Master Thesis Paper

The effect of foreign exchange volatility on trade: evidence from China

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Declaration

I hereby make a declaration that the thesis, which is submitted to the University of the Witwatersrand (Wits Business School) for examination in consideration of the award of a higher degree of Master of Management in Finance and Investment is my own personal effort. Where any of the content presented is the result of input or data from a related collaborative research program this is duly acknowledged in the text such that it is possible to ascertain how much of the work is my own. I have not already obtained a degree from the University or elsewhere on the basis of this work. Furthermore, I took reasonable care to ensure that the work is original, and, to the best of my knowledge, does not breach copyright law, and has not been taken from other sources except where such work has been cited and acknowledged within the text.

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Abstract

Does the volatility of the Renminbi (RMB) have any significant impact on China's trade? This fundamental question has garnered considerable debate in both the academic and financial circles. The recent "currency wars" amongst larger economies has further fueled the question. Using a number of econometric methods, this research dissects the heart of the effect of the volatility of exchange rate on trade. The research makes crucial findings to provide an affirmative response to the central question posed. In line with most theoretical and empirical studies, the study found that volatility of exchange rate has a positive impact on trade by boosting exports and reducing imports. The appreciation of the RMB has tended to lead to a decrease in China's global competitiveness, and often suppresses growth. The research provides an important insight on how Chinese monetary authorities can maintain the managed pegged currency system while simultaneously expanding economic growth.

Key words: Exchange rate volatility; trade balance; imports; exports; causality; appreciation; depreciation.

Chapter 1. Introduction

1.1 Project context

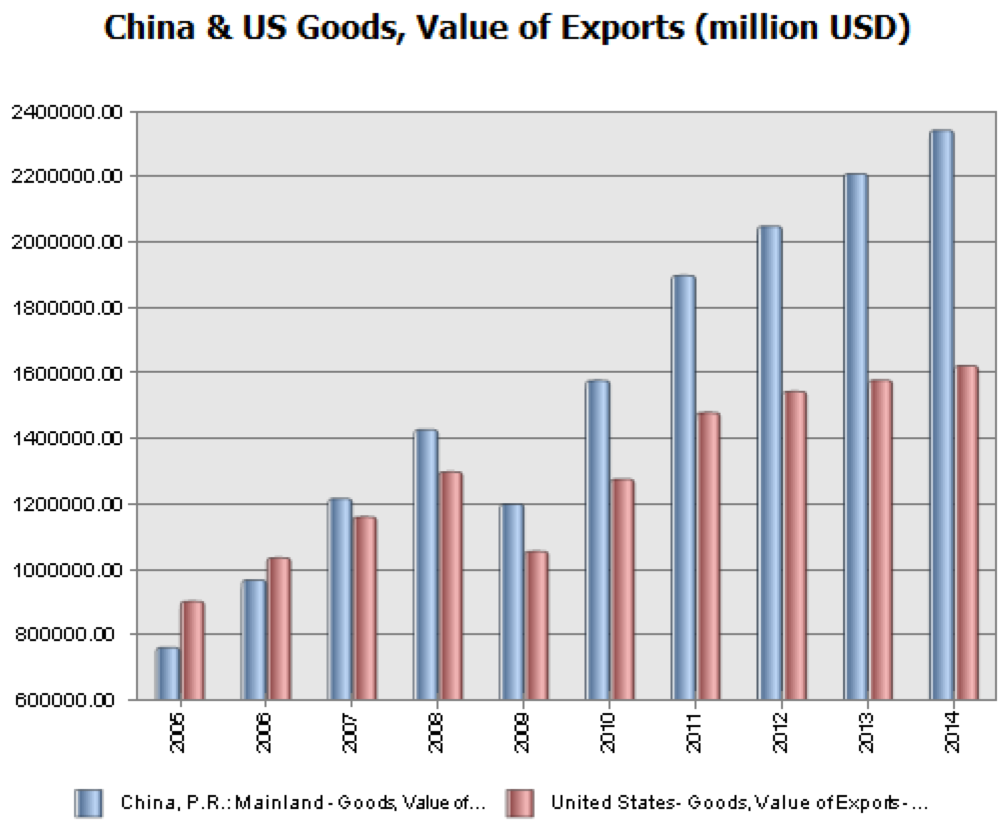
Continuous and stable trade development is an important guarantee of external equilibrium and economic growth. The exchange rate is a fundamental and imperative barometer for measuring the international competitiveness of a country, and hence trade position. Therefore, how to coordinate the relationship between exchange rate and import-export trade has always been a widespread research topic, and deserves the attention of policy makers around the world. According to Stonebraker (2013) currency appreciation would lead to decrease in the price of import products and increase the price of export products, hence the competitiveness of a country's export product can be weakened in the international trade market.

With the rapid development of the world economy and increasing international trade, the impact of exchange rate volatility has become an outstanding issue on international trade. The study of the effect of foreign exchange volatility on trade is helpful and meaningful for both economic policymakers and export firms, in order to reduce the risk of exchange rate volatility. However, most previous studies focused on the impact of the US dollar on international trade performance have not paid close attention to how movements in the Renminbi (RMB) affect China's trade. Given the increasing importance of China in world commerce, and the rising prominence of the

RMB, especially in the light of recent attempts to allow some adjustments to occur, a research of the effect of the exchange rate movements on trade for China would be useful to guide policy and academic and practitioner research. This dissertation is an attempt to fill this gap.

China has been chosen as the empirical case because of the RMB/ US dollar exchange rate has raised a number of global policy concerns lately. China is the major economy country with a highest growth rate of trade and higher export rate in the world, which leading to the obviously exposure of exchange rate volatility. Figure 1 indicates how fast China's exports grew in comparison with United State. As can be seen from Figure 1 Chinese exports lagged behind the United States in 2005 and 2006. However as from 2007 China begun to experience strong export growth, overtaking the United States. The graph shows that this upward trend in Chinese exports has continued throughout most of the recent period, showing the role of China in producing most of the goods consumed by the world in modern history.

Figure 1: China & US Goods, value of exports (million USD), 2005-2014



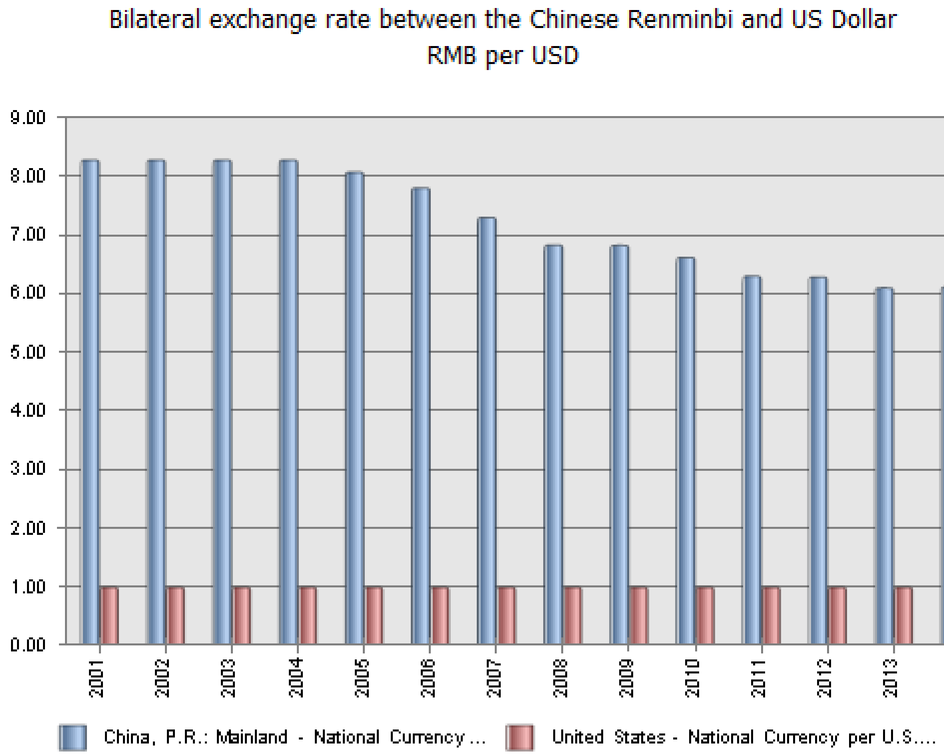
Source: International Monetary Fund (IMF), IMF eLibrary Data, Direction of Trade Statistics (DOTS)

1.2 Problem statement

Since the collapse of the Bretton Woods System in 1973, most of countries adopted more flexible exchange rate regimes. For a long time debate between fixed and flexible exchange regime and the impact with regard to the volatility of foreign exchange on the trade balance has become another unavoidable topic. The economists who supported fixed exchange regime they have indicated that the adoption of flexible exchange regime will lead to the contraction of trade volume and the reduction of profits (Brada & Mendez, 1988). However for those economists who supported fixed exchange regime they have indicated that for the enhancement and development of international trade flexible exchange regime is better than fixed exchange rates. This is because the floating exchange rate is important for a country to achieve external equilibrium without some forms of foreign exchange market intervention.

Since 1994 China adopted a fixed exchange rate of the RMB against the US dollar. According to Chang & Parker (2004), with China's extraordinary economic progress as well as increasing current account surplus of current account, many trading partners believed that the RMB was undervalued, with many authors urging Chinese government to revalue the RMB. This view has also been supported and advanced by Funke and Rahn (2005). By 21st July 2005, China announced to appreciate the RMB by 2.1% and to adopt a regulated system whereby the value of the currency would be allowed to float and to a limited extent determined by the forces of demand and supply. (Baak, 2008). Figure 2 illustrates the RMB/ US dollar exchange rate before and after July 2005 China exchange rate reform. Since then the RMB has appreciated steadily for a long time, but so far, the expansion of China's foreign trade surplus has not been curbed.

Figure 2: RMB/ US dollar exchange rate from 2001 to 2014



Source: International Monetary Fund (IMF), IMF eLibrary Data, International Financial Statistics (IFS)

1.3 Research Questions

This unusual phenomenon of a managed floating exchange rate vis-a-vis growing trade volumes poses a quandary for international economics and it is the subject matter of this dissertation. The following questions are interrogated in the dissertation:

- To what extent is China's export and import trade influenced by movements in the RMB exchange rate?
- What key reforms drive the RMB exchange rate mechanism?
- What is the impact of trade volume on China's growth and vice versa?

1.4 Objective of the research

The objective of this research is to attempt to answer the above questions to further analyze weaknesses and the problems, which need to be solved with regard to the relationship of China's exchange rate regime and its dealing in foreign trade of goods and services. In order to investigate the effect of RMB's exchange rate volatility on China's trade.

The outcome of this study will give insight into current exchange rate regime, and the relationship of exchange rate regime and foreign trade, able to improve trade balance and to be the useful reference of future exchange rate regime.

1.5 Brief Literature Review

In fact, the appreciation of a country's currency is beneficial for a country to expand its imports and curb exports, consequently improve its import-export trade. Previously, many scholars have taken a different index to estimate the exchange rate, however the real exchange rate is most effective and objective to reflect the actual situation of an exchange rate of a particular country. On the issues of the patterns between the real foreign exchange rate and the balance of trade, there are many existing literature.

Arize (2000) base on the research of thirteen developing countries found that the volatility exchange rate has a critical inverse impact on exports of a country. Chou

(2000) analyzed the volatility of the exchange rate in terms of how it impacted on China's multilateral trade and sectoral trade from 1981 to 1996. The results were found that the volatility of the exchange rate has a detrimental effect on exports for China, mining as well as manufacturing, and has positive effects on the country's manufactured goods. Hericourt & Poncet (2013) has confirmed that the volatility of the exchange rate has an influence on the trade and deterring China's exporters, but may imply that this influence to a large extend is still caused by the nature of the financially related constraints in China. Marquez & Schindler (2006) estimated the effect of a real exchange rate appreciation on China trade by apply least squares, the estimation results were found that in early 1990 RMB exchange rate volatility lead to a deterioration of China imports; and a ten percent real appreciation of RMB will lead to a half of a percentage point reduction of the share of China exports. Simultaneously the appreciation reduced the share of China imports by a tenth of a percentage point.

Miles (1979) early investigated the statistical relationship between fourteen counties' currency depreciation and trade balance, evidence shows that depreciation will not change trade balance, only lead to the change of ratio between currency and debt in the portfolio, does not cause the change of the Value of the portfolio. Pan (2006) by use empirical analysis of standard deviation between RMB and JPY exchange rate for the last 12 months to measure the exchange rate fluctuation, to analyze the effect of exchange rate volatility between RMB and JPY on exports from China to Japan. Johansen cointegration results reveal a cointegrating equilibrium relationship between exports and fluctuations in the exchange rate. Results based on Impulse response functions of the Granger Causality indicate that there is short-term significant impact between real exchange rate and trade balance, exports growth rate increased after two month exchange rate fluctuation, exports growth rate decreased after three month exchange rate fluctuation, the influence disappeared after four month exchange rate fluctuation.

1.6 Overview of methodology

This study is based on relevant international economic theory to consider and study the relationship between trade and the exchange. The data used in this study ranges from 1981 to 2014. The GRETL and Eviews 7 software are used to estimate the econometric models. Begin with the construction of GARCH model, the introduction of ML condition; and various time series models, such as Unit root test, co-integrated VAR model and vector auto-regression models are used in this study. Granger causality test is carried out to empirically analyze the RMB exchange rate and China's import and export trade. The methodology can be summarized as follows:

GARCH model is used to estimate the impact of the RMB's volatility on trade, elasticity theory is used to establish co-integration equation, in order to test the Marshall and Lerner (ML) condition. A Vector auto-regression model is estimated. A multivariate to Johansen cointegration econometrics method is often applied to inspect relationship between among the variables of interest for a possibility of long run relationship. The long and short run relationship between trade and exchange rates is examined.

1.7 Significance of study

The exchange rate, which is an important variable to the macro economy of a country, has a special important influence on the economic operation in an open economy. Hence, to accurately evaluate the effect of exchange rate system is the premise to improve exchange rate regime and function better. To clearly understand the current exchange rate regime, the relationship between exchange rate behavior and foreign trade is of great significance in promoting trade balance improvements through the real exchange rate style of management and the development of an economy.

1.8 Research report outline

The rest of the report is organized in the following way:

Chapter 1 is the introduction part, which mainly introduced the project context, research objectives, brief review of previous study, the significance of this study, and brief description of the research methodology.

The second chapter is the detailed review of previous study for relevant issues. The chapter briefly describes the RMB exchange rate as at present state and the import-export trade for China. Given the focus of this report the definition and measurement real RMB is conducted so as to understand effective exchange rate better.

The third chapter, firstly introduces the GARCH model, follow by the theoretical hypothesis of the ML condition. Various econometric tests will also be conducted to find out whether there is any long term relationship between the RMB and Chinese trade patterns; the error correction model to estimate how equilibrium between relative variables is reestablished after there has been shocks in the economy.

The forth chapter bases on chapter 3 to conduct econometric analysis on how the RMB exchange rate volatility affects China's total trade volume, and the effect on long-term and short-term equilibrium.

The last chapter is the conclusion part. Based on the findings of the preceding chapters the study then provide suggestions on future RMB exchange rate reform, China import and export trade.

Chapter 2. Literature Review

2.1 Introduction

The relationship between exchange rate volatility and trade are ambiguous and complicated, thus a careful study of the effect of exchange rate volatility on China's trade is warranted. A good understanding of China's current exchange rate regime and its effect on trade balance is necessary to study the effect of exchange rate volatility on trade thoroughly. This chapter reviews the literature on the relationship between exchange rate volatility and trade. The rest of the chapter is organized in the following manner: Section 2.2 discusses China's exchange rate regime. In section 2.3 we study the effect of the volatility of exchange rate on the trade before examining the volatility of China's RMB and how it affects trade.

2.2 China's exchange rate regime

2.2.1 The classification of the China's exchange rate regime

According to statistic, from 1994 China established the exchange rate system, which refers to the managed floating exchange rate system on the basis of market's supply and demand, and peg to the US dollar. After 2005 currency reforms in China, gradually abandoned the US dollar-pegged exchange rate system, suggests the maximum extent and pace the Chinese might allow the RMB to appreciate, and then enhanced exchange rate flexibility (Qin et al. 2014). Table 1 states RMB exchange rate classification for the past decade and the way moving away from the US dollar-pegged.

Table 1: RMB exchange rate classification from 2002 to 2014

Year	RMB Exchange Rate Regime Classification
Ends Apr.30,2002	Traditional Pegged Exchange Rate Regime
Ends Jan.31,2003	Traditional Pegged Exchange Rate Regime
Ends May.31,2004	Traditional Pegged Exchange Rate Regime
Ends Jul.31,2005	Traditional Pegged Exchange Rate Regime
Ends Jan.31,2006	Traditional Pegged Exchange Rate Regime
Ends Feb.28,2007	Crawling Pegged Exchange Rate Regime
Ends Mar.31,2008	Stabilizing Exchange Rate Regime
Ends Dec.31,2009	Stabilizing Exchange Rate Regime
Ends Jan.31,2011	Crawl-like Exchange Rate Regime
Ends Dec.31,2011	Crawl-like Exchange Rate Regime
Ends Apr.30,2013	Crawl-like Exchange Rate Regime
Ends Dec.31,2014	Crawl-like Exchange Rate Regime

Source: International Monetary Fund (IMF): Exchange Arrangements and Exchange Restriction (2015)

For countries that have their own currencies, there are seven different exchange rate regimes as the followings.

1. Board of Currency Arrangements: this refers to categorical obligation to exchange a locally denominated fund for a particular international currency that is fixed at a predetermined exchange rate.
2. Orthodox fixed peg systems: this system refers to countries that peg their currencies to between -1 or 1 percent margin against the trading partner’s currency.
3. Target zone pegged system: a wider permitted fluctuation compared to conventional fixed peg arrangement.

4. Currency arrangements through a crawling peg system: under this system, the currency is usually adjusted occasionally against the exchange rate of the country of interest.
5. Crawling bands management system: when using this system, the length of the bands that tracks tolerable levels of currency is allowed to increases over the time period.
6. Floating exchange rate regime: this is another currency management method whereby monetary officials will attempt to effect the exchange rate level.

Since 1978, China started economic reform by recognizing privatization, opening domestic markets and offering some freedom to make economic decision for non-sovereign owned corporates and individuals. China economy had experienced a very fast growth until 10 years ago when China economy met a bottle neck. One of biggest drivers for China’s growth was export. However, due to the pegged exchange rate regime, all foreign currencies earned by domestic enterprises and firms must be sold at a fixed rate to China’s central bank. At the beginning of economic reform, China’s government did not have enough foreign currency reserve and the RMB did not supply enough and circulate enough in the economy, the disadvantage of the pegged FX system did not emerge. However, on the one hand, after approximate 30 years’ current account surplus, China’s foreign currency reserve swelled quickly, the RMB were over supplied due to settlement by the People’s Bank of China for foreign funds. As a result, the domestic inflation pressure was high; on the other hand, due to 30 years’ real GDP growth, RMB faced a pressure to appreciate. In 2005, China finally gave up the traditional pegged FX regime and introduced crawling peg arrangement to shrink the current account surplus and encourage domestic demand

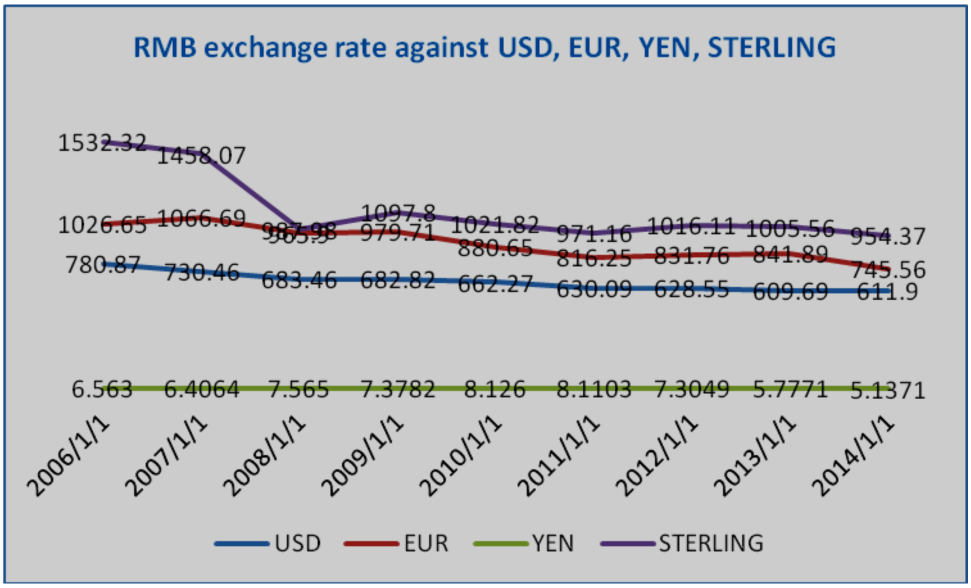
and overseas investments. Once the pegged system loosed, the trend could not reverse. As China's GDP continues to grow and exceeds Canada, France, Germany and Japan, its FX system is more tending to market determination approach. From 2005 to present, RMB has appreciated a quarter. In 2015, in order to be selected as a composite of SDR by IMF, China vows more reform on its FX policy and system.

2.2.2 A basket of currencies and exchange rate regimes

There are two elements of a basket of a foreign currency, one is the component currency, and the other one is the weight of each of component currencies in the basket. In July 2005 China put in place a managed floating exchange rate regime, based on market supply and demand with reference to a basket of currencies, allowing the RMB to fluctuate 0.3 percent above and below in two-sided currency at any particular day. Since then the exchange rate regime in China has transformed from the single currency pegging to a basket currency pegging.

Zhou Xiaochuan, who is Central Bank Governor for China stated that the US dollar, the EURO, the Japan Yen, and the Korean Won are the major currencies in the basket, and they are labeled as the first-tier currencies in the basket (Frankel & Wei, 2007). In addition, Singaporean dollar, British pound sterling, Malaysia ringgit, Australian dollar, Canadian dollar, Russian ruble and Thai baht are labeled as the second-tier currencies in RMB basket. Although the weight of the US dollar is the largest, its importance is reducing steadily. However the frequency of weights adjustment of each component currency was not clear stated (Cui, 2014). Perhaps it will depend on the macro economic conditions of the region. Ma and McCauley (2011) investigated evolving RMB exchange rate regime by using RMB real effective exchange rate index from June 1, 2006 to May 30, 2010. The authors through econometric models and graphical analysis found that the RMB has appreciated progressively against the basket of currencies who are major trading partners for China. The main reason of the RMB appreciation is related to the external trade imbalance, in terms of the massive trade surplus. Figure 3 shows that how the RMB appreciate against some of the important currencies in the basket after 2005 exchange rate regime reform, such as the US dollar, EURO, Japanese Yen and British Sterling.

Figure 3: RMB exchange rate against some of the currency in the basket from 2006 to 2014



Source: State Administration of Foreign Exchange

2.3 The impact of China's foreign exchange rate regime on trade balance

2.3.1 The impact of different exchange rate regime on the trade balance

before 2005

Before July 2005, most of the researches were focusing on the necessity for currency reforms, and the possibility of solving the issue of China's trade imbalance with developing countries, e.g. the United State through the RMB exchange rate reform. From 1998 to 2005 before China exchange rate reform RMB/USD exchange rate fluctuation in a sideways around 8.27, which make sense to outside that China adopted fixed exchange rate of single peg to the US dollar (Reiman & Greenspan, 2009). Yu (2003) indicated that the US dollar pegged exchange rate regime and the double surplus of payment balance will bring great negative effects to China's monetary policy. Along with increasing surplus and foreign reserve, possibly lead to the fluctuations of money supply, which impact the economy stability, Xu (2003) considered that China's continuous increasing of the surplus in the balance of payments to be the major cause of the RMB appreciation pressure. To remain the same RMB's exchange rate, the China's government has to intervene into foreign market heavily. With respect to the balance of payment, the negative effect of easing monetary and fiscal policy is much bigger than adjusting exchange rate. On the other hand, He (2003) and other scholars hold the different opinion of the appreciation of the RMB, they indicated that the appreciation of the RMB will not improve China's economic condition with its trade partners, and the imbalance of payment is the structural problems, cannot be solved by the appreciation of the RMB. Yin and Yu (2004) conducted empirical analysis by using the trade data between China and Japan, the results showed that the currency trading rate is not the chief aspect of trade balance, effectively implying that the RMB appreciation is not the effective way to adjust trade imbalance between China and developed countries.

2.3.2 How China's foreign exchange rate regime affected trade balance post 2005

After the reform which allowed for a certain degree of flexibility in the exchange rate, most of the studies were focusing on the effect of exchange rate regime reform on trade balance. Kamada & Takagawa (2005) established macro-economy model to test the effect of the RMB appreciation, assume that a 10% rise in RMB, there is a larger progress in both imports by China and exports of the trading partners. Marquez & Schindler (2006) conducted an analysis of the relationship between the two variables, namely the import-export trade and the RMB real effective exchange rate. The results showed that 10% appreciation will lead to share of export lower by 0.5 percent , import share lower by about 0.1%, therefore the appreciation of RMB has adverse effect on both import and export trade. Gong (2006) according to import-export data from July 2005 to December 2005, investigated the effect of the RMB exchange rate reform on China's trade. The results showed that the appreciation of the RMB has slowed down the growth of export and speed up the growth of import at the same time. However, Li and Jiang (2007) argued that, on the one hand, the smaller appreciation range will limit the effect on balance of payment; on the other hand, foreign direct investment will not be reduced by the appreciating the RMB due to Chinese more competitive investment policy, cheaper resources and labor cost, and the huge market potential. Therefore, the pressure of increasing surplus couldn't be improved. He, Yu and Shao (2011) showed that RMB exchange rate adjustment has inverse effect on

China’s trade balance; the appreciation of RMB had “negative J curve effect” on trade balance. Xing (2012) based on his research paper summarized that the appreciation of the RMB would have negative effect on both imports and exports, for example, a 10% rising of the RMB would reduce not only export by 9.1% but also imports by 5%. Thus most of the empirical findings and statistic data showed that combined effect of the China’s exchange rate regime reform and its trade imbalance has become more severe.

2.4 The influence of RMB currency rate volatility on the trade

The appreciation of currency does not affect the value of import and export commodity itself, instead by changing their relative value in the international trade to enhance or weaken their competitive ability in the domestic market. Theoretically, the appreciation of a country’s currency is beneficial for a country to expand its imports and curb exports, consequently improve its trade balance. In fact, there always have some different findings about the impact of the volatility of the exchange rate on trade. As mentioned in first chapter the real exchange rate is most effective and objective to reflect the actual situation of a country’s exchange rate, therefore it’s significant for us to further investigate it. Following are the detailed review of previous studies between the relationship of real exchange rate and trade balance:

There is unilaterally influencing relationship between real effective exchange rate and trade balance. Sauer (2001) analyzed the effect of exchange rate volatility on twenty-two advanced economies and sixty-nine developing countries' trade from 1973 to 1993, results found that the fluctuation of the currency has much more detrimental impact on developing economies than developed countries, particularly for Africa and Latin American, but there has less effect for Asian developing countries. Boyd (2001) conducted an analysis for Japan, America, Germany, France and Netherlands which show the real exchange rate has a significant effect on trade balance. Narayan (2006) conducted the study of the relationship between trade balance and exchange rate adjustment by using the case of China's trade with the USA, found that China's trade balance and RMB real change rate against US dollar are co-integrated, a devaluation of the real RMB leads to improvement on trade balance for China not only in the short run but also in the long run, and vice versa. Nishimura and Hirayama (2013) analyzed the effects of the RMB exchange rate volatility on China-Japan trade, which showed that there has negative effect on China's export to Japan, but that there no effect on Japan's export to China, which means Chinese exporters will take more exchange rate risk than Japanese exporters. Soleymani and Chua (2014) through co-integration analysis to estimate the impact of the RMB/Ringgit volatility on trade, found that the volatility of the exchange rate has effect on most of the import and export industries in the short run, less in the long run, and the results indicated that it uncertainty has positive effects on trade.

There is bilaterally influencing relationship between real effective exchange rate and trade balance. In his study of stationarity and unit root analysis, Baharumshah (2001) employed a cointegration test to make bilateral analysis of the trade balance between Malaysia and Japan and Malaysia and American, by using quarterly data from 1980 to 1996, and found that a long-term stationary relation between real effective exchange rate and bilateral trade balance exists. Miller (2005) indicated that changing policy would lead to rise in trade surplus and raise the variance between investments and savings, which subsequently increase the current account balance. Mohsen and Xu (2012) conducted a work to investigate the effect of RMB volatility to the American dollar against two countries' trade flow, even for the third country, the results revealed that 87 out of 101 Chinese export companies and about 66 out of 76 Chinese import sectors were affected by the volatility of the currency in short term, 44 and 39 respectively in the long term; considered the effect of volatility of Canadian dollar on similar firms, and noted that export-import trade flow were affected significantly for both the short and long term.

Rahman and Mustafa (1996) used America's quarterly data for period 1973-1992 to conduct an empirical study and they found that there is no long-run critical relationship between the trade balance US dollar and real effective exchange rate. Similarly, Wilson (2001) applied annual data from period 1970-1996 did a multilateral examination on trade between Japan, the United States and South Korea, and revealed that there was no significance influence between real effective exchange rate and above three countries' trade balance. Based on China's quarterly data during 1998-2003, Shen (2005) conducted econometric analysis. This analysis showed that there is no stationary cointegrating relationship between America's and China's trade balance and the real exchange rate. The empirical study revealed that the increase in the value of RMB does not have a general influence on the trade balance in the long-run (Wang et.al, 2012).

For the investigation of the relationship between exchange rate volatility and trade flow, there are no more consistent conclusions in both theory and empirical analysis. Although above studies have achieved certain success, there is still some issues need to further investigate, such as the problem of continuously increasing surplus of China's trade balance; the best extent of the RMB fluctuation and the key of reform on RMB exchange rate mechanism.

2.5 Conclusion

The experimental studies do not end up with same or similar conclusion on the relationship between FX and global trade. The study's findings were not peculiar after taking into consideration the complication of import and export trade and trade account movements. Many factors play roles in these movements and the relationships among these factors and roles are not linear. However, all studies uncover that both FX variation and FX volatility are two fundamental drivers for trade and trade account balance change. To disclose and understand the relationship between FX and global trade account balance, we have to answer which country and whose import or export are more sensitive to the change of FX rates, respectively.

First, the country with higher sensitivity for its net export on FX benefits from weakening of the local currency and this is penalized by increase in strength of the local currency in term of its current account balance. China's export is very sensitive to FX rate change, while its import is less sensitive to the FX rate change. With a higher weight of export and lower weight of import, Marshall Lerner condition is met. Thus, appreciation of China's RMB, it helps reduce China's current account balance.

Marshall Lerner condition:

$Wx\varepsilon_X + Wm(\varepsilon_m - 1) > 0$

Where:

Wx: weight of export of total trade

Wm: weight of import of total trade

ε_X: price elasticity of export

ε_m: price elasticity of import

Second, FX rate volatility also affects current account balance. Higher FX rate volatility deters international trade as importers and exporters cannot be sure the value of money going to be received or to pay. If the derivative market is available and FX risk is hedged, the hedging cost negatively affects their motivation for international trade and current account balance accordingly. China's central bank has done a great job in keeping Chinese RMB rate in a reasonable range in most of time even though during Asia crisis in 1997 and global economy crisis in 2008. This FX rate stable help

China's international trade to become the country that trades the most in the world.

Third, furthermore, unexpected FX movement not only results in the international trade crashes, it also can lead global economic systematic risk. If a currency is not determined by the market, but a government, when the government surprisingly devaluates its domestic currency, a currency war is very likely triggered. For example, this August, People's Bank of China suddenly depreciated RMB by 2% caused global equity market lost US$5 trillion and stopped Fed to hike Federal Fund rate in its September's FOMC meeting.

Chapter 3. Methodology

3.1 Introduction

In this ensuing chapter we will discuss the methodological approach, which we will embark on this research to determine the impact of the volatility of China's RMB on its trade. We begin with a construction of a GARCH model will allows to reflect the effect of the volatility of RMB on trade, before moving on to make an elaborate discussion regarding the Marshall-Lerner condition. Various econometric tests will also be conducted, including the unit root test and test for cointegration, to ascertain if any long term equilibrium relationship exists between the RMB and Chinese trade patterns. We also make use of the vector error correction approach in order to capture how equilibrium between the RMB, imports and exports relationship is reestablished after there has been shocks in the economy.

3.2 The ARCH model

The main concern of this paper is to determine whether the volatility of the Chinese RMB has any impact on China's trade. We are interested in testing whether change on the RMB/Dollar exchange rate has any impact on the changes in imports and exports. To model volatility of a series, we take the standard deviation or the variance in the series. However, often the presence of unit root in many economic and financial

$y_t = \emptyset + e_t$

time series, like exports, imports, exchange rate and GDP, implies that the series has a mean, which is changing over time. This problem is usually circumvented by converting the level series into a differenced series, which effectively transform the nonstationary series into a stationary one. Yet in other cases, certain time series could be stationary in kernels, while simultaneously possessing conditional variances which changes. In finance, models such as autoregressive conditional heteroskedasticity (ARCH) are frequently applied to analyze stationary series which exhibit a changing conditional variance pattern. Generally, these models are applied in instances where there is reasonable evidence to suggest that the white noise of the series possess an attributable variance and size. Specifically, the ARCH model surmises the variance of the present shock or innovation, captured by the error term, as a factor of the real size of the error term of the past period. This implies that the variance of the series will be closely associated with the squared residuals of past shocks (Engle, 1982).

The ARCH model will be useful in the research to determine if the time series under review display patterns of high volatility, which are then followed by prolonged periods of low volatility. This phenomenon is often called time-varying clustering volatility and is an important basis for using ARCH models. At any given point, volatility is entirely given by the already determined past values and therefore deterministic. If we consider for instance an autoregressive AR (1) white noise:

$$y_t = \emptyset + e_t \qquad (3.1a)$$

$$e_t = ke_{t-1} + v_t, \qquad |k| < 1 \qquad (3.1b)$$

$$v_t \sim N\ (0, \sigma_v{}^2) \qquad (3.1c)$$

Equation 3.1a captures the mean equation of the model, while 3.1b denotes the variance equation of the ARCH model, where the variance coefficient is assumed to be less than the absolute value of one. The variance is normally distributed, as captured by 3.1c. In essences the model reveals the time varying nature of the series, which is depended on the lagged impact in the series. In this case, the volatility is explained as a function of e_t (3.1a). The error term captures the unexpected innovations or shocks, which might fuel some volatility in the model. Based on this, the volatility will be larger if the magnitude of the shock is larger (Engle, 1982).

The LM test, can be used to detect whether ARCH influences are present in the series, will be applied in this research. Assuming the general ARCH models takes the form:

$$e^{\wedge 2}{}_t = \theta_0 + \theta_1 e^{\wedge 2}{}_{t-1} + v_t \qquad (3.2a)$$

When using the Lagrange Multiplier test, we assume that the series or model does not contain any ARCH effects, whereby θ_1 is set to equal zero. At p-values below 5%, the null hypothesis of no ARCH effects is generally rejected.

3.3 The GARCH model

While generally useful in modeling volatility, the ARCH model, just like many other econometric models, has its own limitations. If the number of lags (q) is large, the accuracy of the model may be lost (Nelson, 1991). The Generalized Autoregressive Conditional Heteroskedasticity (GARCH) is used as an alternative way, especially when capturing larger lagged series with less number of parameters. This model is more appealing because it is able to capture lengthy number of lags in innovations with lesser parameters. Essentially, GARCH is a version of the ARCH, which simply adds more lags of the squared residuals that also become determinants of the variance model:

$$h_t = a_0 + a_1 e^2{}_{t-1} + a_2 e^2{}_{t-2} \dots + a_q e^2{}_{t-q} \qquad (3.2b)$$

$$h_t = \delta + a_1 e^2{}_{t-1} + \beta_2 h_{t-q} \qquad (3.2c)$$

Based on equation 3.2c, the volatility of the time series will change as there are changes on the innovative component $e^2{}_{t-1}$, while part of that volatility is due to the momentum component h_{t-q}.

3.4 ML Condition

Foreign exchange rate fluctuations affect a country's trade balance by influencing the prices and quantities of imports and exports. The Marshall-Lerner condition on analysis of the elasticity of the impact of the volatility of the foreign exchange rate on balance of payment account is contributed by a number of researchers, among them Davidson (2009) and other scholars after the establishment of international economics elastic theory. Elasticity analysis from the aspect of commodity markets analyzes the effect of the changes in commodity prices on trade balance which are caused by the foreign exchange rate volatility. However, even if the ML condition is satisfied, whether devaluation could improve trade balance still depends on the adjustment of export and import quota. Elasticity analysis also indicates the condition under which the exchange rate volatility improves the current account..

ML condition is the core of elasticity analysis of trade balance. ML condition was first in the late 1800s by Alfred Marshall who was an economist from Britain and later advanced by Abba Lerner (1905 - 1985). The ML condition states that depreciation could improve the balance of trade on the current account if elasticity of demand for exports and imports exceeds unity and elasticity of supply is infinite. In arriving this conclusion a number of assumptions are made:

1) Only consider two countries and two goods;
2) Adopt partial equilibrium analysis, only consider the effect of devaluation on trade balance, ignore other effects;
3) National income, Interest rate, and balance of payment stays unchanged, thus the demand for imports and exports of goods is determined by price of the goods;
4) Capital flows is zero, and the global balance of payments is equivalent to the trade balance.

For the ML condition to hold, the sum of the absolute value of the elasticity of exports and imports has to be greater than 1 in order for depreciation to lead to an increase in balance of payments (Krugman, Obstfeld and Marc, 2014).

At the heart of the ML condition rests this fundamental question: To what extent does the RMB exchange rate volatility affect import and export trade, and does the effect depend on ML conditions? If the sum of absolute value of demand elasticity for imports and exports is greater than one, then the appreciation of the RMB will produce significant deterioration effect to China's future import and export trade, vice versa. This is because the demand for exports is less responsive to changes on the exchange rate and an increase in the value of the RMB decreases the global competitiveness of products manufactured in China.

Elasticity analysis method is widely applied in the research of the relationship between exchange rate and trade balance. Assume the elastic price of product supply is infinite, then the demand for import and export functions is shown below (see Reinhart, 1995):

$$M_D = M_D (Y, P_M, P_D, E) \qquad (3.3)$$

$$X_D = X_D (Y, P_X, P_F, E) \qquad (3.4)$$

(M_D=demand for imports, X_D=demand for exports, Y=national income, P_M=import product price, P_D=domestic product price, P_X=export product price, P_F=export product price of trade partner, E=exchange rate)

Assume $P_D = P_X = P$ (P=domestic general price level), $P_M = P_X = P^*$ (P*=trade partner countries' general price level), R = E x P/P*, therefore equation (3.3) and (3.4) can be re-specified as:

$$M_D = M_D (Y, R) \qquad (3.5)$$

$$X_D = X_D (Y, R) \qquad (3.6)$$

Based on above equations, the import and export functions can be estimated via the as following equations:

$$m_t = a_m + \beta_m y_t + \lambda_m r_t \tag{3.7}$$

$$x_t = a_x + \beta_x y_t + \lambda_x r_t \tag{3.8}$$

("β, λ" are the coefficients of variables, a=intercept term, m=imports, x=exports)

3.5 Error correction model

Based on the Granger Representation Theorem, the short-term dynamic characteristics can be studied using the error correction approach. In order to establish error correction model, co-integration analysis for the variables is necessary to discover long-run equilibrium relationship. Then the short-term dynamics are also captured in model. Granger indicates that this theorem is also applicable to the situation of multiple variables.

Two main factors have been considered by the error correction model: one is the explained variables resulting in the changes of system when equilibrium condition has been changed; the other one is reversing adjustment of disequilibrium condition. This enables the system gradually to move to equilibrium with a number of other determinants under the control. Specifically, how to adjust an explained variable at "t" time depends on these two factors: the one is that how the explained variable is going to change at "t" time; the other is the size of unbalanced error between explained variables at "t-1" time. Even explained variable does not change at "t" time, as long as imbalance exists at "t-1" time, explained variable needs to be adjusted at "t" time relative to “t-1” time. This adjustment should be reversing one relative to the imbalance, in other words the correction coefficient should be negative. Thus, explained variables change during the process of continuous error correction to maintain a long-term equilibrium relationship among explained variables.

Chapter 4. Empirical analysis

4.1 Introduction

In chapter 3, we did a detailed outline of the methodology employed in this research. Amongst others, we conduct the empirical analysis of the ML condition, the ECM to capture equilibrium adjustments after the shocks in the economy, and we laid out a justification for a GARCH model to capture volatility of the RMB/Dollar. This section is going to study the patterns among the RMB currency as an exchange rate, China's output and China's Trade Volume by using econometric analysis, with a focus on RMB appreciation impacts on trade. The unit root test has been conducted first, followed by the co-integration lag order estimation and test, and then co-integration equation has been established to test the long-run equilibrium behavior in the different series. The short-term relationships between explained variables are introduced as well for the study of error correction model.

4.2 Trend and data analysis

Figure 4: Trend of variables ($000)

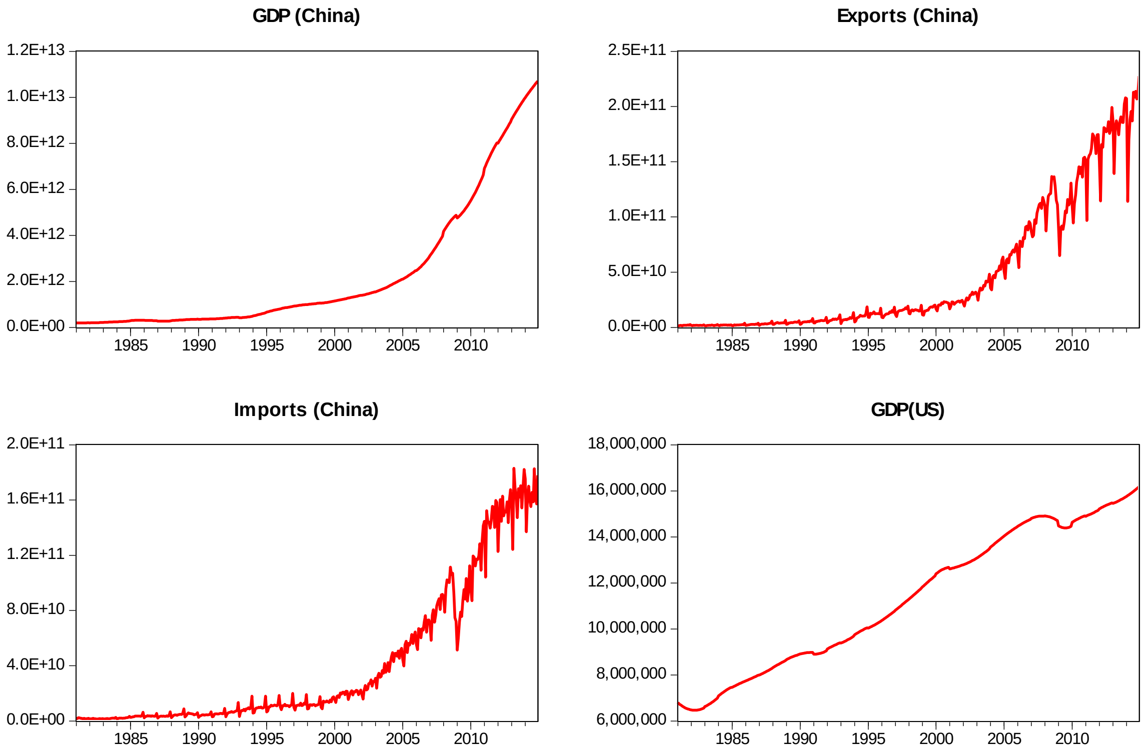
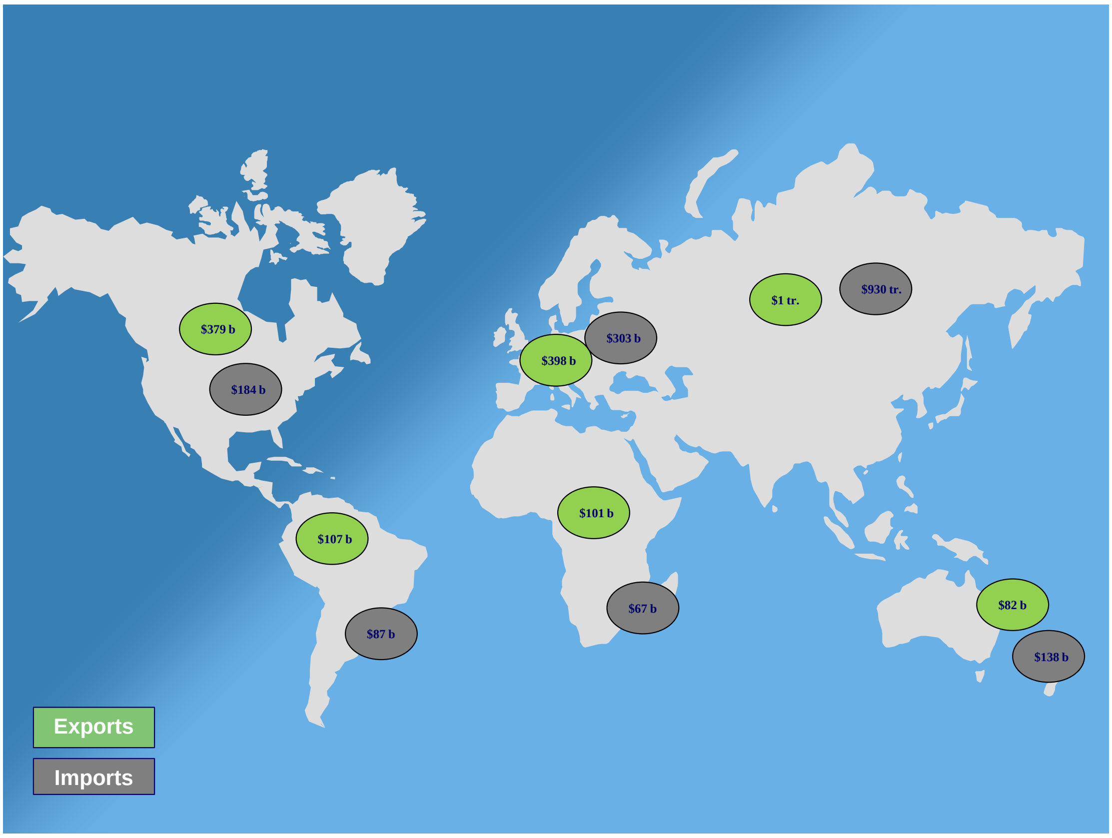


Figure 4 shows the exports, imports and GDP trends for the time period under review. It shows that China's economic growth has more than tripled since the 1980s and has grown exponentially ever since. The rapid economic expansion in China has been fueled by the efforts to diversify the economy into other sectors such as manufacturing and exports (Davidson, 2009). The backbone of the robust economic expansion in the Chinese economy has been exports, which have also expanded significantly, just like imports which have also increased. China's exports and imports to the entire globe are shown in the figure 5 below:

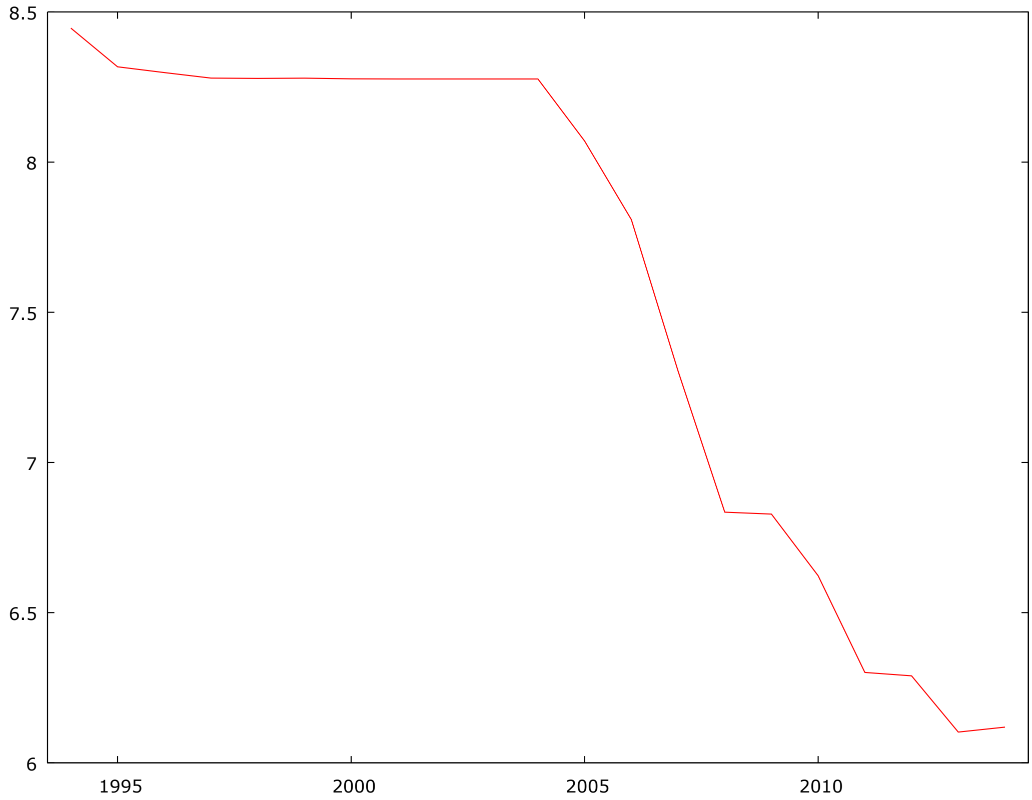
Figure 5: Imports and Exports to the globe by China (2014)



Source: International Monetary Fund (IMF), 2015

The RMB has generally been pegged against the Dollar, though the Chinese monetary authority tend to manage the currency through dozen of alternatives, usually by allowing for currency devaluation and revaluation. The graph below represents the RMB/Dollar real exchange rate, where we see that the RMB was flat against the Dollar for 1994 to 2005 as the Chinese monetary authority pegged their currency against the Dollar. However, beginning in 2006, the Chinese began a series of currency devaluation to increase their global competitiveness and boast exports (see figure 6 below).

Figure 6: RMB/ Dollar



4.3 The selection of variables and data

The data used in this research ranges from 1981 to 2014 for GARCH models in order to allow for more degrees of freedom and 1994-2014 for the remaining analysis is based on data from International Financial Statistics (2015) as well as China's General Administration of Customs and the official website of China's Ministry of Commerce. The selected variables consist of import and exports demand, real effective exchange rate (RER) of USD against RMB, total trade volume and real GDP. The real GDP is generated by nominal GDP adjusting for inflation, so RGDP=(NGDP/CPI)x100 (Tang, 2014). Data analysis is carried out using Gretl Software and Eviews 7.

4.4 Econometric analysis: ML condition

4.4.1 Unit Root Test Analysis

The traditional time series analysis usually assumes that the time series is stationary. However, in practice most macroeconomic and financial time series are non-stationary. The econometric method of this part will base on the unit root test, then conduct Johansen co-integration test for time series data to test whether long run stable co-integration relationship exists.

Co-integration test is only effective for non-stationary time series data, so the unit root test need to be conducted for each of time series in the model. The ADF test is adopted, while the lag order of time series also needs to be tested. Based on the value of Augmented Dickey Fuller and the critical value, if the ADF reported value exceeds the critical value, the time series is said to be non-stationary or to have unit root, otherwise is stationary.

Table 2: Time series RER's ADF test result

	ADF test statistic	t-Statistic	p-value
		0.847652	0.9923
Test critical value:	1% level	-3.42	
	5% level	-2.85	
	10% level	-2.56	

Note the critical value are taken from R.Davidson and J.G. MacKinnon (1993)

Table 3: Unit root test

	Variable	ADF Result	5% level		Variable	ADF Result	5% level		Variable	ADF Result	5% level
	r	0.845	-2.86		r	-2.45	-2.95		r	-5.39	-3.69
d(0)	x	1.64	-3.61	d(1)	x	-3.79	-3.98	d(2)	x	-6.522	-4.39
	m	1.27	-2.98		m	-3.67	-3.98		m	-6.17	-4.33
	y	9.47	-3.47		y	-0.6879	-3.98		y	-4.39	-2.66

Under the 5% level, ADF test value of "r" (0.845) is greater than the MacKinnon critical value (-2.86), thus "r" is non-stationary time series, with the same test method, "x, m, y" are also the non-stationary time series. For the non-stationary time series, normally we need do several times difference until the data becomes stationary. As shown in table 3, after second difference we get stationary time series.

4.4.2 Co-integration test

In this ensuing section we will attempt to establish cointegration between the variables of interest. Engle and Granger (EG) and Johansen are the two types of test method of co-integration. The difference between them is that when there are two or more variables, the EG test has a big limitation: with different vector as explained variables, they may get different co-integration relationship between vectors. Thus normally Johansen test will be adopted for the co-integration test for multiple variables model (Zhang, 2005).

Table 4: Co-integration test result (import equation)

Series: **IMPORTS** RER Y				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.095363	48.05759	29.79707	0.0002
At most 1	0.013278	7.668484	15.49471	0.5015
At most 2	0.005646	2.281706	3.841466	0.1309

The co-integration test result for import equation is shown in table 4. The first row trace test value is smaller than Lmax test result (critical value), the null hypothesis is that there is no cointegration. The results show that there is at least one cointegrating vector between the variables in question. This implies that a long run equilibrium relation can be found amongst the real effective exchange rate, imports, and real GDP (Brooks, 2014). From here we proceed to examine the error correction model.

We are interested in determining whether the real exchange volatility has an influence on the imports. Theoretically, there has to be a negative relationship between the real exchange rate and imports (Brada & Mendez, 1988). Table 5 depicts VECM estimates from the based on the Imports equation, where the appropriate lag length was chosen as 2.

Table 5: Output of VEC import equation model

Error Correction:	D(IMPORTS)	D(RER)	D(CGDP)
CointEq1	-0.171720	-0.076249	0.738658
	(0.04606)	(0.01940)	(0.11744)
	[-3.72844]	[-3.93031]	[6.28943]
D(IMPORTS(-1))	-0.421139	-0.419928	-0.158758
	(0.05502)	(0.07493)	(0.14030)
	[-7.65450***]	[-5.60437***]	[-1.13159]
D(IMPORTS(-2))	-0.384544	-0.279636	0.046153
	(0.04606)	(0.14282)	(0.11745)
	[-8.34869***]	[-1.95796]	[0.39295]
D(RER(-1))	-0.476828	-0.419928	-0.021841
	(0.17510)	(0.07493)	(0.02039)
	[2.72315**]	[-5.60437***]	[-1.07114]
D(RER(-2))	0.115048	-0.001893	-0.037219
	(0.02642)	(0.05030)	(0.07450)
	[1.35489]	[-0.03762]	[-0.49961]
D(CGDP(-1))	0.116463	-0.021841	0.275898
	(0.02027)	(0.02039)	(0.05222)
	[5.74486***]	[-1.07114]	[5.28374***]
D(CGDP(-2))	-0.019103	-0.021841	0.291341
	(0.02048)	(0.02039)	(0.05169)
	[-0.93290]	[-1.07114]	[5.63578***]
C	-0.076249	0.023964	0.256792
	(0.01940)	(0.01588)	(0.05159)
	[-3.93031***]	[1.50902]	[4.97723***]
R-squared	0.372425	0.017994	0.787813
Adj. R-squared	0.361359	0.000679	0.784071
F-statistic	33.65618	34.41670	210.5699
Log likelihood	-9733.248	187.2726	-10112.36
Akaike AIC	48.10493	48.09655	49.97711

Notes: ***, ** and * indicates significance at 1%, 5% and 10% levels respectively.

The output of the model is presented above. According to table 5, there is a strong significant long run cointergating relationship between imports, real exchange rate and output. The table shows that the last month real exchange rate is crucial in influencing imports as the t-statistic is significant (2.72315). The negative coefficient of the RER variable confirms the theoretically expectation of an inverse behavior between imports and the real exchange, suggesting that a depreciation of the real exchange rate will lead to a decrease in imports. As imports become costly in China following depreciation, the Chinese will respond by decreasing their demand for imported good, all things being equal. However, the real exchange rate from the previous two months cannot be used to explain the fluctuations in imports. The results also show that the level of GDP in the previous month also plays a role in determining the value of current imports.

Therefore, we may preliminarily determine that there is a long-run relationship between the real effective exchange rate, imports, and real GDP. This implies that in the long term, the volatility of the real exchange rate exerts a positive influence on both imports and exports and therefore the trade balance in China.

While the relationship between exports and real GDP can be ambiguous, many studies have generalized that a weaker currency tends to induce more foreign demand for domestic goods and services, thereby leading to an increase in the volume of exports. We now turn our attention to the analysis of export, real effective exchange rate and real GDP to determine if there is any relationship between these variables. Specifically, we test for the presence of cointegration between these variables. The results of the cointegration test are depicted in table 6:

Table 6: Co-integration test result (export equation)

Series: EXP**ORTS** RER Y				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.096732	50.31192	29.79707	0.0001
At most 1	0.017032	9.312300	15.49471	0.3373
At most 2	0.005911	2.389381	3.841466	0.1222

Just like with the Import equation test, the co-integration test result of export equation as shown in table 6, the first row trace test value is smaller than Lmax test result (critical value), implying that there is one cointegrating equation. As a result, long run equilibrium factor in real effective exchange rate, exports, and real GDP exists. Considering that these variables are nonstationary but cointegrated, we can now run a Vector Error Correction Model whose results a depicted in the table below:

Table 7: Output of VEC export equation model

Error Correction:	D(EXPORTS)	D(RER)	D(CGDP)
CointEq1	-0.213126	-5.35E-13	0.463875
	(0.04430)	(7.7E-13)	(0.08696)
	[-4.81136]	[-0.69629]	[5.33430]
D(EXPORTS(-1))	-0.226205	4.41E-13	-0.201468
	(0.05443)	(9.4E-13)	(0.10685)
	[-4.15595***]	[0.46680]	[-1.88547*]
D(EXPORTS(-2))	-0.220277	1.59E-13	-0.061728
	(0.04946)	(8.6E-13)	(0.09710)
	[-4.45333***]	[0.18516]	[-0.63569]
D(RER(-1))	0.182880	0.323674	-1.59E+09
	(0.05615)	(0.04833)	(5.7E+09)
	[3.25689***]	[6.69676***]	[-0.27891]
D(RER(-2))	-1.38E+09	-0.004956	-6.93E+08
	(2.9E+09)	(0.05028)	(5.7E+09)
	[-0.47562]	[-0.09856]	[-0.12169]
D(CGDP(-1))	-0.200027	-0.182337	0.363926
	(0.04989)	(0.11306)	(0.04877)
	[-4.00898***]	[-1.61281]	[7.46136***]
D(CGDP(-2))	0.098023	-1.38E-13	0.318582
	(0.02476)	(4.3E-13)	(0.04860)
	[3.95917***]	[-0.32038]	[6.55457***]
C	-2.46E+09	0.017063	8.55E+09
	(7.9E+08)	(0.01369)	(1.5E+09)
	[-3.11931***]	[1.24633]	[5.51603***]
R-squared	0.212610	0.414011	0.778616
Adj. R-squared	0.198726	0.000431	0.774713
Sum sq. resids	3.13E+22	9.407006	1.21E+23
S.E. equation	8.87E+09	0.153933	1.74E+10
F-statistic	15.31388	40.06954	199.4668
Log likelihood	-9847.762	187.2224	-10120.96
Akaike AIC	48.67043	-0.885049	50.01953

Notes: ***, ** and * indicates significance at 1%, 5% and 10% levels respectively.

Based on the VEC export model output, referred to table 7, the relationship between the real exchange rate and the exports is significant. The table shows that a depreciation of the currency, other things equal, cause an improvement in exports. These results are consistent with the general expectation that as the currency weakens against a basket of trading partner's currencies, the exports volume should increase. The previous month GDP is also important in explaining exports, though theoretically, exports are more dependent on foreign income. The results do not indicate any significant relationship between the real effective exchange rate and exports. Following shocks to the real effective exchange rate, China's exports will adjust accordingly, until equilibrium is restored.

The import and export equations indicate that during 1994 ~ 2014, the import elasticity of RMB real exchange rate change was 0.47, the export elasticity was 0.18. Thus the sum of the absolute value of them was 0.65, which was less than 1. This demonstrates that ML condition does not hold for China's import and export trade for the past 20 years.

4.5 Econometric analysis of the impact of RMB foreign exchange rate volatility on total trade volume for China

4.5.1 Theoretical model

The standard import and export functions have been described in chapter three.

Assume $P_D = P_X = P$ (P=domestic general price level), $P_M = P_X = P^*$ (P*=trade partner countries' general price level), therefore we get following functions:

$$M_D = M_D (Y, R) \quad (4.1)$$

$$X_D = X_D (Y, R) \quad (4.2)$$

Then the total trade volume can be expressed as:

$$T = X_D + M_D = T (Y, R) \quad (4.3)$$

Based on the above equation, the main econometric functions of total trade volume could be produced as follow:

$$t = ay + \lambda r + \mu \quad (4.4)$$

4.5.2 Unit root test

As mentioned above, to conduct the econometric analysis, we first test for stationarity. Unit root test is a common method to determine the stationarity of a given series, the ADF method is applied. This unit root test consist the variables of China's total trade volume T, real effective exchange rate of USD against RMB (RER), and GDP index.

Table 8: Unit Root test (China's total trade volume)

	Variable	ADF Result	5% Critical Value	1% Critical Value
	t	-2.88	-3.83	-4.64
d(0)	y	-2.43	-3.79	-4.55
	r	-1.76	-3.18	-3.90
	t	-3.31	-3.19	-3.95
d(1)	y	-5.70	-3.18	-3.91
	r	-4.08	-2.15	-2.86

As shown in table 8, under the 1% critical value, ADF test value of "t" (-2.88) is greater than the MacKinnon critical value (-4.64), thus "t" has unit root and it is non-stationary time series. With the same test method, "y" and "r" are also the non-stationary time series.

Since they are the non-stationary time series, we need to do the difference transform until the data become stationary. Under first difference the ADF test value of "t" (-3.31) is less than the MacKinnon critical value (-3.19), so it is stationary data. With the same test method, "y" and "r" are also the stationary time series. Therefore, after first difference we get stationary time series.

4.5.3 Determination of co-integration lags

Unit root test has verified that all the variables are stationary after first difference. Next step needs to determine the reasonable co-integration lags and the credibility of co-integration relationship. In the case of Vector Auto-regression, model could base on test criteria such as AIC and BIC to produce the optimal orders of autoregressive model. As shown in table 9, the smallest AIC and BIC value show that the suitable order of lags of this section's model should be 4.

Table 9: The optimal lag order (China's total trade volume)

lags	loglik	p(LR)	AIC	BIC	HQC
1	-202.19386	0.010444	22.5467	23.1432	22.6477
2	-174.99151	0.000079	21.7768	22.8156	21.9201
3	-150345309	0.004827	21.2298	22.7002	21.3759
4	-126.53366	0.123855	20.6917	22.5749	20.7881

4.5.4 Co-integration test

Johansen test will be adopted for the co-integration test with more variables. This method not only overcomes the limitation of EG method, but also accurately tests the number of co-integration vector. The maximum likelihood estimation method is adopted to test the number of co-integration relationship among multi-variables under the condition of vector auto-regression system. The co-integration test result for China's total trade volume equation is shown in table 10.

Table 10: Co-integration test result (China's total trade volume)

Rank	Eigenvalue	Trace test	p-value	Lmax test	p-value
0	0.87964	43.619	[0.0005]	33.876	[0.0003]
1	0.44824	8.7430	[0.3066]	9.5142	[0.2512]
2	0.014200	0.02288	[0.6324]	0.22883	[0.6324]

The trace test value is greater than Lmax test result (critical value) for the first row, Rank 0. As a result, the null hypothesis has been rejected. The second and third rows' trace tests are smaller than Lmax test results. As a result, the null hypotheses cannot been rejected. These indicate that there is only one co-integration vector among total trade volume, real GDP and real effective exchange rate..

Cointegration test shows a long-run stable equilibrium pattern among the chosen series and present statistical equilibrium relationship that could be used as the empirical evidence for the judgment of equilibrium relationship among these variables. Therefore, the classic regression model method can be adopted to establish the regression model. The coefficients of co-integration equation are shown in table 11.

Table 11: Output of VAR - China's total trade volume equation model

variable	coefficient	std. error	t-ratio	p-value
const	−25.9660	0.8712	−5.3691	0.0628
d_Tt_4	0.2581	0.4250	6.0731	0.5865
d_RGDPy_4	2.44413	2.8968	84.3721	0.4608
d_RERr_4	0.430	1132.51	66.9722	0.5510

Mean dependent var	24.8891	S.D. dependent var	2.59167
Sum squared resid	5.3994	S.E. of regression	134.1578
R-squared	0.9464	Adjusted R-squared	0.732039
Log-likelihood	31.3952	P-value(F)	0.123855
rho	-0.316807	Durbin-Watson	2.5711

The co-integration equation of total trade volume shows as below:

$$t = 2.44y + 0.43r - 25.97 \quad (4.5)$$

Based on the result of this empirical test, long term stable equilibrium relationship among the variables of total trade volume, real GDP and real effective exchange rate exists. During 1994 ~ 2014, total trade volume have positively correlated with the GDP and the RMB real exchange rate. From long-term equilibrium, the rises 1% may increase 0.43% of China's total trade volume, this phenomenon perhaps is caused by the greater influence of the volatility RMB real effective exchange rate on imports than exports, which have been proved by ML condition test. In terms of the elasticity, imports is bigger than exports (0.47 > 0.18). From the perspective of the influence of economic development of China's trade, one can find that China's economic development plays an important role on its trade balance, 1% rise in China's GDP may increase 2.44% of China's total trade volume. This indicates that China's main development force comes from economic growth, which fits the economic theory that economic development enhances the trade volume.

4.6 Error correction model Results

We turn now to look at the estimated ECM results as portrayed in the table 13. Based on above estimation results, we observe that the previous year real exchange rate can be employed to describe the variations in the trade balance as in equation (4.4), given the test statistic of 5.1. Also reported in the table, GDP tends to exert a significant positive impact on total trade and real exchange rate. This could suggest strong import effect, which tends to be fundamentally driven by GDP growth. The reported R-squares are also large, implying that the real exchange rate and GDP variables can be used to explain the changes in the total trade balance. The Error Correction Model obtained from the estimates in table 12 is given as:

Table 12: Estimation results of the ECM model

Error Correction:	D(TB)	D(RER)	D(RGDP)
CointEq1	-0.297941	-0.000295	0.140539
	(0.15572)	(0.00017)	(0.08089)
	[-1.91337*]	[-1.72629*]	[1.73745*]
D(TB(-1))	0.026615	-0.000282	-0.019839
	(0.18542)	(0.00020)	(0.09632)
	[0.14354]	[-1.38970]	[-0.20598]
D(TB(-2))	0.172491	8.05E-05	-0.082673
	(0.15172)	(0.00017)	(0.07881)
	[1.13693]	[0.48432]	[-1.04901]
D(RER(-1))	1326.778	0.026171	88.00637
	(255.354)	(0.27982)	(132.646)
	[5.19585***]	[0.09353]	[0.66347]
D(RER(-2))	-148.1482	1.448675	-359.3914
	(447.212)	(0.49007)	(232.308)
	[-0.33127]	[2.95607]	[-1.54704]
D(RGDP(-1))	5.783124	-0.002592	0.884579
	(0.61561)	(0.00067)	(0.31978)
	[9.39421***]	[-3.84242***]	[2.76619**]
D(RGDP(-2))	-2.989221	0.004740	-0.680312
	(1.01717)	(0.00111)	(0.52838)
	[-2.93878**]	[4.25258***]	[-1.28755]
C	-530.7436	-0.428174	224.0228
	(235.290)	(0.25784)	(122.224)
	[-2.25570**]	[-1.66063]	[1.83289*]
R-squared	0.923920	0.799892	0.934905
Adj. R-squared	0.870663	0.659816	0.889339
F-statistic	17.34857	5.710423	20.51748
Log likelihood	-101.5718	21.12057	-89.78243
Akaike AIC	12.17465	-1.457842	10.86471

Notes: ***, ** and * indicates significance at 1%, 5% and 10% levels respectively.

For the Error Correction Model, we obtain the residuals from the cointegrated equation. The results are reported in table 13 where the ECM coefficients are shown from C (1) to C (8). The error correction term C (1) represents the long run causality while C(4) to C(8) represents the short run causality. Based on table 13, since the coefficient C(1) is negative, so it's marginally significant at 10% level, implying that deviations are corrected in the long run. And the speed of adjustment is faster because the coefficient is negative. For the short run ECM causality, the one year lagged coefficient of the RER C(4) is significant, with p value of less than 5%. To check for a joint significance of all short run ECM coefficients, we make use of the Wald test, with the hypothesis being that real exchange rate and GDP cannot jointly influence the trade balance in the short run. At 5% level of significance, the null hypothesis of no join significance is rejected, implying that in the short run, RER and GDP can jointly explain movements in the Chinese trade balance.

Table 13: Estimation output of the Error Correction Model for long term and short term adjustment

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.297941	0.155715	-1.913370	0.0847
C(2)	0.026615	0.185415	0.143543	0.8887
C(3)	0.172491	0.151716	1.136933	0.2821
C(4)	1326.778	255.3536	5.195847	0.0004
C(5)	-148.1482	447.2120	-0.331271	0.7473
C(6)	5.783124	0.615605	9.394207	0.0000
C(7)	-2.989221	1.017166	-2.938776	0.0148
C(8)	-530.7436	235.2900	-2.255699	0.0477
R-squared	0.923920	Mean dependent var		223.1278
Adjusted R-squared	0.870663	S.D. dependent var		254.8061
Sum squared resid	83973.27	Schwarz criterion		12.57037
F-statistic	17.34857	Durbin-Watson stat		2.090763

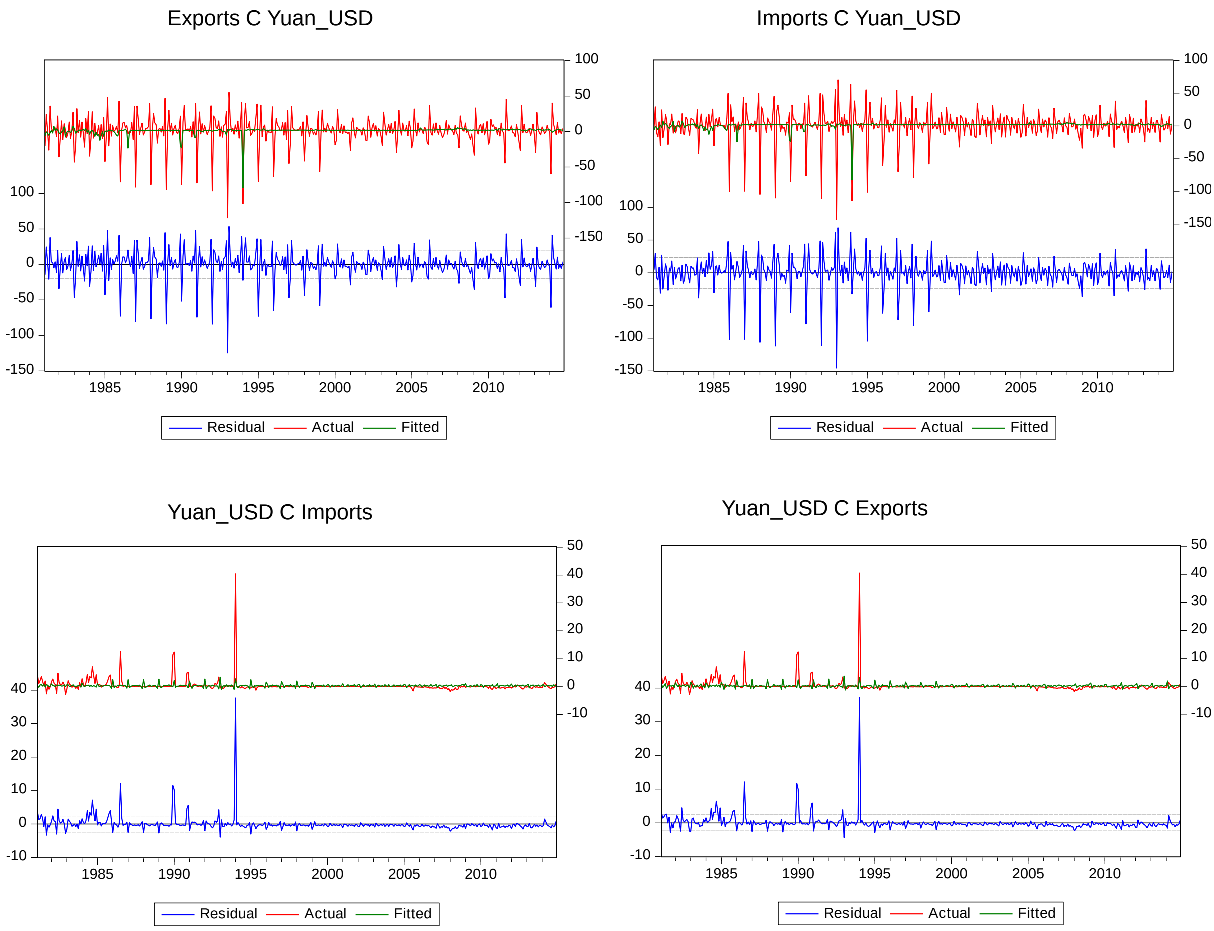
The implication of the ECM results is that, from long-term equilibrium, the RMB real exchange rate rise will not increase China's total trade volume significantly. This is because the effect of the RMB real effective exchange rate volatility on import is more significant than export. Therefore, through the appreciation of the RMB to improve the trade surplus and trade balance does not have empirical base. However, China's economic development played an important role on its trade balance and enhanced the trade volume dramatically.

In the short-term, China's total trade volume changes based on the changes in China's GDP, the RMB exchange rate volatility, as well as the degree of imbalance of long-run relationship. Through the analysis of the stability of error correction model, China's total trade volume function has certain stability in the short-term. As a result, according to short-term trade volume function to accurately predict the growth of short-term trade volume is established.

4.7 The ARCH model

As already mentioned in the preceding chapter, before applying the ARCH model, it is important to determine the presence of time-varying volatility clustering, as well as the presence of ARCH effects. Volatility clustering generally means that period of high swings is accompanied by periods of low swings. Figure 7 plots the residual plots of the following variables: Yuan/dollar exchange rate, Exports, Imports, and China's GDP and US' GDP. These residuals were obtained by running simple Ordinary Least Squares regressions as a first step of establishing which of the time series can be run as ARCH/GARCH models. The upper panel of figure 7 reveals evidence of clustering volatility on the exports-exchange rate and imports-exchange rate data. Careful analysis shows that a period of low swings is accompanied by a period of high swings. Volatility clustering appears to be absent when looking at the lower panel of the figure.

Figure 7: Residuals plot to test for volatility clustering



The presence of arch effects is also imperative requirement which must be established, before constructing an ARCH/GARCH model. Table14 uses residual diagnostics procedure through a heteroscedasticity test to determine the presence of ARCH effects for each of the cases in the table. The null hypothesis is that there are no ARCH effects and the alternative hypothesis is that there are ARCH effects in the data. OLS is used to check for ARCH effects, using the regressors: exports-exchange rate, imports-exchange rate, GDP-exchange rate, exchange rate-exports, exchange rate-imports and exchange rate-GDP respectively. Based on the table, the p-values are small (less than 5%) for the first two cases- the exchange rate-exports and exchange rate-imports. We therefore do not accept the null hypothesis that there is no ARCH influences for these two cases and justified to apply the ACRH/GARCH model to arrive at a more appropriate analysis of volatility. For the remaining four cases, however, we cannot reject the null hypothesis that there are no ARCH effects, owing to larger p-values (greater than 5%).

Table 14: heteroscedasticity test for ARCH effects

F-statistic	Obs*R-squared	Prob. F(1,404)	Prob. Chi-Square(1)
			$exports = c + yuan\_USD$
16.54487	15.97265	0.0001	0.0001
$imports = c + yuan\_USD$			
27.59394	25.95759	0.0000	0.0000
$gdp = c + yuan\_USD$			
1.320933	1.323146	0.2511	0.2511
$yuan\_USD = c + exports$			
0.002758	0.002772	0.9581	0.9580
$yuan\_USD = c + imports$			
0.003392	0.003408	0.9536	0.9534
$yuan\_USD = c + gdp$			
0.002174	0.002184	0.9628	0.9627

4.8 The GARCH Results

4.8.1 Exports analysis

Table one has shown that a general ARCH/GARCH model can be constructed for exports-exchange rate and imports-exchange rate cases since they both possess volatility clustering and ARCH effects. We first run an GARCH (2,0) for exports-exchange rate, implying that there are only ARCH effects but no GARCH effects. The results are then depicted in table 15, where exports represent the dependent variable and the RMB_USD denotes the variable on which exports depend. The table displays the mean equation results as well as the results from the variance equation, which is derived from the mean equation. The table also shows the impact of other external variables on exports, which captures the external variance regressors, to measure the external volatility that can affect China's exports.

Table 15: GARCH (2,0)

exports	GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*RESID(-2)^2 + C(6)*GDP + C(7)*USGDP			
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	2.922485	0.641272	4.557327	0.0000
YUAN_USD	0.834034	0.216107	-3.859360	0.0001
		Variance Equation		
C	143.0608	14.42280	9.919078	0.0000
RESID(-1)^2	1.049948	0.139880	7.506087	0.0000
RESID(-2)^2	0.052359	0.034344	1.524550	0.1274
GDP	-28.32015	9.460079	-2.993649	0.0028
USGDP	15.34563	38.75393	0.395976	0.6921

The mean equation coefficient implies a positive pattern between the changes in exports and the exchange rate and, implying a devaluation of the exchange rate will on average lead to an increase on exports. This relation is familiar in literature and many theoretical studies (Asseery & Peel, 1991) and (Chou, 2000). Based on above variance equation, the volatility of the last month's changes on the exchange rate can influence the volatility of the percentage change on exports, because on the significance of the p-value reported in column 5. The volatility of the RMB/Dollar exchange rate from the previous two months cannot influence the volatility of China's exports because the p-value is large at 0.1274. China and US GDP were entered as external factors that can influence the volatility of exports. The table shows that

China's GDP growth rate does exert an impact on the growth of exports. A plausible explanation for this observation would be that, as the economy expands, the export capacity of the country also increases due to growth in export oriented and manufacturing industries, thereby fueling a surge in exports. US GDP growth is revealed to have insignificant influence on GDP. The insignificance of US GDP growth rate on Chinese exports, can however, be disputed theoretically, when considering that generally, the China exports more to US especially during times of increased economic prosperity amongst Americans. In his empirical study on the relationship between the expansion of US' GDP and China's exports to the US, MacKenzie (1999) showed that an increase in US GDP tends to favour an increase on Chinese exports to the United States.

To test whether the volatility of the exchange rate for the previous two months can jointly affect the volatility of exports, we perform a Wald test, assuming that jointly, the exchange rate volatility in the previous two months does not influence exports. The assumption of hypothesized in the test is that C(4)=C(5)=0, implying that the exchange rate volatility in the previous two month period cannot jointly influence the volatility in Chinese exports. The results from the Wald test show an F-statistic of 32.58 with a probability value of 0.0001, indicating that we reject the hypothesis that the volatility of the exchange rate in the previous two months has no impact on the volatility of exports. Analysis also shows the presence of ARCH effects and no autocorrelation.

4.8.2 Imports Analysis

As already highlighted in the literature review, there is widespread agreement concerning the nature of relation for exports and exchange rate (Koray et al.1989; Campa & Goldberg, 2005). Specifically, Bénassy-Quéré and Lahrèche-Révil (2003) argued that Chinese imports rise as exchange rate loses its value. Therefore, the ensuing analysis considers how the volatility in the Yuan/Dollar exchange rate, if any, affects the volatility in Chinese imports. After running a series of appropriate lag determinations, we test for this relationship as GARCH (1,1) and lay out the results in table 16.

Table 16: GARCH (1, 1)

imports	GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*GDP + C(7)*USGDP			
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	1.117538	1.254722	0.890666	0.3731
YUAN_USD	-1.120011	0.377872	-2.963997	0.0030
		Variance equation		
C	379.4937	26.87773	14.11926	0.0001
RESID(-1)^2	0.620379	0.098156	6.320322	0.0036
GARCH(-1)	0.024488	0.030769	0.795851	0.4261
GDP	-70.15890	18.75897	-3.740018	0.0002
USGDP	-152.4792	130.8747	-1.165077	0.2440

Similar with the analysis from the preceding chapters, table 16 captures the mean and variance equation results associated with the specified GARCH (1,1) model. The mean equation shows that there is an inverse relationship between changes in exchange rate and imports. The coefficient of -1.12 implies an increase in the value RMB against the Dollar will other things equal increase imports. This is observation is in line with a plethora of previous literature studies which have also found an inverse relationship between exchange rate and imports movement. [The question is why? Why do we observe these relationships?]

Turning focus to the variance equation in table 16, the findings reveal that the volatility in the exchange rate in the previous month plays a significant role in determining the volatility in imports. The level fluctuations in GDP also exert an impact on the changes in imports, with growth in GDP for likely going to lead to a fall in imports. This channel is however theoretically untenable, as nations tend to increase their imports as their income expands. Liu et al. (2002) showed that while the linkages between economic growth and imports in China has not been significantly conspicuous, empirical studies have revealed that increased economic growth has generally tended to lead to increased imports (Heitger, 1987). As the Chinese economy has accelerated swiftly for the past three decades, so did the country's trade with the entire globe. While China has been a net exporter with the majority of its trading partners, imports have also grown, fuelled by the country appetite for natural resources (Huang et al., 2010).

Based on the results in table 16, external factors such as changes in US GDP have no effect on China's imports. This implies that the volatility in US GDP is not likely to induce the Chinese to import more from the other parts of the world. This finding, while arguable, suggests that the demand for imports in China is explained by other factors, other than the performance of the US economy. In the preceding paragraph we have shown that primarily, China's imports is explained by the RMB/Dollar exchange rate volatility and country's economic growth. By extension, we can deduce that China's demand for imports responds to volatility on the currency and the changes on the economy's production capacity.

4.8.3 Forecasting

GARCH models are useful in forecasting variables of interest to determine what the future values of such models will be in the light of the previous trends. Forecasting exercise also plays a role in ascertain whether certain chosen modules can be judged as truly accurate. This is because forecasted fitted values would tend to be significantly different from the actual plotted values, if the chosen model was incorrectly specified in variables or lags or the model itself.

Figure 8: Comparison of forecasted and actual values

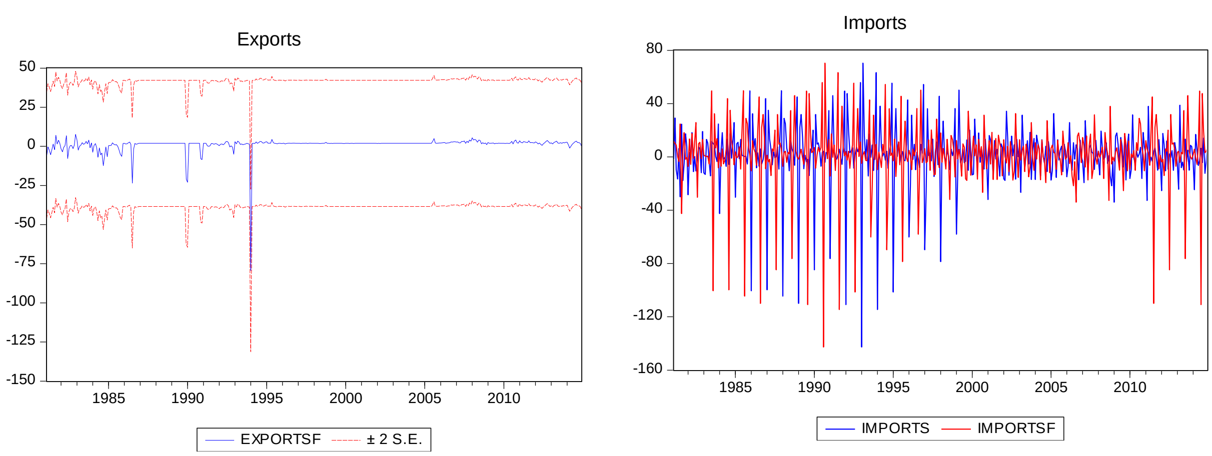


Figure 8 depicts forecasted series of exports and imports over the time span under review. The forecasted (EXPORTSF and IMPORTSF) series is plotted against the actual values of the two variables to determine the reliability of the GARCH models used to generate the forecasts. If the model used is not accurate, the pattern of the forecasted series will be significantly different from the actual series. For both the graphs in figure 8, the forecasted series moves in tandem, or can be said to mirror that of the actual series used to construct both the exports and imports GARCH models. Therefore, the GARCH (2,0) and GARCH (1,1) model are reliable in predicting the volatility of imports and exports based on the volatility of the RMB/Dollar exchange rate.

Chapter 5. Conclusion

5.1 Introduction

Through the empirical analysis in the preceding chapters, this chapter has been divided into two parts: the first part is the overall summary of the key findings. The second part is the suggestion drawn from the research. Generally, we showed how the RMB volatility has an influence on the trade balance for China. However, the impact of this volatility is at times ambiguous, tending to improve under certain circumstances, while often it can have negative impact on trade.

5.2 Summary of the key findings

Based on the GARCH results, we found that from the mean equation, the sign of the coefficient implies a positive relationship between the exchange rate and the changes in exports, showing that a devaluation of the exchange rate will on average lead to an increase in exports. On the variance equation, we found that the volatility of the last month’s changes on the exchange rate can influence the volatility of the percentage change on exports, because of the critical p-value found. The volatility of the RMB/Dollar exchange rate from the previous two months cannot influence the volatility of China’s exports because the p-value is large.

The imports mean equation showed that there is an inverse relationship between changes in the real exchange rate and imports. We also found that, Ceteris paribus, an increase in the value of the RMB against the dollar causes a rise in imports. The findings also revealed that the volatility of currency in the previous month plays a significant role in determining the volatility in imports. We also showed that the level fluctuations in GDP also exert an impact on the changes in imports, with a rise in output likely to lead to a decrease in imports. It was shown that the volatility in US GDP is not likely to induce the Chinese to import more from the rest of the world. This finding, while arguable, suggests that the demand for imports in China is determined by other factors, other than the performance of the US economy. In the preceding paragraph we have shown that primarily, China's imports is determined by the volatility of the RMB/Dollar real effective exchange rate and the country's economic growth. By extension, deduced that China's demand for imports responds to movements on the currency and the changes the economy's production capacity.

The ML condition is not a case in China in recent time interval. The appreciation of the RMB real exchange rate increases China's imports and decreases the exports, but there is no considerable impact the trade balance. Therefore, notion that the appreciation of the RMB would improve the trade surplus and trade balance does not have empirical base. Further studies are warranted.

It was further shown that there is a strong significant long-term cointergrating relationship between the real effective exchange rate, imports, and output. It was proved that the last month real effective exchange rate is critical in influencing imports as the t-statistic is significant were large. The negative coefficient of the RER variable confirmed the theoretically expectation of an inverse relationship between imports and the real effective exchange rate, suggesting that a reduction in the value of the RMB on average decreases imports. As imports become costly in China following depreciation, the Chinese should respond by decreasing their imports. However, it was also shown that fluctuations in the effective exchange rate based on the previous two months period cannot be used to explain the fluctuations in imports. The results also show that the level of GDP in the previous month also plays a role in determining the value of current imports.

Therefore, based on the evidence in the research we arrived at a general conclusion in favor of the seemingly long-term equilibrium relationship between real effective exchange rate, exports, imports, and GDP. This implies that in the long term, the volatility of the real effective exchange rate tends to have a positive effect on both imports and output.

5.3 Suggestion drawn from the research

Because the volatility of the RMB has an impact on trade, the Chinese monetary and fiscal authority should take advantage of the responsiveness of the exports and imports on the currency. The monetary authority can devalue the RMB during times of weak growth to improve their global competiveness.

By harnessing the position of the RMB, more growth can be achieved for China. Since the appreciation of currency does not necessarily affect the value of import and export commodity itself, instead changing their relative value in the international trade to enhance or weaken their competitive ability in the domestic market, the RMB can be manipulated to achieve certain desired results on trade. We also found that the appreciation currency is beneficial to expand its imports and curb exports, and ultimately arriving at a much more balanced trade.

This further substantiated by the GARCH finding that the appreciation of the RMB often tends to lower GDP will also possibly increasing foreign output. The prompted changes in income partly counterpoise any possible the changes in exports and trade balance instigated by the RMB’s appreciation. Ultimately, if we take into cognizant the GARCH induced changes in China’s GDP the exchange rate volatility would have profound impact not only on trade but also on the economy at large. The paper has shown that the appreciation of the RMB real exchange rate increases China’s imports and decreases the exports while there is no significant effect and instead will lead to a decline on the trade balance. Therefore, the Chinese authorities have to keep the RMB weaker relative to its trading partners in order to remain competitive. This will eventually lead to an increase on exports and growth. Because China’s economic growth appears to be export led which in turn depends on the exchange rate, the country has to continue managing its currency to ensure that it maintains its global competitiveness.

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