israel	35.89***	21.8	0.36	0.13	0.59	0.00	-0.01	0.02
Italy	-266.52**	-23.81	-0.12	-0.23	-0.02	0.00	-0.01	0.01
Japan	-127.22**	-26.21	-0.02	-0.03	0.00	0.00	0.00	0.00
Malaysia	3.21	-1.43	-0.04	-0.23	0.15	0.00	-0.01	0.02
Malta	18.04	-1.56	-0.49	-1.29	0.32	0.00	-0.02	0.02
Netherlands	84.1***	53.94	0.47	0.29	0.66	0.00	-0.01	0.02
New Zealand	6.55	-	-0.07	-0.37	0.23	-	-	-
Nigeria	223.27***	53.68	-1.14	-1.83	-0.45	-0.01	-0.05	0.03
Norway	-19.26***	-	0.18	0.05	0.31	-	-	-
Pakistan	-5403.06***	-80.12	5.93	3.84	8.03	0.00	-0.02	0.02
Panama	-8.75	-11.55	0.10	-0.54	0.75	0.00	-0.02	0.02
Peru	115.99	-	-0.40	-1.08	0.28	-	-	-
Philippines	12.65**	14.27	-0.01	-0.02	0.00	0.00	0.00	0.00
Poland	12.35***	14.13	-0.10	-0.15	-0.04	0.00	-0.01	0.00
Romania	-165.19***	-	0.27	0.15	0.39	-	-	-
Russia	140.92***	-180.11***	-1.40	-2.22	-0.57	0.05	0.02	0.09
Saudi Arabia	-2539.52***	-588.96	-0.49	-0.78	-0.20	0.00	-0.03	0.03
Singapore	54.26***	-1.43	0.44	0.12	0.76	0.00	-0.02	0.02
South Africa	-103.42*	115.82	0.34	-0.03	0.71	-0.01	-0.06	0.03
South Korea	70.98***	44.95	-0.57	-0.86	-0.27	-0.01	-0.03	0.01
Spain	-76.95	-28.61	0.50	-0.43	1.43	0.00	-0.01	0.01
Sri Lanka	-11.96	-25.3	-0.05	-0.13	0.04	0.00	-0.01	0.01
Sweden	21.11	-7.65	-0.04	-0.18	0.10	0.00	0.00	0.00
Switzerland	91.83**	-	-0.21	-0.41	0.00	-	-	-
Taiwan	-21.96	-	0.23	-0.16	0.61	-	-	-
Thailand	-126.3***	-1.99	-0.72	-0.91	-0.53	0.00	0.00	0.00
Turkey	541.08***	2149.13**	-0.52	-0.75	-0.28	-0.02	-0.04	0.00
UK	-18.29	69.79	0.02	-0.04	0.07	0.00	0.00	0.00
USA	0.37**	0	-1.02	-1.99	-0.06	0.00	-0.04	0.04
Ukraine	-8.79	9.39	0.10	-0.03	0.23	-0.01	-0.03	0.01
Venezuela	57.13	-	-0.43	-1.87	1.00	-	-	-
Vietnam	-22.24***	-8.27	0.24	0.13	0.35	0.01	-0.01	0.02

Note: * $p < .1$; ** $p < .05$; *** $p < .01$. This specification includes industry and year fixed effects. Potential export to China is specified as "n/a" as it is a home country.

Figure 3.3: Comparison of the decomposed risk premia of actual export destinations between the baseline model and median regression.

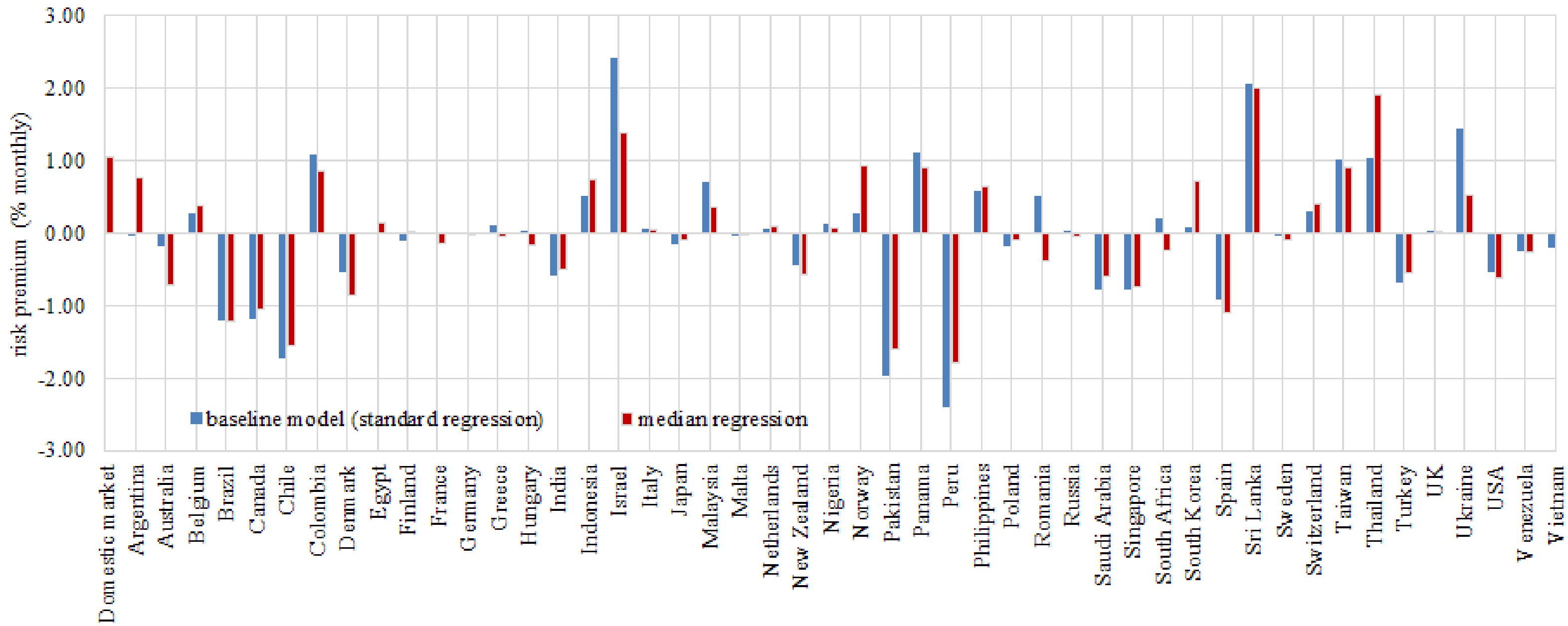
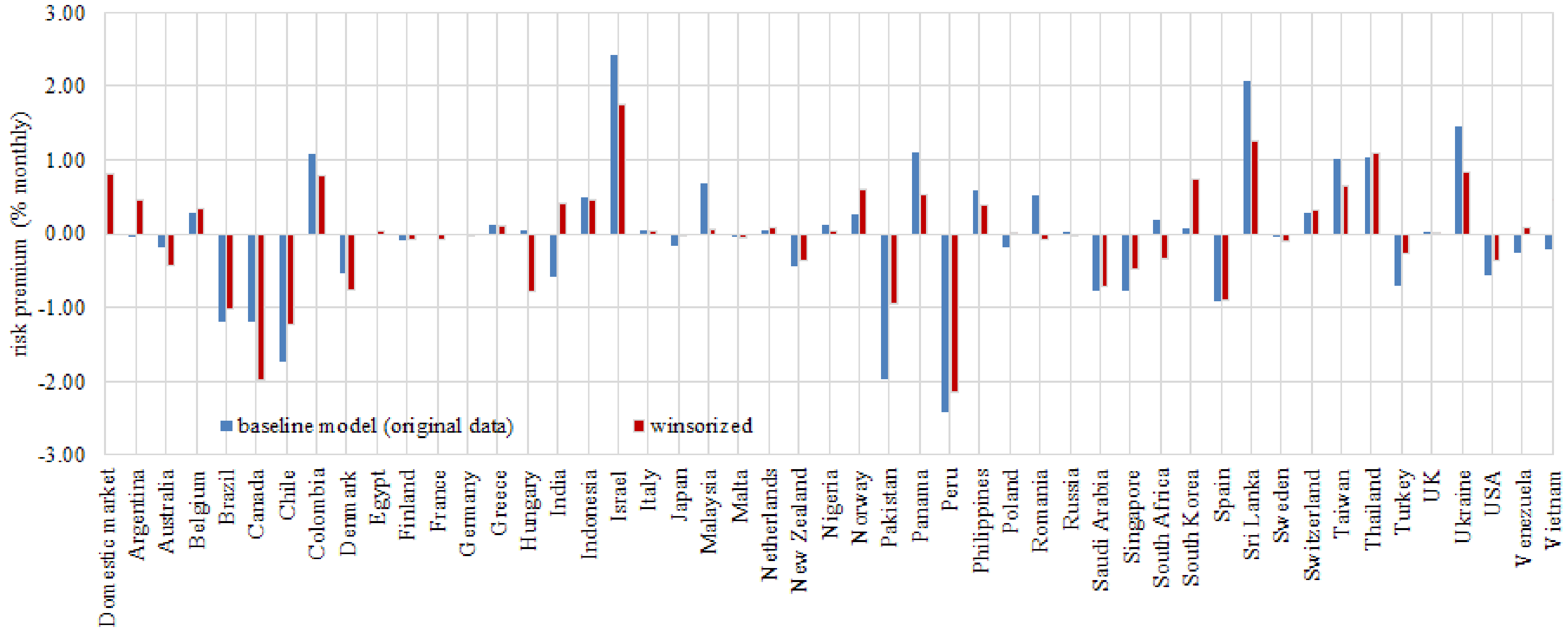


Figure 3.4: Comparison of the decomposed risk premia of actual export destinations between the baseline model using original data and winsorized data.



3.6 Conclusions

In this study, we aim to decompose the country-specific risk premium of exporting firms in China by using monthly Chinese exporting firms data collected from CCTS and Bloomberg during 2000-2006. To our knowledge, geographical decomposition of exporting firms has never been examined anywhere before and it is thus the key contribution of our study.

The methodology employed in decomposing risk premium of each firm is adopted from the model of Fillat et al. (2015) where we improve covariance representation by using time-varying covariance instead of time-invariance. The results show that risk premium of Chinese exporting firms is significantly influenced by most of their current export destinations. However, risk contributions from the potential export destination countries are somewhat negligible. This could imply that potential export destination of firms have insignificant influence on the expected risk premium in investors' perspective. Alternatively, it could possible that information on such future projects are not widely disclosed to public thereby this missing piece takes no part in investor expectation.

We also conduct additional tests to confirm the robustness of the empirical results obtained. Export destinations that show significant risk premia remain significant when we remove statisticall insignificant countries. In addition, it is shown that our estimation results are not affected by existing outliers in original data. The further study on altering data frequency from monthly to yearly shows that investment horizon affects risk premium contribution of each export destination in which the results obtained from the two datasets are different. Finally, it is found that bivariate covariances (assuming that risk is represented by stock markets in China and another export destination) underestimate risk premia for most destinations comparing to the case using trivariate covariance (assuming that risk is represented by stock markets in China, another export destination and the rest of the world).

Chapter 4

Economic Liberalizations and The Sources of Volatility Spillovers

4.1 Introduction

A series of economic liberalizations[1] of emerging market economies in the past two decades has accounted for significant increase of trade and financial integration into the global economy and financial system. As a result, spillovers of emerging market shocks to equity prices in advanced and emerging market economies have risen substantially. In consequence, it is more challenging for investors to manage risk effectively. Understanding of volatility spillover is valuable information in planning investment diversification. For instance, two countries with low volatility spillover are preferable for diversification benefit as they tend to be less correlated than those with higher spillover. It is thus even more beneficial for investors and policy makers if information on volatility spillover can be investigated deeper than in country level.

[1]From the definition given by the United Nation, economic liberalization is: "the process, including government policies that promote free trade, deregulation, elimination of subsidies, price controls, and rationing systems, and often, the downsizing or privatization of public services".

Increasing volatility spillover in stock markets is more or less attributed to the aftermath of economic liberalization. The motivation that emerging countries decide to relax or remove trade or financial restrictions is to improve the functioning of economic systems (Bekaert and Harvey (2003)). For example, a financial liberalization increases the availability of funds through increased access to domestic and international capital markets and allowing cross-country risk diversification, which increases efficiency of capital allocation. Consequently, the overall effect also contributes to higher rates of economic growth. However, on the downside, it leads to the problem of increasing volatility, giving way to financial fragility and a greater propensity to crisis (Ranciere et al. (2006)). The closer connection between economies also enables easier transferring of shocks from one to several economies.

Risk associated to connection and interaction between domestic market and related economies are often studied in terms of volatility spillover. Technically, spillover is referred to changes in volatilities in one market due to a transmission of information from other markets (Fleming et al. (1998)). The definition of a volatility spillover in this study is referred to the term coined in Engle (1990) as volatility transmission from other markets to the market of interest. The volatility spillover demonstrates that the fluctuation of an equity market not only depends on its own historical variations, but may also be affected by those from other markets. From the definition, a volatility spillover indicates towards the level of market integration. The value measures the extent to which markets are integrated. The higher the interdependence among markets, the higher will be the cross-market spillover and the greater would be the chances of contagions occurring in the event of a financial crisis (Engle and Susmel (1993) and Bekaert and Harvey (1995)).

Understanding the sources of volatility spillover and contribution of each source is one way to assist in making a decision regarding portfolio risk management and portfolio diversification. The motivation of our study is thus primarily to identify sources of volatility spillovers from major stock markets, namely, the US, the UK and Japan from January 1997 to December 2014. Additionally, apart from studying the volatility spillover to the whole Chinese stock market, we investigate volatility spillovers from major stock markets which are the US, the UK and Japan to the three separate portfolios of exporting firms, domestic manufacturing firms and domestic services firms in order to provide more insights for volatility spillovers among portfolios of Chinese firms.

We select China as a market of interest, since, as of 2016, its stock market value is the largest among emerging economies. Besides, China is the second largest economy in terms of nominal GDP and the world's largest economy by purchasing power parity according to the IMF. The success of China's development is due to several major transformations from a centrally-planned closed economy towards an open free market economy. Since the start of the economic reforms in the late 1970s, China has been gradually opening its borders for international trade, liberalizing its stock markets and continually reforms its exchange rate regimes. A series of critical economic liberalizations with its importance in the world economy make China the suitable country to study the volatility spillover.

The initial examination of economic liberalizations is established to ascertain the effects from economic liberalizations on stock market volatility which are still indecisive in past literature, whether liberalizations lead to increase or decrease in stock return volatility. Events of economic liberalizations are selected based on key policy implementations that relax prior regulations or support international market integration. The events are ranging from deregulations in trade, stock market and exchange rates. Supporting details on why particular events are selected and their potential effects on Chinese stock market are discussed in Section 4.2.

We also create three return indices associated to the three stock portfolios which are exporting firms, domestic manufacturing firms and domestic services firms. Each portfolio is constructed for the purpose of distinguishing effects of economic liberalizations that might affect firms of different business types inequally. For instance, exporting firms seems to be more connected to global markets than domestic counterparts, they are hence likely to be exposed to more volatility spillover when trade or exchang rate are liberalized. Comparing among domestic firms, those who require imported inputs could be more prone to a change in exchange rate regime than those who do not. The exploration on potential distinction of volatility spillovers impacts on different firm types is therefore interesting.

Afterwards, we examine the sources of volatility that spill over to Chinese stock markets and to the portfolios under different economic liberalization events. The question arises naturally whether the sources of volatility spillovers and their contributions to stock return volatility of Chinese firms are the same in each economic liberalization. Also, whether exporters, domestic manufacturers and domestic services firms have identical sources of volatility spillovers. To answer the aforementioned questions, we study volatility spillovers through a spillover table developed by Diebold and Yilmaz (2012). In the table, a volatility spillover from each source is measured by contribution of forecast error variance to Chinese stock markets or to the three portfolios. A high contribution value signifies strong connection between the sources of volatility spillovers and Chinese stock markets. Different economic liberalization events could cause different contribution of volatility spillover from each source, this can be investigated by studying spillover tables over a period covering each event.

To create a spillover table, series of time-varying volatilities of variables are required to perform the variance decomposition. Originally, Diebold and Yilmaz (2012) estimate the volatilities time series of a stock index from daily high/low/open/close index values. This estimation approach, however, ignores the effect of comovements among variables. We thus improve the volatility estimation method by employing the multivariate Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model to generate time series of conditional volatilities of multiple variables that also takes into account time-varying correlation among variables.

In consequence, the contributions of our study can be clarified as; first, this study identifies the sources of volatility that spill over to Chinese stocks under different economic liberalization events which are not studied elsewhere before. Second, we further investigate the sources of volatility spillovers under different economic liberalization events separately on exporters, domestic manufacturers and domestic services firms. Since high volatility spillover demonstrates close connection between markets, information on volatility spillovers of different portfolios is useful for policymakers in developing a framework to stabilize Chinese stock market. For instance, if any portfolio exhibited obviously higher volatility spillover than others, some certain regulations could be imposed to reduce an impact from shocks transmitting from foreign stock markets to that portfolio.

The rest of this chapter is structured as follows: The next section demonstrates the background of economic liberalizations in China, followed by a review of related literature. Section 4.4 exhibits data, variables construction and volatility measurement. Subsequently, we present the methodology employed in this study in Section 4.5. Then, Section 4.6 reports the results, accompanied by the robustness check in Section 4.7. Lastly, Section 4.8 summarizes the findings of this study.

4.2 Background of Economic Liberalizations in China

In our study, the episodes of economic liberalizations in China are broadly divided into three categories: stock market liberalization, trade liberalization and foreign exchange rate liberalization. Comprehensive details on each economic liberalization in China are given in the Appendix B.6. We extract the following key events to study their impact on volatility and volatility spillover.

1. Stock market liberalizations:

a) Opening B share market to domestic investors: The first stock market in China is Shanghai stock exchange which was opened on 26 November 1990, followed by Shenzhen stock exchange which was opened on 11 April 1991. Initially, only the public A shares were allowed to trade on the exchanges. In 1992, the B shares were introduced for foreign investors trading. The B shares are ordinary shares denominated in Chinese Yuan but are traded in foreign currencies. The A and B share markets thus were completely segmented. The B share markets were relatively small compared to the A share counterparts and lack of trading volume. On 19 February 2001, China Securities Regulatory Commission and the State Administration of Foreign Exchange Bureau announced that Chinese nationals with foreign currency deposit accounts with a domestic commercial bank are allowed to trade B shares. The policy is perceived as an attempt to integrate the B share market to the A share market. A number of researchers, e.g., McGuinness (2002) and Lui (2002), regard the opening of the B share market to domestic investors as a beginning of stock market liberalization in China.

b) The launch of Qualified Foreign Institution Investors (QFII) program: On 5 November 2002, China Securities Regulatory Commission announced the Qualified Foreign Institutional Investors (QFII) program to allow foreign investors to participate in China's stock markets, the A share markets for the first time. By means of the QFII scheme, the Chinese government has not only facilitated the inflow of foreign capital and professional knowledge into its financial market, but has also minimized any possible negative effects that may have arisen due to the inflows of foreign capital (Chen et al. (2007)).

c) The revision of QFII regulations: The original QFII rules are considered a tight restriction on foreign investors, e.g., a capital lock-up period of 1-3 years, limiting capital withdrawal (and leaving China) and also other operating restrictions. On 24 August 2006, China Securities Regulatory Commission revised some regulations such as increasing quota of foreign investment capital for foreign investors and relaxing qualifications for approving QFII to promote more participation of foreign institutional investors. The immediate results were a growing number of qualified institutional investors from international that participated in Chinese stock market.

2. Trade liberalization: China has become a member of World Trade Organization (WTO) since 11 December 2001. WTO membership provides China growing trade values, foreign investment and it is also the origin of financial liberalization. China were required to cut import tariffs by nearly 40 percent, removed import licenses and quotas, relaxed membership restrictions on foreign businesses and allowed foreign companies to participate in many sectors in that were previously prohibited. The benefit from WTO accession is however considered a positive drive for China's economic development. On the consequence of WTO membership, it is anticipated that Chinese stock market might be affected by global economic activities through a transmission mechanism from the Global to the Chinese economy and then from the Chinese economy to the Chinese stock market.

3. Exchange rate liberalization: The Chinese Yuan (CNY) had been basically pegged to US dollar (USD) at the level of 1 USD to 8.27 CNY between October 1997 and July 2005. The fixed exchange rate led China to continuing large trade surpluses. Also, its rapid accumulation of foreign exchange reserves had focused considerable global attention on China's fixed exchange rate regime. Following its trade and stock market liberalizations, China's growing integration into the global economy and the fact that changes in its exchange rate regime could have a major external impact, the pressure to appreciate CNY and the options for China to alternate the exchange rate regime had

become the major attention to many countries. In response to accumulating external pressures for CNY revaluation, the People's Bank of China (China's central bank) announced a switch of the exchange rate regime to a basket of foreign currencies instead of USD alone on 21 July 2005. There was thereby considered as liberalization on China's exchange rate mechanism.

4.2.1 Potential Effects of Economic Liberalizations on Stock Markets

Based on the liberlization events defined above, there exists fundamental drivers responsible for the intensification of linkages between Chinese and international stock markets, and hence corresponding volatility spillovers across stock markets. Such factors are related to trade and commerce linkages, the adoption of financial generalization policies, and the exchange rate regime which China pursued at a time. And it is those factors that bring China which were geographically distant, had structurally, and functionally distinct financial markets to become more interdependent and integrated to global stock markets.

Firstly, we consider impacts of stock market liberalization in China on volatility spillovers to Chinese stock market. Bekaert and Harvey (2003) proposed that financial liberalization broadly takes two forms. One, it refers to those policies aimed at deregulating the domestic economy, such as privatization of government owned businesses and banking sector reforms. Two, it refers to those progressive policies aimed at facilitating the inward and outward flow of foreign investment by relaxation and lifting of capital controls to facilitate free capital mobility. For China, the first category seems to be the case while the latter does not (as there are still capital control measures in active). The consequences of such deregulation on stock markets are found that financial liberalizations bring about substantial integration for a home market to international equity markets through the equalization of domestic and foreign market expected returns (Bekaert and Harvey (1995, 1997, 2003);

Darrat and Benkato (2003)). This allows shocks from one market pass through to connected markets more easily and subsequently causes a surge in volatility spillovers.

Secondly, we look at the channel that trade liberalization could bring volatility spillovers to Chinese stock market. Basically, the extent to which the equity markets of two countries are interdependent is largely influenced by the degree in which their economies depend on each other in terms of bilateral trade and investments. As such, the stronger the bilateral trade and investment ties between countries are, the higher the magnitude of co-movement of their respective stock markets will be. Lane and Milesi-Ferretti (2003) discover that trade openness may increase the willingness to conduct cross-border financial transactions, thus gradually reducing the equity home-bias[2]. Additionally, Pretorius (2002) demonstrates that if a significant proportion of country A's exports contributes to a substantial portion of country B's imports, an economic downturn in country B will result in a slump in B's stock market as well as a decline in country A's stock market due to reduction in A's exports to the country B. Frankel and Rose (1998) find that pairs of countries that trade more with each other usually exhibit a higher degree of business cycle co-movement. These studies evidently demonstrate a strong relationship between cross-border trade in goods and services and investment in financial assets. Countries having strong bilateral trade linkages tend to exhibit synchronicity in terms of business cycles which promotes volatility transmission across stock markets.

Lastly, we contemplate if exchange rate liberalization could affect volatility spillovers across stock markets. It is widely acknowledged that international equity markets are bounded to the effect of exchange rates more or less. Mitra and Bhattacharjee (2015) summarize channels in which exchange rates affect stock market return and volatility. The first channel comes through goods market. Basically, changes in exchange rate affect firms that trade in-

[2]The "home-bias" puzzle refers to a phenomenon in which investors tend to disproportionately hold a large share domestic stocks in their portfolios and only a small amount in foreign equity French and Poterba (1993).

ternationally (export and import) in competitiveness of multinational firms and hence their earnings and eventually their stock prices[3] and stock return volatility. In the second channel, through input prices, output prices, or demand for products which are exposed to exchange rate movements and fluctuate with exchange rate movements (Adler and Dumas (1984)). It follows that changes in exchange rate have an impact on not only stock return volatility of firms trading internationally but also on stock return volatility of firms trading domestically but require inputs from abroad. As such, when exchange rate regime is changed from fixed to managed-float, it can be expected that stock return volatility from international stock markets could more easily pass through to Chinese stock markets and brings about subsequent volatility spillovers.

Although economic liberalizations engender volatility spillovers to home market, it is hard to envisage the comparative impact from each event and it is even harder to foresee which event could causes more volatility spillovers than others. The experiments in Section 4.6 are designed to explore this question accordingly. Nonetheless, we hypothesize that stock return volatility spillovers from foreign stock markets to China should be limited due to its active capital control policies. For instance, Azmi and Haron (2004) and Raghavan et al. (2010) discover that volatility spillovers from major stock markets (particularly Singapore) to Malaysia was significantly reduced when a capital control measure was imposed in late 1998. The effecive capital flow regulation in China could thus be considered as a bar to fully integrated stock market. Rather, Chinese stock market would still be segmented although several economic liberalizations have been promoted and hence we expect weak volatility spillovers across the events. This argument will be examined further in Section 4.6.

[3] A depreciation of the local currency make exports cheaper (in foreign currency), which in turn will boost the demand and sales of goods in foreign markets

4.3 Literature Review

This section is divided into two subsections. First, we review literature that study effects of economic liberalizations on stock return volatility. We are particularly interested on whether liberalizations increase or decrease stock return volatility in various countries and the methodologies involved in such studies. Then, we review literature examining volatility spillover and relevant methodologies, with the focus on the approach that is employed in our study.

4.3.1 Effects of economic liberalizations on stock return volatility

Several studies have examined the issue of economic liberalizations and volatility in the stock market. They empirically show that market opening either decreases or increases volatility.

Initially, we begin with studies related to effects from stock market liberalization. Empirical evidence provides ambiguous results on the effects of stock market liberalization on volatility. Levine and Zervos (1998), Koot and Padmanabhan (1993), Grabel (1995) and Jayasuriya (2005) find volatility significantly increase in most emerging economies after liberalization. In contrast, Bekaert and Harvey (1997), Kwan and Reyes (1997), Kim et al. (1993) and Han Kim and Singal (2000) find volatility to significantly decrease. Additionally, De Santis et al. (1997) find no obvious relationship between stock market liberalization and volatility. The mixed results across literature are due to differences in methodology and definition of liberalization. We summarize the methodologies employed, definitions of liberalization, findings and other key features of empirical literature in Tables 4.1 to 4.3.

Table 4.1: Summary of empirical literature.

Paper	**Scope of the study**	**Liberalization indicator**	**Liberalization date**	**Methodology**	**Results**
Kim and Singal (1993)	16 emerging markets. Focus on 12 or 24 months around market liberalization using monthly data.	Increase in the issuance of share capital.	Latest liberalization date.	Compare volatilities estimated for pre- and post-liberalization periods.	Stock market volatilities are not different for the period within 12 months before and after liberalization but are different for the period within 24 months before and after liberalization.
Koot and Padmanabhan (1993)	Jamaica from 1969-1990 using monthly data.	Foreign participation upon the liberalization program.	December 1982.	Compare pre- and post-liberalization volatilities estimated by the GARCH(1,1) model.	Stock market volatility is higher after liberalization.
Grabel (1995)	6 emerging markets from 1984- 1993 using monthly data.	Financial liberalization program initiation.	Date of initiation.	Construct volatility indices and compare the mean estimates for pre- and post-liberalization periods.	Increase in stock market volatility in Chile, Colombia, Venezuela and Korea.

Table 4.2: Summary of empirical literature (continued).

Paper	**Scope of the study**	**Liberalization indicator**	**Liberalization date**	**Methodology**	**Results**
Bakaert and Harvey (1997)	17 emerging markets from 1976- 1992 using monthly data.	Introduction of a country fund or a structural break in the series of the ratio of the US ownership to market capitalization	Dates from Bekaert (1995).	Identify post-liberalization periods with a dummy variable and check its significance by estimating the GARCH(1,1) model.	Stock market liberalization reduces volatility across countries.
De Santis and Imrohoroglu (1997)	5 emerging markets from 1988- 1996 using weekly data.	Increased issuance of share capital to foreigners.	Date that shows a significant increase in share capital.	Compare pre- and post-liberalization volatilities estimated by the GARCH(1,1) model.	No relationship between a stock market liberalization and stock market volatility.
Kwan and Reyes (1997)	Taiwan from 1988 to 1994, using weekly data	Removal of foreign investment restrictions.	January 1991	Identify post-liberalization periods with a dummy variable and check its significance by estimating the GARCH(1,1) model.	Liberalization significantly reduces volatility.
Levine and Harvey (1997)	16 emerging markets from 1976- 1993.	Removal of foreign capital flow restrictions.	Liberalization date of each market listed by the IFC.	Perform a test according to Perron (1989) to investigate if there is a structural break on the liberalization dates.	Stock market volatilities in most countries are higher after liberalization.

Table 4.3: Summary of empirical literature (continued).

Paper	**Scope of the study**	**Liberalization indicator**	**Liberalization date**	**Methodology**	**Results**
Kim and Singal (2000)	14 emerging markets. Focus on 10 years around liberalization of each country, using monthly data.	Removal of foreign capital flow restrictions.	Liberalization date of each market listed by the International Finance Corporation (IFC).	Compare pre- and post-liberalization volatilities estimated by various specifications of GARCH models (from GARCH(1,1) to GARCH(4,3)).	Stock market volatility eventually decreases in about 2 or 3 years after liberalization in all markets.
Jayasuriya (2005)	15 emerging countries from 1984-2000 using monthly data.	Either the month that a country establishes its country fund or its stock index rises at least 10%	7 days prior to 7 days after the date specified by liberalization indicator.	Identify post-liberalization periods with a dummy variable and check its significance by estimating the EGARCH and TGARCH models.	Stock market volatility increases after liberalization in most countries.

Next, for the effects of exchange rate liberalization on stock market volatility, we start with the work of Dornbusch and Fischer (1980) which develops a theoretical model that links exchange rates to stock prices. The model suggests that domestic stock prices should fall in response to domestic currency appreciation and vice versa. The rationale behind this is that when a shock causes the home currency to appreciate, the resulting unfavourable terms of trade (represented by the ratio of an index of a country's export prices to an index of its import prices) are going to cause a decline in local stock prices, and vice versa. This leads to a negative relationship between exchange rates and stock prices (exchange rate appreciation causes stock price decline but not for the reverse). On the effect of exchange rate liberalization on stock volatility, Zhang and Fung (2006) explain the cause of stock market volatility due to exchange rate reform in China. They refer to speculative cash flows from foreign investors which aim to reap the benefits of Chinese Yuan appreciation by putting money into Chinese real estates, stock markets, bank accounts, and other financial products. Guo and Huang (2010) investigate the extent of the impact of speculative capital inflow on the fluctuations of China's real estate market and stock market and find that it significantly increases property prices and contributes to the accelerating volatilities in both markets. Hua et al. (2015) examine the impact of China's exchange rate regime switching in July 2005 on three major asset markets: house, land, and stocks. Their empirical results show that the exchange rate liberalization significantly affects the three markets in terms of return and volatility. The effect on stock markets, however, is much lower than the effects on the other markets.

4.3.2 Volatility spillover

The issue of contagion has been one of the most debated topics in international finance since the emergence of Asian crises in 1997. There is now a reasonably large body of empirical work testing for the existence of contagion during financial crises. The most common methods employed to test for the contagion effect in empirical literature are such as the analysis of market correlation coefficients, the GARCH model, the cointegration test, and the probability of event happening.

In the early literature, King and Wadhwani (1990) and Lee and Kim (1993) employ the correlation coefficient between stock returns to test for the impact of the US stock crash in 1987 on the stock markets in England, Japan, and several other countries. Empirical findings show that the correlation coefficients between several markets significantly increase during the market crash. However, later studies point out a number of methodological problems in correlation-based assessments and propose alternative approaches. Forbes and Rigobon (2002) show that correlations among variables are naturally increased during crises due to surge in volatility which consequently leads to biased results. They thus develop an adjusted correlation coefficient and find that there is not a significant change in correlation during the 1997 Asian financial crisis, the 1994 Mexican crisis, and the 1987 US stock market crisis.

In a field of spillover and contagion analyses, many researchers employ univariate ARCH and GARCH models in their studies. Hamao et al. (1990) estimate conditional variance with the GARCH model to study spillovers among stock markets during the 1987 US stock market crisis. The empirical results show an existence of spillover effects from the US and the UK stock markets to the Japanese market. Edwards and Susmel (2001) employ the switching ARCH which accommodates systematic changes of variables. They find that many Latin American equity markets are significantly correlated during the times of high market volatility indicating the contagion effect.

Later, many studies employ multivariate GARCH models to analyze co-movements and volatility spillovers between financial assets. Wang and Di Iorio (2007) use a DCC-Bivariate GARCH to examine the impact of Asian financial crisis on Chinese Economic Area (CEA which includes China, Hong Kong and Taiwan) during 1992 to 2000. The empirical findings show that the conditional correlation coefficients of stock returns are positive and co-movement exists between Thailand and CEA markets. In addition, the variances are higher in the post-crisis period than in the pre-crisis period and the means of conditional correlation coefficient in the post-crisis period significantly increases, which confirm the contagion effect.

Most recently, a new methodology is proposed to exhibit “directional spillover” which has the advantage over the earlier mentioned methods in such a way that it is able to specify spillovers to and from each variable. The idea is originated by Diebold and Yilmaz (2009) based on the forecast error variance decomposition framework which measure a spillover in terms of a contribution of forecast error variance of one variable that is explained by other variables. Spillovers across variables are summarized by a spillover index which is an average spillover in all directions among a set of variables. They plot spillover indices over rolling data of 19 global equity markets and find that return spillovers present a gently increasing trend without bursts whereas volatility spillovers display no trend but clear bursts.

However, it is pointed out in the paper that their empirical results are sensitive to variable ordering[4] due to orthogonalization procedure of variance decomposition. Klößner and Wagner (2014) develop new algorithms to calculate average spillover over numerous possibilities of variable ordering. It is shown that their results are the robust version of Diebold and Yilmaz (2009). To circumvent the problem of sensitivity to variable ordering, Diebold and Yilmaz (2012) apply generalized variance decomposition method which does not require orthogonalization. The resulting spillover calculations from this approach are thus in-variant to variable ordering. They apply the new methodology to study volatility spillovers across US stock, bond, foreign exchange and commodities markets, from January 1999 to January 2010. The empirical results reveal that cross-market volatility spillovers are quite limited before the subprime crisis in late 2007 and later heightened when the crisis becomes in-

[4]Variable ordering means placing all the variables in the decreasing order of exogenity. For example, an ordering of x_1, x_2 and x_3 implies that x_1 is more likely to influence x_2 and x_3 while the reverse is not true. Likewise, x_2 is more likely to influence x_3 while the reverse is not true.

tensified. Zhou et al. (2012) employ the method of Diebold and Yilmaz (2012) to measure total volatility spillover, regional volatility spillovers and directional volatility spillovers between the Chinese and world equity markets between February 1996 and December 2009. The results show that US stock market demonstrated high volatility impacts on other markets during the subprime mortgage crisis. The volatility of the Chinese market has had a significantly positive impact on other markets since 2005. In addition, it is found that the volatility interactions among the markets of China, Hong Kong, and Taiwan are more prominent than those among the Chinese, western and other Asian markets are.

4.4 Data description

This section elaborates details of data and variables used in our study. We describe how to measure return volatility. Moreover, preliminary analysis of the effect of economic liberalizations on stock return volatility is elaborated in this section.

4.4.1 Data

Bloomberg provides daily major stock indices from the US (S&P500), the UK (FTSE100), Japan (NIKKEI225) and market value of our Chinese firms. Our study covers the study period from 2 January 1997 to 31 December 2014 with 4,504 observations for each time series.

Of all Chinese firms retrieved from Bloomberg, we identify exporting firms as those contained in the Chinese Custom Trade Statistics (CCTS) database, which is comprised of 654 firms. In addition, we identify domestic firms using firm-specific foreign revenue data from Bloomberg. Domestic firms are defined as firms with no revenue from foreign markets. Subsequently, we further classify them into two different groups, namely domestic manu-

Table 4.4: Classification of domestic firms by GICS sectors.

GICS sectors	Domestic manufacturing	Domestic services
Consumer Discretionary	•	
Consumer Staples	•	
Energy	•	
Financials		•
Health Care		•
Industrials	•	
Information Technology		•
Materials	•	
Telecommunication Services		•
Utilities		•

facturing and domestic service firms according to their industry sectors following the Global Industry Classification Standard (GICS) as shown in Table 4.4. As a result, there are 711 and 1,077 firms for domestic manufacturing and domestic services, respectively.

4.4.2 Variables

This subsection describes the method used in constructing variables for subsequent studies. For the preliminary analysis, it involves an investigation whether economic liberalization events cause a change in stock return volatility. Accordingly, we construct time series of stock return volatilities and dummy variables representing liberalization events for using in later analyses.

For the main study of volatility spillovers through the spillover table, we also require time series of volatilities. In our study, we use the time series of conditional volatilities estimated by dynamic conditional correlation generalized autoregressive conditional heteroskedasticity (DCC-GARCH) model with the aim to improve the accuracy of resulting spillover tables.

In both the preliminary analysis and volatility spillover study, there contains two levels of examinations. The first one concerns an investigation at an aggregate level for all Chinese firms represented as Chinese stock market. The second one demonstrates an investigation at deeper level in which exporting, domestic manufacturing and domestic services firms are treated as separate portfolios.

When studying volatility spillovers to Chinese stock market and to the three portfolios, the global stock markets of our interest are from the major countries which are the US, the UK and Japan. Hence, from the structure of analyses outlined above, the variables involved in the study are:

4.4.2.1 Major stock market indices (S&P500, FTSE100 and NIKKEI225)

The daily return time series of these major stock indices are available from Bloomberg. The time series of S&P500, FTSE100 and NIKKEI225 are selected as representative proxies of major stock markets in North America, Europe and Asia that could have influence on Chinese equities. The returns are natural logarithmic returns which are subsequently used to estimate volatilities.

4.4.2.2 Chinese stock market index

We construct a daily Chinese stock market index by using weighted returns of all our sample firms (exporting, domestic manufacturing and domestic services firms combined). The weight is calculated as the share of firm's market value over total market values of all firms as follows:

$$w_{i,t} = \frac{mv_{i,t}}{\sum\limits_{i} mv_{i,t}} \tag{4.1}$$

where $w_{i,t}$ is a market value share of firm i at time t and $mv_{i,t}$ is a market value of firm i at time t. The weighted returns are subsequently calculated by applying the weight of each firm to its corresponding daily return as follows,

$$WR_t = \sum_i w_{i,t} R_{i,t} \tag{4.2}$$

where WR_t is a weighted return at time t, $w_{i,t}$ is a weight of firm i at time t and $R_{i,t}$ is daily logarithmic return of firm i at time t.

4.4.2.3 Portfolio construction

We construct the three separate portfolios for exporting, domestic manufacturing and domestic services firms. For each portfolio, the weighted returns of each portfolio follow the same method as calculating the weighted returns of all Chinese firms according to equations (4.1) and (4.2).

4.4.2.4 Economic Liberalization Events

In our study, the episodes of economic liberalizations in China are broadly divided into three categories: trade, stock market and foreign exchange rate liberalizations. Specifically, the trade liberalization is represented by WTO accession in December 2001. The stock market liberalization comprises of three episodes, the permission of domestic investors to purchase B shares in 2001, the launch of Qualified Foreign Institutional Investors (QFII) program in November 2002 and its subsequent regulation relaxation in August 2006. The foreign exchange liberalization is denoted by the announcement of the People's Bank of China (PBOC) to change the exchange rate regime from fixed to managed float in July 2005.

We construct dummy variables to represent each event. We use a 6-month window to represent a time span of each period to cover reaction in the stock market 3-month before and 3-month after the announcement date. Five dummy variables are created to correspond with

Table 4.5: Economic liberalization events in China.

Dummy variable	Liberalization events	Announcement date	Estimation window		
$dummy_1$	Domestic individual investors are allowed to purchase B shares	19-Feb-01	21-Nov-00	to	20-May-01
$dummy_2$	China's accession to WTO	11-Dec-01	12-Sep-01	to	11-Mar-02
$dummy_3$	QFII scheme launched	05-Nov-02	07-Aug-02	to	03-Feb-03
$dummy_4$	Exchange rate reform (to managed float)	21-Jul-05	22-Apr-05	to	19-Oct-05
$dummy_5$	Revision of QFII regulations	24-Aug-06	26-May-06	to	22-Nov-06

an estimation window length of each event. Each dummy variable takes the value of 1 during the estimation window and 0 otherwise. Details for window ranges of liberalization events are presented in Table 4.5.

4.4.3 Volatility Measurement

Generally, volatility refers to the dispersion of all likely outcomes of an uncertain variable (Poon (2005)). Measuring volatility can be broadly divided into two categories, i.e., unconditional and conditional. Unconditional volatility estimation is based on historical information, where all observations are treated equally. In contrast, conditional volatility estimation is based only on the latest available information, which is useful since volatility is likely to be affected by more recent events. Furthermore, unconditional volatility ignores potentially relevant information on the random process that generates the return. Thus, in our study, conditional volatility is selected as a volatility measure for uncertainty of variables while we also check the sensitivity of our results by looking at unconditional volatility.

To elaborate the model employed in measuring volatility of multiple variables in our study, we first give a brief introduction to unconditional volatility, then we provide details on a specific multivariate conditional volatility measurement model in the following subsections.

4.4.3.1 Unconditional volatility

Unconditional volatility is the simplest way to measure dispersion of variables which is also the advantage of this approach. Its mathematical expression is the sample standard deviation, that is

$$\sigma = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(r_t - \bar{r}_t)^2} \tag{4.3}$$

where r_t is the return on day t , and $\overline{r_t}$ is the average return over the T-day period. A rolling window of a fixed length is often used to minimize the effect of the sample size on results. If a rolling window is imposed, T in equation (4.3) is interpreted as a window length.

The limitation of unconditional volatility is that volatility of a variable is assumed to be constant over time. The time variation of the resulting estimation comes largely from the recursive computation, i.e., every time the volatility is calculated, the sample window is shifted by one observation. The shorter length of the rolling window thus naturally generates more time variation.

4.4.3.2 Conditional volatility

In this subsection, we show an approach to estimate conditional volatility of multiple variables. The idea of conditional volatility modelling is to accurately capture the heteroskedasticity characteristic of financial data which refers to the fact that the market volatility varies and tends to cluster in periods of high volatility as well as periods of low volatility. The model commonly used in describing conditional volatilities of a single variable is the GARCH model. For the case of multiple variables, the multivariate GARCH model is employed to take into account comovements of variables.

In our study, when conducting a preliminary analysis, we estimate conditional volatilities of Chinese stock market and the three portfolios with the univariate GARCH model[5]. For the study of volatility spillovers, a spillover table requires inputs as volatility time series. In order to describe conditional volatility of individual asset and allow correlation of variables to vary over time, we estimate the time series of multivariate conditional volatilities with the dynamic conditional correlation GARCH (DCC-GARCH) model. A brief description of the multivariate GARCH model is provided below.

The DCC-GARCH model[6] for multivariate conditional variance is of the following form,

$$H_t = D_t R_t D_t \tag{4.4}$$

where H_t represents time-varying covariance matrix of all variables in a dataset, D_t is a diagonal matrix of conditional volatilities and R_t is a matrix of time-varying correlations.

Elements in the diagonal matrix (D_t) are squared root of conditional variances (standard deviations) from univariate GARCH models as shown below,

$$D_t = \begin{bmatrix} \sqrt{h_{1t}} & 0 & \cdots & 0 \\ 0 & \sqrt{h_{2t}} & \cdots & \vdots \\ \vdots & \vdots & \ddots & 0 \\ 0 & \cdots & 0 & \sqrt{h_{Nt}} \end{bmatrix} \tag{4.5}$$

The univariate GARCH specification employed in our study is the commonly used GARCH(1,1)-ARMA(1,1) model (Hansen and Lunde (2001)) which has the following mean and variance

[5]Details of the univariate GARCH are given in the Appendix B.4.

[6]Comprehensive details of the multivariate DCC-GARCH model are given in the Appendix B.5.

equations:

$$r_{n,t} = \mu_n + a_n r_{n,t-1} + b_n \varepsilon_{n,t-1} + \varepsilon_{n,t}, \tag{4.6}$$

$$h_{n,t} = \omega_n + \alpha_n \varepsilon^2_{n,t-1} + \beta_n h_{n,t-1} \tag{4.7}$$

for all variables $n = 1, ..., N$ in the dataset.

The time-varying correlation matrix (R_t) is defined as

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{4.8}$$

$$Q_t = (1 - \eta - \kappa)\overline{Q_t} + \eta z_{t-1} z^T_{t-1} + \kappa Q_{t-1} \tag{4.9}$$

where $\overline{Q} = Cov[z_t z_t^T] = E[z_t z_t^T]$ is the unconditional covariance matrix of the standardized errors ($z_t = D_t^{-1} \varepsilon_t$) which can be estimated as $\overline{Q} = \frac{1}{T} \sum_{t=1}^{T} \varepsilon_t \varepsilon_t^T$ and Q_t^* is a diagonal matrix with the square root of the diagonal element of Q_t at the diagonal.

As mentioned earlier, we divide our studies on volatility spillovers into two parts to provide broad and detailed perspectives on volatility spillovers. In the first part, we examine volatility spillovers from the foreign stock markets to all firms (aggregated) in China. In the second part, since it is sensible that volatility of firms is influenced by not only by foreign markets but also by spillovers from other businesses in China (domestic markets), Chinese firms in this part of the volatility spillover study are thus segregated into exporting, domestic manufacturing and domestic services firms to explore volatilities that are transmitted from the portfolios and from foreign stock markets. This is also to inspect the source of volatility spillovers across portfolios, in addition to volatility spillovers from foreign stock markets to China.

Consequently, there are two estimations with respect to the two parts of our studies. The first one is the initial estimation which we use the daily returns of S&P500, FTSE100,

Table 4.6: Estimation of DCC-GARCH model parameters for the initial estimation.

Parameters	All firms	S&P500	NIKKEI225	FTSE100	Joint
μ	0.026*	0.056**	0.04*	0.042*	
a_1	0.359**	0.946*	0.047	0.924	
b_1	0.345*	-0.963*	-0.073*	-0.949*	
ω	0.027**	0.017**	0.043**	0.013**	
α_1	0.059**	0.102**	0.086*	0.092**	
β_1	0.931***	0.887**	0.897**	0.901*	
η					0.003**
κ					0.996**

Notes: * p<0.1; ** p<0.05; *** p<0.01.

Table 4.7: Estimation of $\overline{Q}$ for the initial estimation.

	All firms	S&P500	NIKKEI225	FTSE100
All firms	1.002	0.093	0.014	0.075
S&P500	0.093	0.997	0.124	0.521
NIKKEI225	0.014	0.124	1.000	0.282
FTSE100	0.075	0.521	0.282	0.997

NIKKEI225 and daily returns of all Chinese firms. The second one is the extended estimation to study volatility spillovers across portfolios. The daily returns of S&P500, FTSE100, NIKKEI225 and the daily returns of three portfolios are employed in this estimation.

The DCC-GARCH model is employed to model the dynamics of stock return volatility and correlation among variables in the two estimations. The resulting conditional volatilities are subsequently used as inputs for spillover tables. The parameter estimation results of the DCC-GARCH model on the initial estimation are presented in Table 4.6 and Table 4.7. Table 4.6 shows estimated parameters of univariate GARCH(1,1)-ARMA(1,1) for each variable and estimated parameters for the conditional correlation matrix. Table 4.7 exhibits the matrix $\overline{Q}$ that is used in constructing the conditional correlation matrix.

For the initial estimation, most of the parameters estimated for conditional variance are statistically significant at least at 10 percent level. α's and β's are positive indicating that

Table 4.8: Estimation of DCC-GARCH model parameters for the extended estimation.

Parameters	Exporters	Domestic manufacturers	Domestic services	S&P500	NIKKEI225	FTSE100	Joint
μ	0.022*	0.009*	0.021*	0.056**	0.04*	0.042*	
a_1	0.538**	0.908**	0.289*	0.946*	0.047	0.924	
b_1	0.524*	0.888***	0.271	-0.963*	-0.073*	-0.949*	
ω	0.028*	0.056**	0.025*	0.017**	0.043**	0.013**	
α_1	0.061**	0.061***	0.048**	0.102**	0.086*	0.092**	
β_1	0.930***	0.920***	0.943***	0.887**	0.897**	0.901*	
η							0.017**
κ							0.971**

Notes: * p<0.1; ** p<0.05; *** p<0.01.

Table 4.9: Estimation of $\overline{Q}$ for the extended estimation.

	Exporters	Domestic manufacturers	Domestic services	S&P500	NIKKEI225	FTSE100
Exporters	1.004	0.930	0.820	0.020	0.143	0.057
Domestic manufacturers	0.930	1.003	0.777	0.021	0.143	0.061
Domestic services	0.820	0.777	1.003	0.037	0.161	0.080
S&P500	0.020	0.021	0.037	0.997	0.124	0.521
NIKKEI225	0.143	0.143	0.161	0.124	1.000	0.282
FTSE100	0.057	0.061	0.080	0.521	0.282	0.997

yesterday conditional variance and yesterday shocks associated of each asset have positive impact on today's conditional variance.

For parameters estimation for the extended estimation, the estimated parameters for GARCH(1,1)-ARMA(1,1) and time-varying correlation matrix are given in Table 4.8. In addition, the estimated matrix $\overline{Q}$ is shown in Table 4.9. The results show that most of the parameters estimated are statistically significant at least at 10 percent level and signs of α's and β's are positive.

The time series of estimated conditional volatility for all Chinese firms and the three portfolios can be obtained by substituting estimated parameters into the DCC-GARCH model. The time series of estimated conditional volatility from this section are subsequently used as an input to find the sources of volatility spillovers in later analysis.

4.4.4 Preliminary Analyses

This section aims to present the effects of economic liberalizations on stock return volatility for Chinese stock market. In addition, we examine those effects to the three portfolios which are exporting firms, domestic manufacturing firms and domestic services firms in China. We focus on three aspects of economic liberalizations in China as mentioned before.

The estimation model to test the effects of liberalization events on stock return volatility is

$$\sigma_t = \alpha + \beta t + \sum_{s=1}^{5} \theta_s dummy_s + \varepsilon_t \tag{4.10}$$

where σ_t denotes conditional volatility at time t estimated from the GARCH(1,1) model, α denotes a constant, t represents the time trend, $dummy_s$ is a dummy variable for an event $s = 1,...,5$ and ε_t is an error term. The GARCH(1,1) model is selected to estimate conditional volatility since it is commonly employed in estimating univariate conditional volatilities (Hansen and Lunde (2005)). The estimation results of GARCH(1,1) parameters for each time series are reported in the Appendix B.4.

The results show that all estimated coefficients are statistically significant at least at 5% level (Table 4.10). The estimated coefficients in Table 4.10 are reported in percentage points. For example, the coefficient for the WTO event ($dummy_2$) is 1.423 for exporters (column(2)) indicating that daily stock return volatility of exporters increases by 1.423% during 12 September 2001 to 11 March 2002 in response to China's accession to WTO. The results show that, overall, all economic liberalizations significantly increase volatility to all Chinese firms and to all portfolios.

When considering by portfolios and liberalization events, the permission to buy B shares for Chinese domestic investors increases stock return volatility of exporters most by 0.796%, followed by domestic services (0.648%) and domestic manufacturers (0.6%).

For the WTO membership of China, it is observed that stock volatility of exporters increases most (1.423%), followed by domestic manufacturers (0.67%) as a result of the event. It could be possible that exporters were expected to gain more benefit from lowered trade tariffs after WTO accession and hence leading to higher speculation and higher volatility in equities of exporting firms. This also implies that WTO causes more uncertainty to exporters.

The launch of QFII program allows foreign investment to take part in the stock market. Our results show that, in terms of all firms aggregated, this event increases the volatility (by 0.94%) which is consistent with the finding of Wang and Shen (1999) that foreign investments increase the volatility of stock returns. Considering by portfolios, domestic manufacturers volatility increases most by 1.477%, followed by exporters who experience 1.317% increase in volatility. Our conjecture is that stocks of domestic manufacturers are more speculated once foreign investors are allowed to trade in Chinese stock market.

According to the change of the exchange rate regime from fixed to managed float, the Chinese Yuan was expected to appreciate largely against the dollar after the change of exchange rate system which directly decreases revenue of exporters. This could cause worry on the sentiment of investors holding stocks of exporting firms leading to a tendency to sell-off. Accordingly, the portfolio of exporting firm stocks is impacted more than the others with an increase of 1.206% in volatility. This indicates that the exchange rate reform results in higher uncertainty to exporters.

The revision of QFII regulations leads to increasing number of eligible foreign institutional investors in Chinese stock market which could also cause more volatility to the market. We find that exporters are affected most by 0.577% increase in their stock volatility.

It is clear from the empirical results that economic liberalizations increase volatility to all firms in China. Also, when looking at the impact among exporting firms, domestic man-

Table 4.10: Effects of economic liberalizations on stock return volatility.

Variable	All firms (1)	Exporters (2)	Domestic Manufacturers (3)	Domestic Services (4)
Time trend	0.001***	0.001***	0.000***	0.001***
$dummy_1$	0.775***	0.796***	0.600***	0.648***
$dummy_2$	0.589***	1.423***	0.674***	0.298***
$dummy_3$	0.944***	1.317***	1.477***	0.562***
$dummy_4$	0.739***	1.206***	1.012***	0.676***
$dummy_5$	0.483**	0.577***	0.298***	0.514***

Note: *p<0.1,**p<0.05,***p<0.01.
$dummy_1$= B share purchase, $dummy_2$=China's accession to WTO, $dummy_3$=QFII scheme launched, $dummy_4$= Exchange rate reform, $dummy_5$=Revision of QFII regulations.

ufacturing and domestic services firms, all portfolios experience an increase of volatility caused by those events. Moreover, we observe that exporters receive strongest impacts in all liberalization events except for the event concerning the relaxation of QFII regulations.

In the next study, we proceed to a more interesting question in identifying the source of volatility spillovers for all firms and the three portfolios in different economic liberalization events.

4.5 Methodology

In order to construct a spillover table, the process begins with an estimation of volatility time series. Then the time series are used to perform a forecast error variance decomposition and subsequently building a table. In Diebold and Yilmaz (2009) and Diebold and Yilmaz (2012), the weekly stock return volatilities are calculated using underlying daily high/low/open/close prices with a formula given in Garman and Klass (1980) and Alizadeh et al. (2002). The volatilities, however, are calculated individually market-by-market without concerning dynamics of market interactions. To improve the accuracy of volatility estimates, we employ multivariate GARCH with Dynamic Conditional Correlation model

(DCC-GARCH) to produce conditional volatilities for subsequent spillover calculation. The estimation results for DCC-GARCH are exhibited in Tables 4.6 to 4.9.

Directional Spillover Measurement

To measure the magnitude and direction of a spillover, we adopt the methodology of Diebold and Yilmaz (2012) in construct a spillover table [7] as an approach to measure direction and magnitude of a spillover from volatilities. Consider a covariance-stationary N variables vector autoregressive model, VAR(p)

$$X_t = \sum_{i=1}^{p} \Phi_i X_{t-i} + \varepsilon_t \tag{4.11}$$

where $X_t = (X_{1t}, X_{2t}, ..., X_{Nt})$, Φ is an $N \times N$ parameter matrix and $\varepsilon_t \sim (0, \Sigma)$ is a vector of i.i.d. disturbances. In our subsequent empirical works, X_t denotes a vector of multivariate conditional volatilities which is modelled by the multivariate dynamic conditional correlation GARCH (DCC-GARCH).

By covariance stationarity, VAR(p) can be converted to a vector moving average (VMA) representation, i.e.,

$$X_t = \sum_{j=0}^{\infty} A_j \varepsilon_{t-j} \tag{4.12}$$

where A_j is an $N \times N$ coefficients matrix obeying $A_j = \phi_1 A_{j-1} + \phi_2 A_{j-2} + ... + \phi_p A_{j-p}$ with A_0 being an $N \times N$ identity matrix and $A_j = 0$ for $j < 0$. The VMA representation is used to determine the forecast the future for-step-ahead, subsequently, the forecast error variances of each variable are decomposed into parts attributable to the various system shocks. In

[7] This approach is an improved version of Diebold and Yilmaz (2009) to circumvent the problem that the results of error variance decomposition is varied with the order of variables. The application of generalized error variance decomposition in Diebold and Yilmaz (2012) makes resulting spillover tables invariant to the variable ordering.

details, equation (4.12) can be written as

$$X_t = \varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + ... \tag{4.13}$$

Let e_{t+H} denotes error from H-step-ahead at time t which is given by

$$\begin{aligned} e_{t+H} &= X_{t+H} - E\left[X_{t+H}|X_t, X_{t-1}, ...\right] \\ &= X_{t+H} - E\left[\varepsilon_{t+H} + A_1\varepsilon_{t+H-1} + A_2\varepsilon_{t+H-2} + ...|X_t, X_{t-1}, ...\right] \\ &= X_{t+H} - (A_H\varepsilon_t + A_{H+1}\varepsilon_{t-1} + A_{H+2}\varepsilon_{t-2} + ...) \\ &= \varepsilon_{t+H} + A_1\varepsilon_{t+H-1} + A_2\varepsilon_{t+H-2} + ... + A_{H-1}\varepsilon_{t+1}. \end{aligned} \tag{4.14}$$

With Σ denoting the covariance matrix of ε_t, since X_t is covariance-stationary, then the variance of H-step-ahead is expressed as

$$\begin{aligned} Var(e_{t+H}) &= \Sigma + A_1\Sigma A_1^T + A_2\Sigma A_2^T + ... + A_{H-1}\Sigma A_{H-1}^T \\ &= \sum_{h=0}^{H-1} A_h\Sigma A_h^T \end{aligned} \tag{4.15}$$

where A_0 is an identity matrix as defined previously. In order to measure a spillover, the primary objective is to decompose the forecast error variances, i.e. the elements on the diagonal of $Var(e_{t+H})$. Consequently, the spillover from variable j to variable i is defined as

$$s_{ij} = \frac{\sum_{h=0}^{H-1} (A_h)_{ij}^2}{\sigma_{ii} \sum_{h=0}^{H-1} (A_h\Sigma A_h^T)_{ii}} \tag{4.16}$$

where σ_{ii} is the standard deviation of the error term of variable i . The variance decomposition above in equation (4.16) is known as the generalized variance decomposition (GVD).

To ensure that $\sum_j s_{ij} = 1$, we normalize each entry of the variance decomposition matrix by the row sum as

$$\tilde{s}_{ij} = \frac{s_{ij}}{\sum_j s_{ij}} \times 100. \tag{4.17}$$

A resulting spillover table presents the own volatility ($\tilde{s}_{ii}$) and a volatility spillover ($\tilde{s}_{ij}$) of all variables i, j in the table format as illustrated in 4.11.

Table 4.11: A spillover table obtained from the generalized variance decomposition (GVD) approach.

	X_1	X_2	$\cdots$	X_N	From all
X_1	$\tilde{s}_{11}$	$\tilde{s}_{12}$	$\cdots$	$\tilde{s}_{1N}$	$\sum_{j=1}^{N} \tilde{s}_{1j},\ j \neq 1$
X_2	$\tilde{s}_{21}$	$\tilde{s}_{22}$	$\cdots$	$\tilde{s}_{2N}$	$\sum_{j=1}^{N} \tilde{s}_{2j},\ j \neq 2$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
X_N	$\tilde{s}_{N1}$	$\tilde{s}_{N2}$	$\cdots$	$\tilde{s}_{NN}$	$\sum_{j=1}^{N} \tilde{s}_{Nj},\ j \neq N$
Total to	$\sum_{i=1}^{N} \tilde{s}_{i1},\ i \neq 1$	$\sum_{i=1}^{N} \tilde{s}_{i2},\ i \neq 2$	$\cdots$	$\sum_{i=1}^{N} \tilde{s}_{iN},\ i \neq N$	

where $\tilde{s}_{ij}$ represents a spillover from column j to row i as defined in equation (4.17). The column "From all" denotes a total volatility spillover from other variables to a variable whereas the column "Total to" indicates a total spillover from a variable i to all other variables $j \neq i$.

4.6 Results

Our preliminary evidences show that the economic liberalizations increase the volatility of Chinese firms. However, the influence from each source of volatility could be different along the series of economic liberalizations. Consequently, our main contribution of this study is to examine the contribution of the sources of volatility spillover to Chinese stocks (as a whole stock market) and separate portfolios under different economic liberalization events as defined in Table 4.5. Therefore, we examine stock return volatility spillovers on two estimations (which are initial and extended estimations with details provided below), event-by-event.

In our study, volatility spillovers to and from each variable is presented in a form of a spillover table. The table construction begins with estimating volatility time series, then decomposes the variance of forecast error for each variable. The forecasting horizon is set as 30 days ahead ($H = 30$). Since we investigate volatility spillovers of each event separately, for each estimation window (see Table 4.5), we estimate conditional volatilities of each event using raw data with the length covering the window. For instance, to create a spillover table to reflect volatility spillovers to firms in China in an aggregate level (from S&P500, FTSE100 and NIKKEI225 to all firms in China) during the WTO event, the series of conditional volatilities are estimated with the DCC-GARCH model using 180 daily return observations during 12 September 2001 to 11 March 2002.

Next, we present the empirical results of the initial estimation to demonstrate volatility spillovers from foreign stock markets to Chinese stock market as a whole, followed by the results based on the extended estimation which provides additional information on volatility spillovers across portfolios. For both estimations, there contains five spillover tables associated to five economic liberalization events.

4.6.1 Volatility Spillover for the initial estimation

There are four variables in this estimation which are Chinese stock market index, S&P500, FTSE100 and NIKKEI225. The aim of the study of volatility spillovers is to see which market has most influence on Chinese listed firms and whether such influence is consistent across episodes of economic liberalizations in China.

In a spillover table, the column "From all" reports the sum of volatility spillovers to a variable excluding its own volatility. A high value of volatility spillover indicates high connection between a volatility transmitter and a volatility receiver, and vice versa.

1. Permission of domestic investors to buy B shares

From Table 4.12, it is observed that the majority of volatility of all Chinese firms is from Chinese stock market (86.56%). Contributions from the major stock markets accounts for 13.44%, mainly from US stock market (8.09%). In addition, volatility transmission from Chinese stock market to major stock markets is also small, indicating that global stock markets are lightly impacted by this event in China.

Table 4.12: A spillover table for the time around the event that domestic investors were permitted to buy B shares.

	All firms	S&P500	NIKKEI225	FTSE100	From all
	(1)	(2)	(3)	(4)	(5)
All firms	86.56	8.09	2.83	2.52	13.44
S&P500	0.14	72.32	15.39	12.15	27.68
NIKKEI225	0.54	50.57	35.06	13.83	64.94
FTSE100	0.07	42.17	20.29	37.47	62.53

2. WTO accession

The main driven source of stock volatility for Chinese stock market is still from its own stock market (92.96%). Contribution from external stock markets is still low (7.04%), mainly from US stock market (6.44%). However, we observe an increase of the impact from Chinese stock market on major stock markets compared with the previous event. Specifically, among the stock markets in the US, Japan and the UK, Japanese stock volatility increases most by 9.36% due to shocks from Chinese stocks around this event.

Table 4.13: A spillover table for the time around the event that China became a member of WTO.

	All firms	S&P500	NIKKEI225	FTSE100	From all
	(1)	(2)	(3)	(4)	(5)
All firms	92.96	6.44	0.07	0.52	7.04
S&P500	0.22	24.00	8.53	67.25	76.00
NIKKEI225	9.36	0.31	85.38	4.95	14.62
FTSE100	1.48	1.85	3.79	92.88	7.12

3. The launch of QFII program

The main source of volatility spillovers around this event comes from domestic while 17.02% of Chinese firms' stock return volatility is from external. The main external source of volatility spillovers to Chinese firms is from US stock market, making up of 14.45% of total volatility of Chinese stock return volatility. In this event, foreign investment in Chinese stock market brings about more volatility spillovers from international stock market than the previous two events.

Table 4.14: A spillover table for the time around the event that QFII program was announced.

	All firms	S&P500	NIKKEI225	FTSE100	From all
	(1)	(2)	(3)	(4)	(5)
All firms	82.98	14.45	0.46	2.11	17.02
S&P500	6.47	37.09	0.50	55.94	62.91
NIKKEI225	7.18	11.87	71.26	9.69	28.74
FTSE100	2.25	7.55	2.01	88.19	11.81

4. Change of exchange rate regime from fixed to managed float

In this event, stock volatility of Chinese firms is mainly from Chinese stock market (91.25%) while foreign stock markets only contribute 8.75%, mainly from Japan (5.53%). However, in terms of volatility transmission to stock markets outside China, this event causes big impact on stock return volatilities in Japan (49.85%) and the UK (40.71%).

Table 4.15: A spillover table for the time around the event that China changed its exchange rate regime

	All firms	S&P500	NIKKEI225	FTSE100	From all
	(1)	(2)	(3)	(4)	(5)
All firms	91.25	0.95	5.53	2.27	8.75
S&P500	36.35	44.07	4.12	15.46	55.93
NIKKEI225	49.85	3.41	46.59	0.15	53.41
FTSE100	40.71	10.82	13.38	35.09	64.91

5. The revision of QFII regulations

The relaxation of QFII rules leads to increasing number of eligible foreign investors in China and consequently lead to stronger connection to global stock markets. It is observed that spillovers from the major stock markets to Chinese stock market is highest comparing to all other events (17.85%), mainly from US stock market (14.54%). Nevertheless, shocks in Chinese stock market is still the main contributor to volatility.

The foreign stock markets also experience a big impact from Chinese stock market upon this event. Stock return volatility in the US and Japan are mainly caused by the volatility spillover from China. For US stock market, in particular, volatility from Chinese stocks makes up to 50% of its volatility.

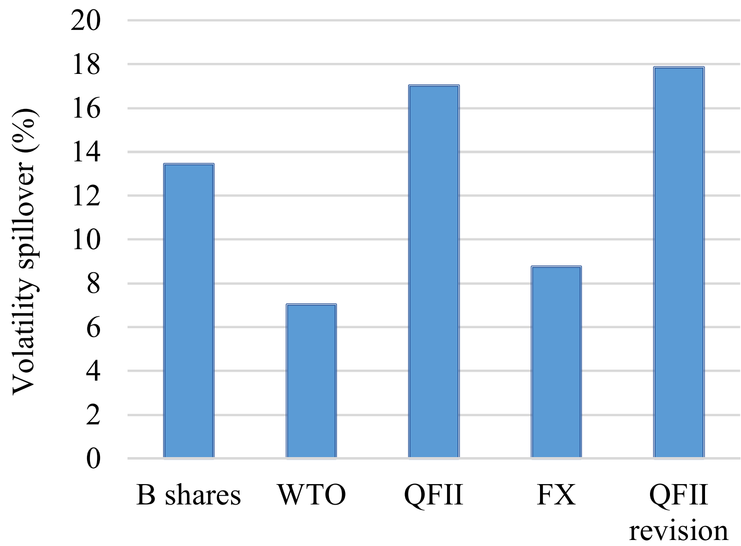
Table 4.16: A spillover table for the time around the event that QFII regulations were relaxed.

	All firms	S&P500	NIKKEI225	FTSE100	From all
	(1)	(2)	(3)	(4)	(5)
All firms	82.15	14.54	0.24	3.07	17.85
S&P500	50.07	36.55	3.64	9.74	63.45
NIKKEI225	39.26	18.83	30.19	11.72	69.81
FTSE100	31.92	25.57	2.31	40.20	59.80

The summary of volatility spillovers to Chinese stock market in different liberalization events is illustrated in Figure 4.1. The results show that the magnitudes of volatility spillovers from international markets (column (5) in Table 4.16) in all events are not over 20%, implying that despite the liberalizations in trade, stock market and foreign exchange, stock volatility in China is mainly caused by shocks from Chinese stock market rather than international stock markets. The events that demonstrate lowest volatility spillover to Chinese stocks is the WTO accession which implies that trade liberalization does not make Chinese stock market more connected to the world market. In contrast, all three episodes of stock market liberalizations (allowance of domestic investors to buy B shares, the launch of QFII and the subsequent regulations relaxation), which aim to integrate Chinese stock markets to global stock markets, lead to the volatility spillovers from international stock markets of 13.44%, 17.02% and 17.85%, respectively. More importantly, when Chinese stock market is more liberalized (proceeding from the permission of domestic investors to purchase B shares to the relaxation of QFII regulations), shocks from international markets increasingly impact stock return volatility in China.

In terms of sources of volatility spillovers to Chinese stocks, the US stock market is the main contributor in all events except when China changes its exchange rate regime (in which the volatility spillover is largely from Japan).

Figure 4.1: Volatility spillovers from international stock markets to Chinese stock market in different economic liberalization events.



Note : B shares = The permission of domestic investors to buy B shares, WTO = China's accession to WTO, QFII = The launch of QFII program, FX = Change of exchange rate regime from fixed to managed float, QFII revision = The revision of QFII regulations.

4.6.2 Volatility Spillover for the extended estimation

In this estimation, there contains six volatility time series of exporting firms, a portfolio of domestic manufacturing firms, a portfolio of domestic services firms, S&P500, FTSE100 and NIKKEI225. The study aims to investigate variation in sources of volatility spillovers across the three portfolios which could also be viewed as a decomposed-version of the analysis on the previous estimation.

The empirical results are presented in a spillover table, event-by-event, as in the initial estimation. Two additional columns are added into a spillover table to summarize total spillovers from domestic and international stock markets. The column "from domestic" denotes the total volatility spillover from other portfolios to one portfolio and the column "from international" indicates the total volatility spillover from foreign stock markets to the portfolio. For example, for domestic manufacturers during the permission of domestic investors to buy B shares, the total spillover value in the "From all" column show that this portfolio receives volatility spillover from other portfolios and the major stock markets combined by 35.02% (column (2) in Table 4.17). This total spillover value can be attributed to total volatility spillover from exporters and domestic services alone at 20.05% and the total spillover from the major stock markets alone at 14.97%. Details of the volatility spillovers in each economic liberalization are given below.

1. Permission of domestic investors to buy B shares

The main source of volatility for each portfolio is from shocks of its own, 65.72% for domestic services firms, 64.98% for domestic manufacturing firms and 45.08% for exporters (see Table 4.17). Considering contribution of shocks from foreign stock markets, the US accounts for the majority to all portfolios, i.e., 10.57% for exporters, 10.87% for domestic manufacturers and 13.11% for domestic services firms.

When breaking down the source of spillovers into domestic and international markets, it is found that the three portfolios primarily receive volatility transmission domestically. Volatility spillovers from domestic and international markets, however, are different from portfolio to portfolio. For exporters, 35.70% out of 54.92% (total spillover) is attributed to volatility spillover from domestic manufacturing and domestic services firms, while 19.22% is from international stock markets. For domestic services, in contrast, volatility spillovers come from domestic and international sources quite evenly, i.e., 17.52% from exporting firms and domestic manufacturing firms combined and 16.76% from the major stock markets.

Overall, around the time of this event, the three portfolios demonstrate similar characteristics that the main source of volatility is from shocks of their own stock market rather than from international stock markets.

2. WTO accession

We learn from the initial estimation that WTO accession does not cause much volatility spillovers from external stock markets to Chinese stock market. In this estimation, it is also observed that the main source of volatility spillovers for the three portfolios is from volatility transmission from domestic rather than international stock markets. For instance, 52.08% of stock return volatility of exporters is due to shocks from domestic manufacturers and domestic services while 7.36% is from the major stock markets (see Table 4.18). In addition, considering only spillovers from international stock markets, the US is still the main transmitter of volatility to the three portfolios in China.

Although volatility spillovers from international stock markets are small, we observe substantial volatility spillover outwards to international stock markets. The main source of volatility transmission is from the portfolio of exporters which is expected to receive direct effect from China's membership of WTO. It is found that shocks from exporting firms following this event account for 15.28% for US stock market, 27.80% for Japan stock market and 26.50% for UK stock market.

In sum, the findings of volatility spillovers in WTO event for the extended estimation are consistent with those in the initial estimation in which the main source of volatility of each portfolio is from Chinese stock market. Volatility spillovers from foreign stock markets are small (under 10%) while volatility spillovers to foreign stock markets are considered an impact – particularly for volatility spillovers from exporters. In addition, volatility spillovers among portfolios still dominates volatility spillovers from international stock markets.

3. The launch of QFII program

Around this event, we observe an increase of volatility spillovers from foreign stock markets to the three portfolio (31.65% for exporters, 29.30% for domestic manufacturers and 38.08%

from domestic services firms as shown in column (9) of Table 4.19) comparing to the two events before (under 20%). The findings demonstrate that the QFII program leads Chinese stock market to be more connected to the foreign stock markets and naturally absorbs more shocks from global stock markets. Nonetheless, the majority of volatility spillovers for each portfolio is still from domestic sources, except for domestic service firms that spillovers from international stock markets are marginally larger than spillover from domestic source (38.08% compared to 36.09%).

In addition, own volatility is not the main source of volatility for portfolios of exporters and domestic manufacturers but rather from domestic services firms. For instance, the volatility of exporters comes from their own shocks for 22.91% while the volatility spillover from domestic services firms to exporters accounts for 24.98% of total volatility of exporters. This suggests a closer connection among firms of different firm types and a closer connection to international stock markets comparing to other events (77.09% for exporters, 78.9% for domestic manufacturers and 74.17% for domestic services).

The volatility spillovers to each portfolio, apart from domestic sources, are principally from US stock market. With strong influence of US stock market, the volatility transmission from S&P500 index thus dominates volatility spillovers from the UK and Japan. Shocks regarding S&P500 contribute 20.17%, 16.56% and 18.99% of total volatility of exporting firms, domestic manufacturing firms and domestic services firms, respectively.

4. Change of exchange rate regime from fixed to managed float

Following the change of exchange rate regime, the source of volatility spillovers is mainly from domestic rather than from external stock markets. In point of fact, almost all of the volatility spillover magnitude comes from shocks from domestic sources. For example, the portfolio of domestic manufacturers receives the volatility spillover of 55.85% in total, of which 54.41% is from portfolios of exporters and domestic services firms (see Table 4.20).

The main sources of volatility of exporters and domestic services are not from their own shocks but from domestic manufacturing portfolios. Specifically, for exporters, the stock volatility is mainly driven by shocks from domestic manufacturers (39.66%). Likewise, for domestic services firms, the main driver is shocks from domestic manufacturing firms which make up to 40.32% of their stock return volatility. Moreover, volatility spillovers from international stock markets for this case are small (under 3%) for all portfolios where the main source is from Japanese stock market.

In contrast to small volatility received from international stock markets, volatility spillover from Chinese stocks to foreign stock markets is quite substantial. Shocks from domestic manufacturers stocks show the strongest impact in US, Japanese and UK stock markets (23.25%, 33.09% and 25.39%, respectively), followed by shocks from exporters (20.32% to S&P500, 18.30% to NIKKEI225 and 20.55% to FTSE100). The plausible explanation may be that an appreciation of the Chinese Yuan causes worries in international stock markets as uncertainty among trade partners e.g., Chinese exporters trading against foreign importers, is heightened.

In sum, the empirical results of volatility spillovers using this dataset are consistent with those obtained from the initial estimation. That is, volatility spillovers from international stock markets to Chinese stocks are relatively small comparing to volatility spillover from Chinese stocks to global stock markets.

5. The revision of QFII regulations

The aftermath of relaxing regulations is an increasing number of foreign investors in Chinese stock market which naturally integrates the stock market to the world. In terms of volatility received, the majority is attributable to shocks from domestic source. In addition, the leading source of volatility for all portfolios is from their own shocks and US stock market is still the main source of volatility spillovers from international stock markets.

Comparing across economic liberalization events, it is found that the main sources of volatility for the three portfolios are from shocks of their own. Although there is a substantial contribution of volatility spillovers from the major stock markets in some cases (the launch of QFII and QFII regulations relaxation), the contribution from domestic shocks still dominates. In addition, when focusing on volatility spillovers from foreign stock markets to the portfolios, shocks from US stock market are the leading source in all events but the change of exchange rate regime. This finding is in line with the study of Zhou et al. (2012) which reports that volatility of Chinese stock market is relatively more correlated with the volatility of the US stock market than other stock markets. Volatility spillovers from foreign stock markets to Chinese stocks are considered limited (at most 38.08% to domestic services firms when the QFII program is initiated). These findings are consistent with the work of Zhou et al. (2012). They find that the Chinese stock market was hardly affected by world markets in terms of volatility spillover from 1996 to 2009. Prior to 2005, the Chinese market was slightly affected by other markets. In addition, this possible reason could be due to the tight restriction of capital control. China restricts short-term inflows and outflows while encourages long-term capital inflows in order to reduce the possibility of capital flight. Kimball and Xiao (2006) report the effectiveness of capital control in China for preventing the stock market collapse during the Asian crisis in 1998. The capital flows restriction consequently leads to longer-term investment strategy for institutional investors (both domestic and QFII) in China which helps limit stock volatility following the speculation of the major stock markets shocks. The empirical results that volatility spillovers from international stock markets are limited (relatively to their own volatility or volatility spillovers across Chinese firms) are in line with the findings in the studies of Azmi and Haron (2004) and Raghavan et al. (2010) that the spillover effects from foreign markets are reduced substantially if a capital control measure is imposed.

From Table 4.17 to Table 4.21, it is observed that volatility spillovers from international stock markets are relatively at the same level across portfolios. Particularly for Table 4.20 which exhibits the volatility spillovers during the transition of fixed to managed float exchange rate regime, there is no significant difference among the magnitudes of volatility spillovers from major stock markets to each portfolio. The results are supported by the work of Mitra and Bhattacharjee (2015) that earnings and stock returns of firms that trade internationally should be affected from changes in exchange rate, and the study of Adler and Dumas (1984) which points out that stock returns of domestic firms are affected from exchange rate through input prices, output prices, or demand for products although they do not trade with foreign markets. Therefore, both domestic and exporting firms are affected alike in terms of volatility spillovers under the exchange rate liberalization in China.

Table 4.17: A spillover table for the time around the event that domestic investors were permitted to buy B shares.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	45.08	16.62	19.07	10.57	8.25	0.40	54.92	35.70	19.22
Domestic Manufacturers	8.59	64.98	11.47	10.87	2.82	1.28	35.02	20.05	14.97
Domestic Services	6.40	11.12	65.72	13.11	1.27	2.38	34.28	17.52	16.76
S&P500	2.83	2.34	2.50	53.75	1.84	36.74	46.25		
NIKKEI225	3.11	2.78	1.47	21.84	57.63	13.16	42.37		
FTSE100	5.05	1.07	3.27	20.75	16.35	53.52	46.48		

Table 4.18: A spillover table for the time around the event that China became a member of WTO.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	40.57	38.74	13.33	5.66	0.65	1.05	59.43	52.08	7.36
Domestic Manufacturers	38.47	41.19	14.22	3.19	1.75	1.19	58.81	52.69	6.12
Domestic Services	36.50	19.09	40.02	2.43	1.05	0.91	59.98	55.59	4.39
S&P500	15.28	1.86	0.72	24.54	8.04	49.57	75.46		
NIKKEI225	27.80	14.71	13.61	0.22	39.78	3.88	60.22		
FTSE100	26.50	6.42	3.50	4.03	4.35	55.20	44.80		

Table 4.19: A spillover table for the time around the event that QFII program was announced.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	22.91	20.46	24.98	20.17	7.19	4.29	77.09	45.44	31.65
Domestic Manufacturers	22.94	21.10	26.66	16.56	8.43	4.31	78.90	49.60	29.30
Domestic Services	18.23	17.87	25.83	18.99	13.74	5.35	74.17	36.09	38.08
S&P500	4.65	2.92	4.78	40.27	7.43	39.96	59.73		
NIKKEI225	1.04	0.71	2.27	18.06	51.94	25.98	48.06		
FTSE100	8.80	4.54	13.22	4.33	3.81	65.30	34.70		

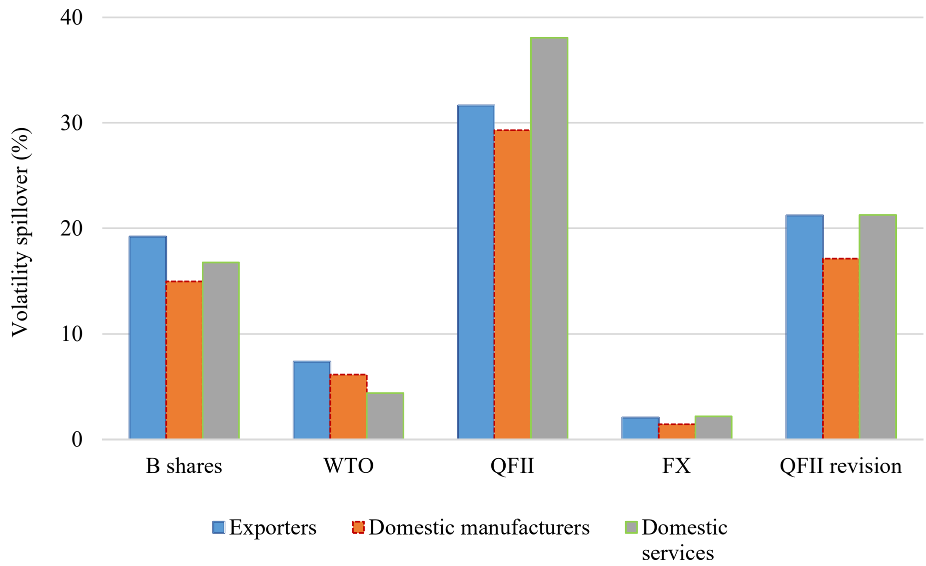
Table 4.20: A spillover table for the time around the event that China changed its exchange rate regime from fixed to managed float.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	33.00	39.66	25.27	0.52	1.13	0.42	67.00	64.93	2.08
Domestic Manufacturers	30.88	44.15	23.53	0.22	0.70	0.52	55.85	54.41	1.44
Domestic Services	30.39	40.32	27.10	0.22	1.47	0.50	72.90	70.72	2.18
S&P500	20.32	23.25	14.46	29.54	1.66	10.78	70.46		
NIKKEI225	18.30	33.09	16.17	1.20	29.36	1.88	70.64		
FTSE100	20.55	25.39	20.06	8.75	5.90	19.34	80.66		

Table 4.21: A spillover table for the time around the event that QFII regulations were relaxed.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	40.80	25.23	12.77	9.22	5.02	6.96	59.20	38.00	21.20
Domestic Manufacturers	25.86	40.59	16.41	10.99	2.67	3.47	59.41	42.27	17.14
Domestic Services	17.69	13.07	47.98	12.33	4.43	4.50	52.02	30.76	21.26
S&P500	16.64	20.03	19.99	26.06	8.17	9.10	73.94		
NIKKEI225	22.80	17.05	12.81	15.05	22.08	10.21	77.92		
FTSE100	15.26	9.89	10.95	22.90	6.57	34.45	65.55		

Figure 4.2: Spillovers from international markets to each portfolio by events.



4.7 Robustness

We check the robustness of results by using time series of unconditional volatilities in constructing spillover tables. Time series of unconditional volatilities are calculated as 12-month rolling standard deviation of return time series. We estimate unconditional volatilities individually for all Chinese firms, the portfolio of exporting firms, the portfolio of domestic manufacturing firms, the portfolio of domestic services firms, S&P500, FTSE100 and NIKKEI225. Subsequently, spillover tables are constructed using the GVD approach as described earlier.

We also investigate volatility spillovers by two estimations. The first one focuses on volatility spillovers from S&P500, FTSE100 and NIKKEI225 to Chinese stock index (all Chinese firms) while the second one examines volatility spillovers from international stock markets to the three portfolios. All the spillover tables are presented in Table 4.22 to Table 4.26.

Table 4.22: A spillover table for the time around the event that domestic investors were permitted to buy B shares.

	All firms (1)	S&P500 (2)	NIKKEI225 (3)	FTSE100 (4)	From all (5)
All firms	87.80	6.24	5.10	0.86	12.20
S&P500	2.48	59.22	30.88	7.42	40.78
NIKKEI225	0.21	74.16	13.91	11.72	86.09
FTSE100	12.09	44.10	12.51	31.31	68.69

Considering volatility spillovers to Chinese firms at an aggregate level, it is shown that the main source of volatility spillovers is from Chinese stock market rather than global markets and the principal volatility transmitter from international stock markets is still S&P500 index in all liberalization events except when China changes its exchange rate regime. The results are thus consistent with those obtained from using conditional volatilities.

When decomposing all Chinese stocks into the three portfolios, we find that most of the conclusions are similar to the case of conditional volatilities. Specifically, the main source of volatility for each portfolio is from its own shocks for all events, except for the cases of QFII initiation and exchange rate regime change events; also volatility spillovers from international stock markets are limited, compared to volatility spillovers among portfolios. The US stock market still shows closest connection to Chinese stock market, comparing to other major markets.

Overall, it could be concluded that conditional and unconditional volatilities, although resulting volatility spillover tables are different in terms of magnitude, the main conclusions drawn are relatively the same.

Table 4.23: A spillover table for the time around the event that China became a member of WTO.

	All firms (1)	S&P500 (2)	NIKKEI225 (3)	FTSE100 (4)	From all (5)
All firms	90.18	6.16	2.26	1.40	9.82
S&P500	1.88	12.74	10.97	74.41	87.26
NIKKEI225	29.79	10.62	43.10	16.49	56.90
FTSE100	3.01	3.90	34.44	58.64	41.36

Table 4.24: A spillover table for the time around the event that QFII program was announced.

	All firms (1)	S&P500 (2)	NIKKEI225 (3)	FTSE100 (4)	From all (5)
All firms	89.28	6.33	0.57	3.82	10.72
S&P500	7.73	28.09	2.46	61.72	71.91
NIKKEI225	0.16	13.67	75.93	10.24	24.07
FTSE100	12.74	35.14	11.06	41.06	58.94

Table 4.25: A spillover table for the time around the event that China changed its exchange rate regime

	All firms (1)	S&P500 (2)	NIKKEI225 (3)	FTSE100 (4)	From all (5)
All firms	88.83	0.67	6.14	4.35	11.17
S&P500	27.98	58.97	4.77	8.29	41.03
NIKKEI225	5.91	5.40	85.42	3.27	14.58
FTSE100	58.05	0.36	3.72	37.86	62.14

Table 4.26: A spillover table for the time around the event that QFII regulations were relaxed.

	All firms (1)	S&P500 (2)	NIKKEI225 (3)	FTSE100 (4)	From all (5)
All firms	89.62	5.73	0.58	4.07	10.38
S&P500	61.65	25.86	4.23	8.26	74.14
NIKKEI225	86.83	4.73	5.48	2.97	94.52
FTSE100	3.65	37.85	0.34	58.16	41.84

Table 4.27: A spillover table for the time around the event that domestic investors were allowed to buy B shares.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	43.29	15.14	18.57	13.77	9.05	0.17	56.71	33.71	23.00
Domestic Manufacturers	8.37	63.49	10.56	13.18	3.45	0.95	36.51	18.93	17.58
Domestic Services	3.35	3.53	75.38	13.88	2.03	1.84	24.62	6.88	17.75
S&P500	4.01	1.96	51.08	38.08	2.99	1.89	61.92		
NIKKEI225	4.72	1.76	52.88	27.13	11.89	1.63	88.11		
FTSE100	6.27	0.56	46.73	28.54	3.67	14.23	85.77		

Table 4.28: A spillover table for the time around the event that China became a member of WTO.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	39.11	35.19	25.24	0.38	0.03	0.05	60.89	60.43	0.46
Domestic Manufacturers	35.79	40.63	22.60	0.76	0.16	0.05	59.37	58.39	0.98
Domestic Services	31.38	27.35	40.86	0.22	0.08	0.10	59.14	58.74	0.41
S&P500	2.88	1.69	4.27	57.55	0.61	33.00	42.45		
NIKKEI225	0.71	0.57	2.49	15.38	62.55	18.30	37.45		
FTSE100	3.49	2.61	4.59	28.12	0.93	60.25	39.75		

Table 4.29: A spillover table for the time around the event that QFII program was announced.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	22.71	19.24	25.81	3.42	9.03	19.78	77.29	45.05	32.24
Domestic Manufacturers	22.58	20.42	26.32	3.40	10.25	17.02	79.58	48.91	30.67
Domestic Services	18.57	17.09	25.89	5.12	19.01	14.32	74.11	35.66	38.45
S&P500	5.10	3.57	6.37	39.20	8.22	37.54	60.80		
NIKKEI225	2.40	1.50	4.37	17.77	46.84	27.12	53.16		
FTSE100	9.10	5.54	14.59	5.42	8.32	57.02	42.98		

Table 4.30: A spillover table for the time around the event that China changed its exchange rate regime from fixed to managed float.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	32.82	39.56	25.16	0.57	1.20	0.69	67.18	64.72	2.45
Domestic Manufacturers	30.72	43.89	23.49	0.28	0.83	0.80	56.11	54.21	1.90
Domestic Services	30.20	40.17	26.96	0.28	1.56	0.83	73.04	70.37	2.67
S&P500	21.00	25.70	15.24	26.38	1.99	9.69	73.62		
NIKKEI225	18.05	32.67	16.08	1.47	28.68	3.04	71.32		
FTSE100	21.49	29.32	20.12	7.31	5.62	16.13	83.87		

Table 4.31: A spillover table for the time around the event that QFII regulations were relaxed.

	Exporters	Domestic Manufacturers	Domestic Services	S&P500	NIKKEI225	FTSE100	From all	From Domestic	From International
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Exporters	44.24	29.24	17.37	6.82	0.86	1.47	55.76	46.62	9.15
Domestic Manufacturers	28.83	48.05	19.10	3.05	0.58	0.40	51.95	47.93	4.02
Domestic Services	20.27	15.52	56.73	5.28	1.55	0.65	43.27	35.80	7.47
S&P500	15.66	19.06	20.89	27.45	8.60	8.34	72.55		
NIKKEI225	21.71	16.57	13.42	16.72	21.90	9.68	78.10		
FTSE100	14.75	10.46	12.38	22.55	7.49	32.36	67.64		

4.8 Conclusions

This study investigates volatility spillovers from major stock markets to Chinese firms under different economic liberalization events during 1997-2014 in two respects. The first one focuses on volatility spillovers to all Chinese firms in aggregate while the second one explores deeper by segregating Chinese firms to the three portfolios which are exporting, domestic manufacturing and domestic services firms. The latter analysis aims to provide insights on both volatility spillovers from international stock markets and from different portfolios which has not been studied elsewhere before and is the key contribution of this study.

Prior to examining volatility spillovers, we perform a preliminary test on the effect of economic liberalization events on Chinese stock return volatility. It is found that all the liberalization events increase volatility to all Chinese firms. Similarly, an increase in stock return volatility is observed when considering at separate portfolios of exporting, domestic manufacturing and domestic services firms.

We measure volatility spillovers through a spillover table developed by Diebold and Yilmaz (2012). In general, the inputs of spillover tables are time series of volatilities which are commonly estimated by not taking into account time-varying correlation among variables. Consequently, we eliminate this deficiency by estimating volatility time series by the DCC-GARCH model.

The empirical results show that, at an aggregate level (initial estimation) of Chinese firms, different liberalization events demonstrate different levels of volatility spillovers. Events related to stock market liberalizations cause highest volatility spillover. The possible explanation is that liberalizing stock markets directly integrates Chinese stock market to global financial markets and thus creates channels for shocks transmission in turn. Interestingly, it is observed that the more Chinese stock market is liberalized, the more the more volatility from the international stock markets is transmitted to China. The close connection between

US and Chinese stock markets results in S&P500 being the main volatility transmitter to Chinese stock market. The most important finding is that despite of a series of liberalization events, it is found that the main source of volatility to Chinese stocks is from domestic shocks rather than international stock markets. This shows that volatility spillovers in Chinese stock market are hardly affected by the international markets which is consistent with the work of Zhou et al. (2012). One possible reason explaining the modest volatility spillover from international stock markets to Chinese stocks is due to the presence of restriction on short-term inflows and outflows in China.

Breaking down the aggregate Chinese stocks into the three separate portfolios provides possibility to investigate sources of volatility spillovers across portfolios in addition to volatility transmitted from foreign stock markets. For all portfolios, the main source of volatility spillovers is from domestic shocks in most of the economic liberalization events, particularly from their own volatility. Volatility transmitted from foreign stock markets is generally incomparable to volatility spillovers from domestic sources in each portfolio.

Chapter 5

Conclusions

This thesis has investigated the relationship between international trade participation and performance of listed Chinese firms. The availability of high quality datasets allowed us to explore many issues in deeper level than what have been done in existing literature.

In Chapter 2, we measure the effect of exchange rates on firm's stock returns through exchange rate exposure. We construct a firm-specific exchange rate index based on destination specific export and import values. We adjust the model of Allayannis and Ihrig (2001) to establish a baseline model which assumes that exchange rate exposure of a trading firm comes from two channels; export markups and imported input markups. We compare the percentage of firms showing significant exchange rate exposure with other two benchmark models; the first one is the model of Jorion (1990) employing trade-weighted exchange rate index and another one is the model of Jorion (1990) employing our firm-specific exchange rate index. The comparison of the baseline model and the first benchmark model is to evaluate the merit of the firm-specific exchange rate index over the trade-weighted counterpart while the comparison against the second benchmark model assesses the benefit of markups incorporation in the model.

The estimation results show that our baseline model can detect more firms significantly exposed to exchange rates than the rest, thanks to the use of firm-specific exchange rate index and markups. In addition, we find that the percentage of firms significantly exposed to exchange rate is higher when China adopted the managed float exchange rate regime. The possible explanation is that the unpegging of the exchange rate between the US and China results in additional exposure on firms and hence more firms show significant exchange rate exposure when the regime changes. Subsequently, further studies regarding exchange rate exposure are conducted. We first examine if appreciation or depreciation in local currency affects stock returns differently. The estimation results show that stock returns exhibit asymmetric impact of exchange rates whereas the majority of Chinese firms exhibit that CNY appreciation or depreciation affects firm returns similarly. The percentages of firms showing significant exposure obtained from median and standard (mean) regressions are fairly similar, implying that the estimation results and findings from standard regression remain robust against outliers. Lastly, we examine variables that could be determinants of exchange rate exposure. It is observed that firms with high export intensity (high export over sales ratio) tend to have higher exchange rate exposure than those with lower export intensity. Nevertheless, experiences of firms gained through years of operation and exporting to diverse markets are factors that help lessen exchange rate exposure to trading firms in China.

In Chapter 3, the study shows the decomposition of exporting firms' risk premium by current and potential export destinations. The methodology of Fillat et al. (2015) which is initially used to geographically decompose risk premium of MNEs is applied to decompose risk premium of exporting firms in China. We represent risk underlying in each export market with stock market fluctuation instead of GDP growth variation as used in the approach of Fillat et al. (2015). The ensuing benefits are that risk reflected through stock markets is forward-looking and high frequency data of stock returns allows us to estimate time-varying covariances. The latter advantage provides a more realistic risk proxy comparing to the use of time-invariant covariances in the work of Fillat et al. (2015). For each firm, risk premium contribution from each export destination is determined by two factors; the elasticity of the firm's market value with respect to stock market returns and the trivariate covariance of China, export destination countries and the rest of the world. The concept of real options is applied to relate firm's risk premium to future export destinations whereby the probability to export to each new market is varied firm-specific.

The empirical results show that risk premia from current export destinations clearly dominate those of potential exports, implying that plans for future business expansion limitedly affect risk premium of exporting firms. Moreover, assuming that firms are exporting to all 48 destinations in the sample, when aggregating risk premia across export destinations , it is found that the risk premium from current export destination is negative. This points out that, on the average, stock returns of Chinese exporting firms during 2000-2006 are less than the risk-free investment (return from holding three-month treasury bill of China). The aggregate risk premium for future export destinations is positive but with small magnitude and insignificant when adding up to total risk premium of exporting firms. The largest contribution for exporting firms is from domestic sales, suggesting that the risk premium of domestic firms during the study period is higher than risk premium of exporting firms and that current exports during that time are not well rewarded for the risk taken. Following the decomposition of risk premium, further studies are conducted. We begin with the robustness check by removing countries with insignificant risk premia and re-estimate the risk premium again with only countries with significant risk premia. The results show that most of the remaining countries still exhibit significant risk premium contribution. Subsequently, we check if outliers affect decomposed risk premium estimates by comparing the estimation results from median and standard (mean) regression. It is exhibited that the results obtained from the two regression methods are quite similar in terms of magnitude and sign. In addition, we check if estimation results would change after removing suspected outliers in raw data. By using firm returns which are winsorized at 10^{th} and 90^{th} percentiles, the resulting decomposed risk premia for each export destination demonstrate consistent signs and magnitude to those estimated with original data. The results on median regression and winsorized data thus imply that our initial estimation results are robust against existing outliers. Then, we examine if variation in data frequency could alter the decomposed risk premium estimated. It is observed that risk premia estimated from monthly and yearly data generate different estimations of decomposed risk premium, risk premium contribution of each destination differs both in terms of sign and magnitude. Hence, the estimation of risk premium by countries is varied by the lengths of return horizon. Lastly, we examine if the decomposed risk premium is changed if different assumption is drawn when calculating covariances. We alternatively estimate covariances with two components; a stock market index of China and a stock index of an export destination country, thereby assuming that risk from exports can be proxied by co-movement between Chinese stock market and an export market while interdependence to other markets is ignored. The results show that the decomposed risk premia derived from bivariate covariances are generally smaller in magnitude (either less positive or less negative) than those obtained from trivariate covariances. It could thus be considered that using bivariate covariances may result in underestimation of decomposed risk premia.

In Chapter 4, we measure volatility spillovers to Chinese stocks over different economic liberalizations taking place in China. We employ the approach of Diebold and Yilmaz (2012) to represent a volatility spillover as a percentage of volatility contribution from other sources. To construct a spillover table, given time series of volatilities of variables, a generalized forecast error variance decomposition on each variable is conducted to find shares of volatility contributed from various sources. Typically, literature that employ the method of Diebold and Yilmaz (2012) estimate time series of volatilities without concerning dynamic correlation among variables. We thus improve the estimation of volatility time series by the use of a multivariate dynamic conditional correlation generalized autoregressive conditional heteroskedasticity (DCC-GARCH) process. Accordingly, the resulting spillover tables then take into account correlation dynamics which could reflect volatility spillovers in different time period more accurately. Subsequently, we examine volatility spillovers between Chinese stocks and global stock markets which are represented by three major stock indices; S&P500 (the US), FTSE100 (the UK) and NIKKEI225 (Japan) in different liberalization episodes. In addition to examining volatility spillovers among stock markets, we also investigate volatility spillover across firm types in China by establishing separate portfolios of stocks of exporting, domestic manufacturing and domestic services firms. The liberalization events in our interest are broadly categorized as liberalizations in trade, exchange rate and stock markets. The trade liberalization in China took place when China became a membership of WTO in December 2011. The exchange rate liberalization emerged when China adopted the managed float exchange rate regime in July 2005. The stock market liberalizations are considered to have three phases; beginning with the permission for domestic investors to trade B shares (which were formerly reserved for foreign investors) in February 2001 which marked the official connection between domestic and international stock markets, followed by the launch of qualified institutional investors (QFII) program to allow foreign investors to invest in Chinese stock market and then the stock market liberalization became materialized when tight regulations for QFII was relaxed to attract even more foreign capitals to Chinese stock market.

When considering spillovers from the international stock markets to Chinese stock market, the empirical results reveal that the main source of volatility to Chinese stocks is from shocks in Chinese stock market rather than from foreign stock markets. Besides, the levels of volatility spillovers to Chinese stocks are varied in each liberalization event. Volatility spillovers to Chinese stocks are highest during the stock market liberalization events, especially when QFII restrictions are further loosened. Conversely, the lowest volatility spillovers are observed in the event of trade liberalization. In addition, when breaking down Chinese stock markets into three portfolios, the empirical results show that the main source of volatility to each portfolio is still own volatility (of each portfolio), followed by volatility spillovers from other portfolios and volatility spillovers from international stock markets. Such finding is the same to all portfolios. Comparing across economic liberalization episodes, it is found that volatility spillovers to each portfolio are different from event to event. We observe substantial contributions of volatility spillovers from the major stock markets in some cases (the launch of QFII and QFII regulations relaxation); nonetheless, volatility spillovers across portfolios still dominate. In terms of the source of volatility spillovers from international stock markets, US stock market is ranked as the top volatility transmitter to Chinese stock market.

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Appendix A

Additional Details for Chapter 2

To give a broad picture of Chinese firms, we provide information of the types of firm, we analyse information about the types of our sample firm which are exporting, importing or both and their percentage shares in each year. Statistics in Table A.1 illustrate how many firms are exporters or importers or both exporters and importers during 2000-2006. For example, during this sample period, there were in total 654 companies which are 38 exporting firms (5.8 percent), 78 importing firms (11.9 percent) while 538 companies (82.3 percent) conduct both export and import at the same time. The total number of firms reportedly involved in international trade increased from 304 firms in 2000 to 527 firms in 2006 as shown in Table A.1. 74.2 percent of these firms engaged in both exporting and importing, 10.8 percent of the firms are exporters and 15 percent of all firms are importers. We can see that most firms do the international activities engaged in both export and import. This is consistent with the work of Manova and Zhang (2009) that more than half of Chinese firms engaged in both exporting and importing.

Table A.1: Firm types.

Year	Firm Type	No. of firms	% of total
2000	Exporters	41	13.5
	Importers	54	17.8
	Both	209	68.8
20001	Exporters	56	14.7
	Importers	65	17.1
	Both	259	68.2
20002	Exporters	52	11.8
	Importers	76	17.3
	Both	311	70.8
2003	Exporters	60	11.8
	Importers	90	17.3
	Both	346	70.8
2004	Exporters	58	10.8
	Importers	101	18.8
	Both	378	70.4
2005	Exporters	60	11.3
	Importers	93	17.6
	Both	376	71.1
2006	Exporters	57	10.8
	Importers	79	15
	Both	391	74.2
2000-2006	Exporters	38	5.8
	Importers	78	11.9
	Both	538	82.3

Table A.2: WIOD industry groups and industry groups in Bloomberg.

WIOD Industry Groups	Industry Groups in Bloomberg
Agriculture, Hunting, Forestry and Fishing	Agriculture
Air Transport	Airlines
Basic Metals and Fabricated Metal	Building Materials
Basic Metals and Fabricated Metal	Hand/Machine Tools
Basic Metals and Fabricated Metal	Iron/Steel
Basic Metals and Fabricated Metal	Metal Fabricate/Hardware
Chemicals and Chemical Products	Chemicals
Coke, Refined Petroleum and Nuclear Fuel	Coal
Coke, Refined Petroleum and Nuclear Fuel	Energy-Alternate Sources
Coke, Refined Petroleum and Nuclear Fuel	Oil&Gas
Coke, Refined Petroleum and Nuclear Fuel	Oil&Gas Services
Construction	Engineering&Construction
Construction	Home Builders
Electrical and Optical Equipment	Electrical Compo&Equip
Electrical and Optical Equipment	Electronics
Electricity, Gas and Water Supply	Electric
Electricity, Gas and Water Supply	Gas
Electricity, Gas and Water Supply	Water
Financial Intermediation	Banks
Financial Intermediation	Diversified Finan Serv
Financial Intermediation	Insurance
Financial Intermediation	Private Equity
Food, Beverages and Tobacco	Beverages
Food, Beverages and Tobacco	Food
Health and Social Work	Biotechnology
Health and Social Work	Cosmetics/Personal Care
Health and Social Work	Healthcare-Products
Health and Social Work	Healthcare-Services
Hotels and Restaurants	Leisure Time
Hotels and Restaurants	Lodging
Inland Transport	Transportation
Leather, Leather and Footwear	Apparel
Machinery, Nec	Machinery-Constr&Mining
Machinery, Nec	Machinery-Diversified
Manufacturing, Nec; Recycling	Auto Manufacturers
Manufacturing, Nec; Recycling	Computers
Manufacturing, Nec; Recycling	Home Furnishings
Manufacturing, Nec; Recycling	Household Products/Wares
Manufacturing, Nec; Recycling	Housewares
Manufacturing, Nec; Recycling	Miscellaneous Manufactur
Manufacturing, Nec; Recycling	Office/Business Equip
Manufacturing, Nec; Recycling	Packaging&Containers
Manufacturing, Nec; Recycling	Pharmaceuticals
Manufacturing, Nec; Recycling	Semiconductors
Mining and Quarrying	Mining
Other Community, Social and Personal Services	Advertising
Other Community, Social and Personal Services	Commercial Services
Other Community, Social and Personal Services	Entertainment
Other Community, Social and Personal Services	Environmental Control
Other Community, Social and Personal Services	Holding Companies-Divers
Other Community, Social and Personal Services	Software
Post and Telecommunications	Internet
Post and Telecommunications	Telecommunications
Public Admin and Defence; Compulsory Social Security	Aerospace/Defense
Pulp, Paper, Paper , Printing and Publishing	Forest Products&Paper
Pulp, Paper, Paper , Printing and Publishing	Media
Real Estate Activities	Real Estate
Renting of M&Eq and Other Business Activities	Storage/Warehousing
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	Retail
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	Auto Parts&Equipment
Textiles and Textile Products	Textiles
Transport Equipment	Shipbuilding
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	Distribution/Wholesale

Appendix B

Additional Details for Chapter 4

B.1 Test of Stationarity of Raw Return Data

We perform the augmented Dickey-Fuller test on four weekly market-value-weighted return series of Chinese listed companies and four daily return series of major stock indices. All the return series cover the period of January 1997 to December 2014. Each dataset contains 924 observations. The objective of the test is to investigate if the return series follow a unit-root process. The null hypothesis is that each return series contains a unit root, and the alternative is that it is generated by a stationary process.

Table B.1: Results from the augmented Dickey-Fuller test at lagged difference of 10.

	Test Statistic	Interpolated Dickey-Fuller		
		1% critical value	5% critical value	10% critical value
all firms	-8.025	-3.96	-3.41	-3.12
exporters	-7.658	-3.96	-3.41	-3.12
domestic manufacturers	-7.919	-3.96	-3.41	-3.12
domestic service	-8.311	-3.96	-3.41	-3.12
S&P500	-9.499	-3.96	-3.41	-3.12
FTSE100	-9.981	-3.96	-3.41	-3.12
NIKKEI225	-9.013	-3.96	-3.41	-3.12

Table B.1 displays the test resulting test statistics of the augmented Dickey-Fuller[1] regression with the number of lagged difference of 10. The results suggest that we can reject the null hypothesis of a unit root on all return time series at all common significance levels. In addition, experiments conducted with fewer or more lags in the augmented regression also yield the same conclusion.

B.2 Test of Serial Correlation

After obtaining estimation results of the univariate GARCH model on the return series, we perform the weighted Ljung-Box test to check if standardized squared residuals of each fitted GARCH model exhibit a serial correlation.

[1]The Dickey-Fuller test statistic is not normally distributed. A Critical value for any sample size T can be approximated by using interpolation formulas in Banerjee et al. (1993). The critical values reported in this table are linearly interpolated based on the tables in Fuller (1996).

Table B.2: Results from the weighted Ljung-Box test on standardized squared residuals at 12 and 14 lags.

Test	all firms	exporters	domestic manufacturers	domestic service
lags = 12	0.22(0.99)	1.84(0.66)	0.32(0.98)	0.19(0.99)
lags = 24	1.41(0.96)	3.36(0.69)	1.65(0.94)	1.28(0.97)

Notes: p-values are displayed in parentheses.

The test results from Table 2 indicate that the standardized squared residuals from fitting a GARCH model on each time series do not have a serial correlation. Also, the conclusions remain the same when perform a test at fewer or more lags.

B.3 Estimation Results of The GARCH(1,1) Model

Figure B.1: Estimation results of the GARCH(1,1) model.

Parameters	All firms	Exporters	Domestic manufacturers	Domestic services
μ	-0.082***	-0.257***	-0.306***	-0.125***
a_1	0.557***	0.945***	0.743***	-0.939***
b_1	-0.544***	-0.932***	-0.711***	0.938***
ω	0.087***	0.121***	0.159***	0.102***
α_1	-0.007*	-0.038**	-0.056***	-0.004*
β_1	0.961***	0.948***	0.937***	0.954***

Notes: * p<0.1; ** p<0.05; *** p<0.01.

B.4 Constructing Conditional Mean and Conditional Variance Using a Univariate GARCH Model

Given a univariate time series r_t denoting a logarithmic stock return ($log(r_t) - log(r_{t-1})$) at time t, its conditional mean can be described by the following equation:

$$r_t = E\left[r_t|\Omega_{t-1}\right] + \varepsilon_t \quad \text{(B.1)}$$

where $E\left[.|.\right]$ is the conditional expectation operator, Ω_{t-1} denotes the information set up to time $t-1$ and ε_t is the innovations or residuals of the time series representing the uncorrelated random disturbances with zero mean (white noise).

B.4.1 ARMA Mean Equation

In our study, we employ the ARMA process to model the mean equation whereby the innovations are modelled by GARCH process. The ARMA(m,n) process of autoregressive order m and moving average order n can be described as

$$r_t = \mu + \sum_{i=1}^{m} a_i r_{t-i} + \sum_{j=1}^{n} b_j \varepsilon_{t-j} + \varepsilon_t \quad \text{(B.2)}$$

where μ is a constant. If $n = 0$, equation (B.2) turns to an autoregressive process, AR(m) and if $m = 0$, it is a moving average process, MA(n).

B.4.2 GARCH Variance Equation

The mean equation presented earlier cannot capture heteroskedastic effects of time series typically observed in form of, for instance, fat tails, volatility clustering and leverage effect. Consequently, Engle (1982) introduces the Autoregressive Conditional Heteroskedastic model (ARCH) which is later generalized by Bollerslev (1986) to Generalized Autoregressive Conditional Heteroskedastic model (GARCH).

Engle (1982) redefines the innovation ε_t in the ARMA mean equation (B.2) as an autoregressive conditional heteroskedastic process where ε_t is of the following form:

$$\varepsilon_t = z_t \sqrt{h_t} \tag{B.3}$$

where $z_t \sim D_\varphi(0,1)$ is an i.i.d. process of the innovations under the probability density function D_φ with zero mean and unit variance and $\sqrt{h_t}$ is the conditional volatility of $\varepsilon_t$which is time-varying. Optionally, φ is additional distributional parameters to describe the skew and the shape of the distribution.

The variance equation of the univariate GARCH(p,q) model can be expressed as

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j h_{t-j} \tag{B.4}$$

If all the coefficients β are zero, the GARCH model in equation (B.4) is reduced to the ARCH model.

B.5 Modelling Multivariate Conditional Volatilities Using a DCC-GARCH model

Spillover tables and spillover indices can determine how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. The variables applicable are a time series of return and a time series of return volatility.

The DCC-GARCH belongs to the class "Models of conditional variances and correlations". It was introduced by Engle and Sheppard (2001). The idea of the models in this class is that the covariance matrix (h_t) can be decomposed into conditional standard deviations, D_t and a correlation matrix (R_t). In the DCC-GARCH model both D_t and R_t are designed to be time-varying. The DCC-GARCH model is formally defined as:

$$\begin{aligned} r_t &= \mu_t + \varepsilon_t, \\ \varepsilon_t &= H_t^{1/2} z_t, \\ H_t &= D_t R_t D_t \end{aligned} \tag{B.5}$$

where

r_t $N \times 1$ vector of log returns of N variables at time t .

ε_t $N \times 1$ vector of innovations of N variables at time t with $E[\varepsilon_t] = 0$ and $Cov[\varepsilon_t] = H_t$.

μ_t $N \times 1$ vector of an expected value of r_t at time t .

H_t $N \times N$ matrix of conditional variances of ε_t at time t.

$H_t^{1/2}$ $N \times N$ matrix at time t such that H_t is the conditional variance matrix of ε_t.

$H_t^{1/2}$ can be obtained by a Cholesky factorization of H_t.

D_t $N \times N$ diagonal matrix of conditional standard deviations of ε_t at time t.

R_t $N \times N$ conditional correlation matrix of ε_t at time t.

z_t $N \times 1$ vector of standardized innovations where $z_t = D_t^{-1}\varepsilon_t$.

Elements in the diagonal matrix (D_t) are squared root of conditional variance (standard deviation) from univariate GARCH models as defined in equation (B.4), specifically,

$$D_t = \begin{bmatrix} \sqrt{h_{1t}} & 0 & \dots & 0 \\ 0 & \sqrt{h_{2t}} & \dots & \vdots \\ \vdots & \vdots & \ddots & 0 \\ 0 & \dots & 0 & \sqrt{h_{Nt}} \end{bmatrix} \tag{B.6}$$

where $h_{nt} = \omega_n + \sum_{i=1}^{p} \alpha_{ni}\varepsilon^2_{n,t-i} + \sum_{j=1}^{q} \beta_{nj}h_{n,t-j}$ for all $n = 1,...,N$. Note that a specification of a univariate GARCH models is not limited to the standard univariate GARCH(p,q) but can include any other variants of GARCH processes. However, for our case, only the standard univariate GARCH(p,q) is considered.

For a conditional variance matrix (H_t), since a correlation matrix (R_t) is of the form:

$$R_t = \begin{bmatrix} 1 & \rho_{12,t} & \rho_{13,t} & \cdots & \rho_{1N,t} \\ \rho_{12,t} & 1 & \rho_{23,t} & \cdots & \rho_{2N,t} \\ \rho_{13,t} & \rho_{23,t} & 1 & \vdots & \vdots \\ \vdots & \vdots & \dots & \ddots & \rho_{N-1N,t} \\ \rho_{1N,t} & \rho_{2N,t} & \dots & \rho_{N-1N,t} & 1 \end{bmatrix} \tag{B.7}$$

and R_t is symmetric. Therefore, elements of $H_t = D_tR_tD_t$ can be expressed as $[H_t]_{nm} =$

$\rho_{nm}\sqrt{h_{nt}h_{mt}}$ with $\rho_{nn} = 1$ where n and m are row and column indices, respectively. When specifying a form of R_t two requirements have to be considered:

1. H_t has to be positive definite because it is a covariance matrix. To ensure H_t to be positive definite, R_t has to be positive definite (D_t is positive definite since all the diagonal elements are positive).

2. All the elements in the correlation matrix (R_t) have to be equal to or less than one by definition.

To ensure both of these requirements in the DCC-GARCH model, R_t is decomposed into:

$$\begin{aligned} R_t &= Q_t^* Q_t Q_t^{*-1} \\ Q_t &= (1-a-b)\overline{Q} + a z_{t-1} z_{t-1}^T + b Q_{t-1} \end{aligned} \tag{B.8}$$

where $\overline{Q} = Cov\left[z_t z_t^T\right] = E\left[z_t z_t^T\right]$ is the unconditional covariance matrix of the standardized errors z_t which can be estimated as $\overline{Q} = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_t \varepsilon_t^T$ and Q_t^* is a diagonal matrix with the square root of the diagonal element of Q_t at the diagonal,

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11t}} & 0 & \dots & 0 \\ 0 & \sqrt{q_{22}} & \dots & \vdots \\ \vdots & \vdots & \ddots & 0 \\ 0 & \dots & 0 & \sqrt{q_{NNt}} \end{bmatrix} \tag{B.9}$$

Q_t^*rescales the elements in Q_t to ensure that $|\rho_{nm}| = |\frac{q_{nm,t}}{\sqrt{q_{nn,t}q_{mm,t}}}| \leq 1$. Additionally, Q_t has to be positive definite to assure R_t to be positive definite. There also requires that, in equation (B.8), $a \geq 0$,$b \geq 0$ and $a+b < 1$to guarantee H_t to be positive definite.

B.6 Background of Economic Liberalizations in China

B.6.1 Stock Market Liberalization

The first stock market in the history of the People's Republic of China, Shanghai Stock Exchange, opened on 26 November, 1990. On 11 April, 1991, Shenzhen Stock Exchange opened. Initially only one class of shares, the public A-shares were allowed to trade on exchanges. In 1992, the B share is created for foreign investors. The A-shares are domestic ordinary shares denominated and traded in Renminbi by Chinese citizens only. The B shares are ordinary shares denominated in Chinese Yuan but traded in foreign currencies. The main differences are that B shares are restricted to foreign investors (before 19 February, 2001), and that price quotes and dividend payments are in foreign currency. The A and B share markets were completely segmented until 19 February, 2001. Since then, China Securities Regulatory Commission allowed domestic investors to purchase B shares with certain conditions. Domestic investors need to open a bank account for trading B shares and foreign currencies used in trading are required to be transferred from foreign banks. China launched the Qualified Foreign Institutional Investor (QFII) scheme in November 2002 after the China Securities Regulatory Commission (CSRC) and the People's Bank of China (PBOC) jointly issued the Provisional Measures on the Administration of Domestic Securities Investments by Qualified Foreign Institutional Investors on 5 November 2002, which came into force on 1 December 2002. As a transitional arrangement given that RMB is not fully convertible under the capital account, the QFII scheme allows authorised foreign institutional investors to invest in and trade on the Chinese securities market. Under the QFII scheme, foreign investors may invest in 'A' shares, bonds and warrants listed on China's domestic stock exchanges, securities investment funds and other instruments permitted by CSRC. A QFII must entrust a domestic commercial bank as the custodian of its assets, and entrust a domestic securities company for its domestic securities trading. The scheme allows a single QFII to hold up to 10 per cent of the 'A' shares in one listed company while the total foreign shareholding held by a QFII in any one listed company should not exceed 20 per cent. The minimum investment quota applied to a single QFII investment is US$50 million as required by the CSRC and the state administration of foreign exchange (SAFE). The accumulated investment quota for a single QFII is currently capped at US$1 billion. SAFE may adjust the above-mentioned investment limits according to the economic and capital market situation, the demand and supply for foreign exchange and the balance of international payments. The first QFII entered to China's capital market was UBS Warburg on 9 July 2003 and only four stocks were purchased. This, however, symbolizes the official entry of foreign institutional investors to Chinese stock exchanges. After the first three years of strict trading quantity control, on 24 August 2006 the government's approval on QFIIs were remarkably relaxed. There were 18 more QFIIs approved in 2006 alone and by the end of September 2013, there were 239 foreign institutions hold the status of QFII.

B.6.2 Trade Liberalization

China's authorities first announced their plans to become a member of the general agreement on tariffs and trade (GATT), later known as the world trade organization (WTO), in 1986. However, due to the consequences of the membership's conditions, further negotiations are postponed until 1992. In 1988, the government diminished the role of the central government and its authorities in China's trade sector of private firms and state-owned enterprises (SOEs). From this point in time, the nation's trade policy became more lenient and is decentralized to local governments. China's negotiations to join the WTO resulted in a number of trade liberalization measures: the elimination of two-thirds of China's import licensing requirements by the end of 1994 and the liberalization of other non-tariff measures such as the removal of all import restrictions and licensing requirements, quotas and other controls on a wide range of products by 1997 and the creation of a more transparent trade system. By the end of the year, tariffs on 53 percent of all dutiable products had been reduced by an average of 7.3 percent, Jaggi et al. (1996). In 1995, China intensified its WTO accession campaign by showing some flexibility on reducing trading rights requirements, export rebates and a number of other trade restrictions. Later in the same year, China reduced tariffs of another 4,000 items and cut tariffs by an average 30 percent. However, some of the reductions in tariffs were offset by increases in taxes on imported products, Jaggi et al. (1996). In December 2001, after 15 years of continual negotiations, China obtained its WTO membership. As a result, China's leaders agreed upon a list of commitments aimed at further reduced trade barriers with other WTO members, Adhikari and Yang (2002). China was to make all tariffs on agricultural items binding and reduce them from an average of 32 to 17 percent. Moreover, all export subsidies on agricultural products were to be eliminated and the volumes of tariff-rate quotes on agricultural imports would be increased rapidly. In-quota tariffs would be reduced to 1-3 percent, while above-quota tariffs for crucial produce, such as grain, would be reduced from 80 to 65 percent – comparable to those in the EU and other Northeast Asian countries. For industrial products, China was to terminate quantitative restrictions still in place and by 2005 the average tariff would be reduced from 25 to 9 percent. Furthermore, all tariffs on information technology products were promised to be eliminated by 2005 and all service sector restrictions concerning foreign enterprises in the areas of licensing, equity participation, geographical location, business scope and operations would either be relaxed or removed in the near future. Finally, China assured to grant access to a large number of key industries, such as telecommunications, financial industries and distribution, for foreign firms. Overall, China's WTO accession forced its authorities to push for an extensive liberalization of trade restrictions across the board. Aside from accommodating market access to other WTO members, China's commitments upon accessing the WTO also involved increasing the transparency of its trade and investment policies. Furthermore, China's authorities promised to eliminate all subsidies prohibited by the WTO, including subsidies to SOEs, Adhikari and Yang (2002).

B.6.3 Exchange Rate Liberalization

China's exchange rate reform started with the introduction of a foreign exchange retention system in 1979. This enabled government controlled trading firms to retain certain quotas of their foreign exchange proceeds and to trade unused remaining quantities of their quotas among other trading firms. In order to stimulate the export sector, the authorities introduced a dual exchange rate system. A devalued settlement rate of CNY 2.8 against the dollar was applied to trade transactions, while the official dollar exchange rate stood at CNY 1.5 per USD. In the ensuing years, a number of currency devaluations brought the official exchange rate down to CNY 2.8 per USD. Consequently, a unified exchange was established by the end of 1984, Jaggi et al. (1996). In 1985, the Chinese authorities opened the foreign exchange swap centers in China's special economic zones that provide trading in foreign exchange retention quotas. Foreign funded enterprises were allowed to trade actual foreign currency here starting in 1986 at fixed rates set by the authorities. After continuous devaluations, the value of CNY to USD reduced from 4.73 in January 1990, to 8.72 in 1994. In 1997, China then raised the value of the yuan and announced a long-term peg to the dollar at CNY 8.28 per USD, Guijun and Schramm (2003). The series of currency devaluation, however, caused China being accused by its major trading partners of manipulating its currency by keeping the yuan artificially low. In consequence, in July 2005, the Chinese government announced that it would abandon its dollar peg regime. The yuan was revalued by 2 percent from 8.28 to 8.11 yuan to the dollar. Furthermore, the PBOC called for an improvement of the exchange rate regime with greater flexibility of the Renminbi. The peg to the dollar was officially abandoned and replaced by, according to the PBOC in 2005, a managed floating exchange rate based on market supply and demand with reference to a basket of currencies, the content of which would be adopted from the viewpoint of China's trade composition.

The PBOC would use the closing price of the CNY in the interbank foreign exchange market and make it the central parity for trading the following day. The CNY would be allowed to float within a band of 0.3 percent around the central parity rate against the dollar, while the trading band against other currencies in the basket was to be a maximum of 1.5 percent – the latter being adjusted several months later to 3 percent. Adjustment of the width of the CNY trading band would be conducted when necessary according to market development as well as the economic and financial situation.