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IN SEARCH OF AN OPTIMAL BASKET
FOR THE RENMINBI

CHOY YIU PONG

MPHIL

LINGNAN UNIVERSITY

2007

IN SEARCH OF AN OPTIMAL BASKET
FOR THE RENMINBI

by

CHOY Yiu Pong

A thesis

submitted in partial fulfillment
of the requirements for the Degree of
Master of Philosophy in Social Sciences
(Economics)

Lingnan University

2007

ABSTRACT

In Search Of An Optimal Basket For The Renminbi

by

CHOY Yiu Pong

Master of Philosophy

In July 2005, Mainland China announced that she would adopt a more flexible exchange rate regime, “making reference to a basket of currencies”, instead of the de-facto peg to US dollar. This raises questions of how the new system works and what the best weights and composition are in China’s circumstances. In review of the literature, this paper first reviews the internal and external forces for China to reform her regime in 2005 suggested by Chinese and foreign scholars. Afterwards several stages of exchange rate regime of China since 1970s are examined. Then it compares simulated exchange rate movements and volatilities of various baskets with different weighting methods—original trade weights and Hong Kong re-export adjusted trade weights, of both total trade and manufacture goods trade, and alternatively the real “world output” basket proposed by Ho(2000). Considered currency baskets include the single currency basket (US dollar), the three major currency basket (US dollar, Japan Yen and Euro), four, six and thirteen currency baskets, and the eleven currency basket revealed by China’s central bank. Afterwards it simulates the effects on China’s bilateral trade balances with her major trading partners under each basket by using Johansen cointegration test and vector error correction estimation. The result of the paper indicates that a country which has adopted a trade-weighted currency basket will generally enjoy more stable, less fluctuating bilateral nominal exchange rates, nominal effective exchange rate index and real effective exchange rate index with much lower volatilities than other regimes. In terms of exchange rates volatility, it shows that currency baskets are superior to the historical regime, a fixed peg and a WCU link. Moreover, scenarios adopted a currency basket will perform a relative more stable export growth and a more stable trade balance with a lower surplus. However, an increase in the number of currencies in a basket does not necessarily lead to a better result.

DECLARATION

I declare that this is an original work based primarily on my own research, and I warrant that all citations of previous research, published or unpublished, have been duly acknowledge.

(Choy Yiu Pong)
30th August, 2007

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Chapter 1 Introduction

In July 2005, Mainland China announced that she was moving to a more flexible exchange rate system, “making reference to a basket of currencies”, instead of the de-facto peg to US dollar. This raises questions of how the new system works and what the best composition and weights are in China’s circumstances.

Indeed, issues about the RMB again became a hot topic in recent decade and many studies were related to the determination of equilibrium exchange rate of RMB. Most of them focused on either how much the RMB was undervalued or how much the RMB should be revalued but not many of them discussed about which exchange rate regime should be adopted for the RMB, with the exception of Goldstein and Lardy (2003), the research team of Merrill Lynch (2004), Frankel (2005), and Williamson (2003b, 2004). However, almost all of them studied the topic with theoretical works but almost without any empirical study. That is, they did not draw their conclusions based on empirical evidence regarding such questions as how a trade-weighted basket currency is superior to a fix peg in the case of RMB in term of China’s exports, exports growth, trade balance, what will happen if China keeps the peg against U.S. dollar, which basket composition (e.g. the 3 currency basket, the 6 currency basket, or the 11 currency basket adopted by China in 2005) is the most suitable for China and what would happen if the RMB had appreciated 15% to 25%. This thesis offers some empirical tests to answer some of these questions.

As neither “fixed exchange rate” nor “free floating” is a suitable regime for China’s current situation, and this view is supported by Ho (2000), Goldstein and Lardy(2003), Huang and Wang(2004), Merrill Lynch(2004), Frankel(2005), and Williamson(2005). For simplicity, this paper will mainly focus on the trade-weighted currency basket which is an intermediate regime. Simulations will be carried out to

compare performances of different currency baskets.

The purpose of the simulation exercises is to answer three major questions: first, how the RMB exchange rates—bilateral nominal exchange rate (bner), nominal effective exchange rate (neer) and real effective exchange rate (reer) will perform under different currency baskets; second, how these performances of exchange rate will affect economic fundamentals of China such as China's export, export growth and trade balance; third, which basket is the best among currency baskets with various basket compositions and weighting methods in China's current circumstances.

This paper is organized as follow:

I shall first go through the literature on the subject in chapter 2. The selection of the RMB exchange rate regime and the internal and external forces suggested by scholars for China to reform her regime in 2005 are discussed deeply. Also, literatures related to the concept of other key terms, methodology, data treatment and empirical simulation are also reviewed.

In chapter 3, some background information on the evolution of China's economy and exchange rate regime is provided since 1950s: a fixed peg to different major trading currencies from 1955 to 1974 in phase 1; a basket link with 15 currencies from 1974 to 1980 in phase 2; a dual-exchange rate system from 1980 to 1993 in phase 3; the *de facto* peg from 1994 to 2005 in phase 4 and a trade-weighted basket link again from 2005 to present in phase 5.

In chapter 4, the basic theoretic framework and the mechanism of currency basket are introduced. In short, currency basket usually is the sum of a basket of weighted currencies, the value of the basket and the weight of each currency in the basket are given and then fixed at the time when the basket is set up.

In chapter 5, volatilities of exchange rate—bilateral nominal exchange rate (bner), nominal effective exchange rate (neer) and real effective exchange rate (reer) are

examined. A basket is deemed superior if exchange rate volatility is lower, or if a relatively more stable exchange rate movement is able to be obtained. Therefore, the optimal basket for the Renminbi (RMB) is estimated by comparing simulated exchange rate movements and volatilities of various baskets with different weighting methods—original trade weights and Hong Kong re-export adjusted weights, of both total ordinary trade and manufacture goods trade, and alternatively the real “world output” basket proposed by Ho(2000). Considered currency baskets include the single currency basket (US dollar), the three major currency basket (US dollar, Japan Yen and Euro), four, six and thirteen currency baskets, and the eleven currency basket revealed by China’s central bank respectively.

In chapter 6, effects of various baskets on China’s economic fundamentals are examined by using Johansen cointegration test and vector error correction estimation. A basket will be concluded as a better alternative if it is compatible with continuous stable growth in export and a sustainable trade balance in long run. To answer the question of the implications of diverse currency baskets for sustainability of the China’s trade balances with her major trading partners, simulations on China’s export, import and trade balance with her major 13 trading partners are carried out. I apply a standard demand model with monthly bilateral merchandise trade data from Feb.1998 to Aug. 2006. In short, ADF unit root test will be firstly applied to each series on both level and 1st difference for testing stationarity. Then the Johansen cointegration test will be applied to test for the presence of a cointegrating relation. After the presence of a cointegrating relation is confirmed, Vector Error Correction estimation will be applied to test the convergence of endogenous variables to check the short run dynamics for the long run cointegrating relations. Finally, estimated equation derived from the VEC model will be used to do the simulation exercises on 8 different scenarios.

The paper shows that a country which has adopted a trade-weighted generally will enjoy more stable, less fluctuating bilateral nominal exchange rates, nominal effective exchange rate index and real effective exchange rate index with much lower volatilities than other regimes. In terms of exchange rates volatility, it shows that currency baskets are superior to the historical regime, a fixed peg and a WCU link. Moreover, scenarios adopted a currency basket will perform a relative more stable export growth and a more stable trade balance with a lower surplus. However, an increase in the number of currencies in a basket does not necessarily lead to a better result.

To conclude, there is no “single best” basket or regime for China, and which regime or basket is preferable depends on what the government wants or needs to achieve and the situation at that time. Although the nominal anchor in the past had appeared to perform very well in promoting exports, it has also led to an accumulation of foreign exchange and large current account surplus. For China in the current situation with a surplus in both current and capital accounts and a huge, increasing foreign reserve causing inflationary pressure on the economy, there is consensus that China should move to a new exchange rate regime with higher flexibility and sustainability. Linking to a currency basket, an intermediate regime between the fixed peg and the free floating, is definitely one of the solutions.

Chapter 2 Literature review

In the review of literature, this paper focuses on literatures related to the RMB exchange rate regime selection. The internal and external forces for China to reform her regime in 2005 are discussed at length too. For other literatures related to the RMB like exchange rate determination and the equilibrium exchange rate of the RMB, they will be discussed just briefly.¹ Literatures related to other concepts used in this paper such as currency basket and real effective exchange rate, methodology and data treatment are also reviewed.

Review of literature related to “the RMB exchange rate regime selection”

There is a big, though with recent, literature related to selection of exchange rate regime of the RMB, including contributions from Chinese scholars as well as foreign scholars. Since the capitals nowadays in the global market have a very high liquidity, the exchange rate regime selection in emerging and developing countries becomes the focus of many studies. Zhang Zhichao (2002a) discussed the evolution and development of exchange rate regime selection theories systematically in his paper, from the “original sin”² to the “the fear of floating hypothesis”,³ and then from the “the hypothesis of the vanishing intermediate regime” to the “Exit strategy”. At time same time, Li Jing (2002) reviewed major literatures regarding selection of the RMB regime from 1999 to 2001, wrote a paper with topic “RMB Exchange Rate Regime:

¹ The details literature review of “the real purchasing power parity of the RMB”, “the real interest parity of the RMB”, “relationship between trade balance and the RMB” and “equilibrium exchange rate” please refer to (Qin Pei-jing, 2004)

² In the original formulation Eichengreen and Hausmann (1999) call “original sin” a situation in which the domestic currency cannot be used to borrow abroad (international original sin) or to borrow long term, even domestically (domestic original sin). Due to incomplete and frangible financial markets, domestic investors face a maturity mismatch—long-term projects are financed by short term loans—or a currency mismatch—projects that generate domestic currency are financed with U.S. dollar. (Mckinnon and Schnabl, 2004a)

³ The theories of “original sin” and “fear of floating” are also discussed in (Mckinnon and Schnabl, 2004b)

Suggestions on Further Reform and Exit Strategy” in 2003.

Before the Asian Financial Crisis, the exchange rate policies of China were led by economic objectives that wanted to be achieved by the government and the objectives of China in that period was to enhance exports and increase accumulation of foreign exchanges. In the period of during and after the crisis, the selection of Chinese exchange rate regime was changed from leading by economic objectives to a nominal peg to U.S. dollar. (Qin Pei-jing, 2004) Before the reform of the RMB exchange rate regime in 2005, the discussions about the exchange rate regime of the RMB were almost related to two questions: “Whether the RMB should keep her peg to U.S. dollar or adopt a more flexible exchange rate system” and “, After China entering the WTO in 2002 and starting the liberalization of capital account, what should the new exchange rate regime be?”

Some scholars suggest that there are inherent risks associated with linking to a nominal anchor. This leads to even more arguments about what exchange rate regime should be adopted in the future and generates a new field of study in the selection of exchange rate regime—the exit strategy—how a economy exit from existing regime and transforming to a new, creditable and reliable regime successfully.

There are two main hypotheses in the fixed exchange rate system: the first one is that unexpected fluctuations in nominal exchange rate may hinder trade and foreign investment. The second one is that the fixed exchange rate system (especially the currency broad) will restrict the government to increase money supply as much as they like in order to cover the fiscal deficit in an economy. Therefore, pegging to a international currency with low inflation can enhance the credit of the central bank, and then reduces the expectation of the public of inflation in future, in order to control the inflation and stabilize the growth of economy. (Yu Qiao, 1998) However, although there are already lots of empirical studies to examine the causal relation between the

nominal anchor and the stable economy growth, many of them are inconclusive or unpersuasive because of incorrect classification of exchange rate regime and the problem of “reverse causation”⁴. (Qin Pei-jing, 2004)

Because of the lesson from the Asian Financial Crisis of East Asian economies, the large amount of surpluses in both current and capital accounts of China and a huge increase in China’s foreign reserve (over 300 billion of U.S. dollar), many scholars point out that China should no longer peg to U.S. dollar and should change to a more flexible regime.⁵ Frankel (1999) also points out that there is simple exchange rate regime and policy that can ensure the best interest of the country all the time. Which regime should be adopted depends on the maturity of financial institutions and market, the credibility and consistency of public policies.

Although the fixed peg of the RMB to U.S. dollar has a lot of deficiencies, some scholars still support the RMB’s linkage to the U.S. dollar. Chen Bing-cai (2001) points out that “as the strong status of U.S. dollar and its function of being the axis of international currency, China should keep her peg to U.S. dollar in order to keep away from unexpected risk.” Also, Feng Fu-yong (2001) demonstrates the mutability of the “floating regime” and concludes that China should not choose a “floating exchange rate regime”. Mundell (2003) believes that it is a wise choice for China to keep her peg for 2 reasons: first, appreciation of the RMB will decrease foreign direct investment and increase the burden of non-performing loan and unhealthy assets of banks. Second, it will harm the creditability of the Chinese government. In addition, Mckinnon and Schnabl (2004) believe that the East Asian should return to a “soft” peg to U.S. dollar in the new millennium. They argued that the currency baskets

⁴ “Reverse causation” means that we cannot distinguish whether the stable exchange rate causes a low inflation and a stable economy growth or a low inflation and a stable economy growth cause a stable exchange rate of a country in empirical testing.

⁵ This view is supported by many scholars such as Ho (1988), Goldstein & Lardy (2003), Merrill Lynch (2004), Williamson (2003, 2004), Frankel (2005), Yu Yong-ding (2005)

adopted by East Asian economies were never announced and the weights that the smaller East Asian economies given to the dollar compared to other major currencies such as Japanese Yen and Euro are too light to intervene the foreign exchange movement and the comparison of volatility in their exchange rates to U.S. dollar now to that of before the 1997-1998 crisis.

In contrast, both Yu Qiao (1999) and Williamson (2004) discuss the fundamental conditions for China to adopt a fixed exchange rate, and both of them conclude that China do not have objective conditions to adopt a fixed exchange rate and any benefit that comes from the peg would not be able to cover the loss. Chen Ping and Wang Xi (2002) also agree with this view and he believes that China does not have the stabilizing mechanism of fixed rate—the expectation of a stable exchange rate in market. Moreover, he points out that any limitation, restriction and intervention in the foreign exchange market will cause distortion in the RMB exchange rate which means that it is impossible of the market to have an equilibrium exchange rate in the current condition. Actually in the studies of the RMB exchange rate regime selection, most scholars agree that China should adopt a more flexible regime and one of the major viewpoints from Chinese scholars is that China should re-introduce the managed float exchange rate system. However, “the hypothesis of the vanishing intermediate regime” must contradict with this viewpoint.

In “the hypothesis of the vanishing intermediate regime”, the main theory is that sustainable exchange rate regimes are either free floating or a fixed exchange rate regime with a very strong and creditable promise such as currency alignment or currency board. Any intermediate regimes between the “fixed” and “free floating” should be vanishing or are vanishing. Eichengreen (1999) also points out that under speculative attacks in the global market, intermediate regimes are not able to neither stop nor prevent currency crisis definitely. Yi Wang (2000) believes that “before

changing of the game rule of international currency system, any economy adopts intermediate regime is in great danger with their opened capital account. Only exchange rate determined by market force is sustainable and safe, but many emerging and developing countries have a long way to go to free floating their exchange rate. Because before currencies of developing countries become freely convertible, it is impossible to have a meaningful equilibrium market rate. As a country without an open capital account, a real elastic, completely free floating and flexible market rate absolutely is a ‘luxury’⁶”.

In conclusion, although there are still lots of arguments about selection of exchange rate regime, most economists believe that China should gradually establish a more flexible exchange rate regime for the RMB.

Although large amounts of literature of both Chinese scholars and foreign scholars regarding the selection of RMB exchange rate regime have already been reviewed by Zhang Zhichao (2002a and 2002b), Li Jing (2002) and Qin Pei-jing (2004), few provide a concrete and tangible suggestion and few spell out clearly the policy implication on the road of China’s exchange rate reform, with the exception of Goldstein and Lardy (2003), Merrill Lynch (2004), Williamson (2003b, 2004) and Frankel (2005). Their views and suggestions on the selection of RMB exchange rate regime will be reviewed in following paragraph.

The view of Morris Goldstein and Nicholas Lardy

Goldstein and Lardy (2003) believe that the reform of RMB is in a dilemma and must face either one of two problems. “If revaluation of the yuan has to wait until China is willing to undertake full capital-account liberalization, then the rest of the world has to live for too long with a misaligned yuan.” Or, “if China is asked to free

⁶ This view also supported by Yu Yong-ding (2001)

float the yuan and adopt capital-account convertibility before it puts its domestic financial sector on a firmer footing, it would be casting aside one of the main lessons of the Asian financial crisis.”(Goldstein and Lardy, 2003)

To solve the dilemma of the RMB, they suggested a “two-step process”. The first step should revalue the RMB moderately by 15% to 25%, widen the exchange rate band from less than 1% to between 5% and 7%, and switch from the *de facto* peg against the USD to a three currency basket peg with weightings of roughly a third each for the U.S. dollar, Japanese Yen and the Euro. The second step would take the form of a managed float, after China has strengthened her domestic financial system enough to permit a significant liberalization of capital outflow.

Moreover, they state that although the “go-slow approach” presumably appeals to the leadership of China because there will be less uncertainty over the short-run effects on China’s exports, incoming FDI and employment, the very small adjustments imply that speculation on the RMB is a one-way bet, thus leading to even greater capital inflows. In contrast, there are four advantages in a medium size revaluation. First, the existing undervaluation of RMB would be dealt with immediately and there would be no more further speculative capital inflows and reserve accumulation. Second, the pressure and difficulty in domestic sterilization would be less and the induced increase in money supply will not go further. Third, it would show the trading partners that China is not attempting to manipulate the exchange rate, therefore reducing the threat of protectionist measures against China’s exports. Fourth, it would make the RMB become part of the solution to the global pattern of payment imbalances instead of part of the problem.

Furthermore, they describe that a fixed exchange rate for the RMB vis-à-vis the USD is no longer suitable nor needed and the stability of China's exchange rate should be interpreted against a wider set of reserve currencies than the dollar alone. One the

other hand, it would be unsound to free float now because of the fragility of domestic financial system, which would rule out large-scale capital flight in response to bad news. The transition from a “fixed peg” to “free float” need not occur in one fell swoop as liberalization of the capital account will need to proceed in stages.

By adopting a three currency basket peg, the stability of China’s overall trade-weighted exchange rate would increase. A basket peg would permit the dollar to depreciate against the RMB without a series of RMB parity changes. That could not happen if China retains its present unitary peg to the dollar.

In conclusion, they point out that “the currency regime that has served China well in the past is not the currency regime that will serve China best today or in the future”. With some compromise by all parties and with the right sequencing of China's currency reform, a workable solution of global payment imbalance is in sight.

The view of a report from Merrill Lynch

A research team of Merrill Lynch (2004) believes that proper reform on China’s exchange rate regime and appreciation of the RMB is necessary in order to achieve China’s primary macroeconomic goals and objective. If the RMB is not revalued and the current peg to U.S. dollar continues, inflation in China would keep rising to unacceptable levels. Also, a gradual revaluation would be ineffective according to the historical experiences. The authors proposed a two-part foreign exchange regime change, the first one is a significant (10%) USD to RMB revaluation and the second one is a coincident move to a basket pegged exchange rate with a 5% trading band at the end of 2004.

In the paper, it is pointed out that the external (international) pressures is not the incentive of the policy change, whereas the internal policy objectives such as economic growth, employment, financial stability and low inflation are the reasons

which drive China to make a change. The models of trade and capital flows adopted in the paper imply that the RMB is undervalued by 20% in term of trade weighted, an external imbalance that is being exacerbated by pegging to the depreciating U.S. dollar. The huge trade surplus does not justify the existing exchange rate regime as this external imbalance is generating internal imbalance. The capital account causes capital inflows outside of FDI, which have surged 3% of GDP (which in principle should be close to zero). The risks to RMB exchange rate keep rising and these inflows are becoming more and more difficult to sterilize by government intervention. Imported inflation from the falling dollar and rising domestic price may be long lasting and dramatic as the models imply that inflation was on its way to 9% in 2005, which is a totally unacceptable outcome for China. They believe that a realignment of the nominal exchange rate will help contain inflation, slow economic growth to sustainable levels and allow for an increase in nominal interest rate in order to restore the internal balance. In contrast, an undervalued exchange rate and the massive external imbalance which link to each of the three main drivers of the economic boom - exports, investment, and credit.

For the long-term models of trade and capital flows used to determine ideal longer-term dynamics in exchange rates in the paper, it is a COMPASS valuation model for the G10⁷ currency regions underpinned by the Fundamental Equilibrium Exchange Rate (FEER)⁸ approach. The model presumes that the domestic economy is in equilibrium, that is, inflation is at its target and output is at its trend, and then determines whether the balance of payments is on a sustainable path. If not, the role of

⁷ G10 here refers to US, Euroland, Japan, UK, Switzerland, Sweden, Norway, Canada, Australia, and New Zealand.

⁸ The term "fundamental equilibrium exchange rate" meant an exchange rate at which it would not be possible to achieve simultaneously both of the basic objectives of macroeconomic policy. These were usually formulated as "internal balance", meaning non-inflationary full employment or a similar concept, and "external balance", meaning a balance of payments position that appeared sustainable and desirable.

the equilibrium exchange rate is to adjust trade to ensure the external balance.

First of all, it sticks to the less aggressive assumption of 1% sustainable deficit in China's capital account and they point out two factors that motivate a sustainable deficit over a medium term horizon. The first one is that, as China is an emerging economy one would expect investment to exceed national savings. The second factor is that, the favorable external position of China prevents debt constraint.

According to the International Institute of Economics, the revaluation of the real exchange rate necessary to restore external equilibrium is estimated to be 15% to 20%, whereas the trade-weighted exchange rate in China has been depreciating with the dollar's downturn. For simplicity, they take the mid-point of the range and assume the degree of undervaluation is 20%.⁹ Moreover, it is presumed that this adjustment come through nominal exchange rates to arrives at specified estimates for the USD-RMB equilibrium rate. Since in the past two year (2002-2003) the trade-weighted exchange rate of RMB has dropped 13%, the question that remained is that what the USD-RMB exchange rate would need to be in order to restore an external equilibrium over the medium term.

The result shows that "if the world were to move toward internal equilibrium, the 'fair value'¹⁰ for USD-RMB is 6.31 implying an undervaluation of the Chinese renminbi of 31.2%. ... This is the exchange rate that would be required if all currencies were to adjust so that global capital flows and current accounts were sustainable." (Merrill Lynch 2004, p.13)

Then the paper discussed the path or the timing for China to phase in the new exchange rate regime. It referred to another by using six cases of appreciation

⁹ It result is found according to the FEER estimate of the trade-weighted undervaluation.

¹⁰ The 'fair value' assumptions are from the COMPASS model in the G10 currency regions and purchasing power parity in emerging Asia.

pressures since the dissolution of the Bretton Woods. Three cases involve Chile in 1992, 1994 and 1997 respectively, Hungary in 2001, Indonesia in 1996, and Singapore in 1973. Generally, the market pressures have been instrumented to changes in foreign exchange policy. Sterilization cannot be effective when there are burgeoning inflows and these inflows driven by the expectation of foreign exchange appreciation can only be stopped when the exchange rate actually appreciates. Also, a move to a wider exchange rate band will likely take foreign exchange all the way to the strong end of the new band. Moreover, the appreciation following the change in exchange rate regime is not typically long lasting. Furthermore, the change of the exchange rate regime in almost all cases leads to a fall in inflation, but it seems there is not any clear pattern in interest rates.

At last, statistical analysis based on “principal component”¹¹ is given in the Appendix, which shows that “the trade-weighted basket based on the USD currency crosses of China’s eight major trading partners can be mimicked effectively by a much simpler G3¹² FX basket.” (Merrill lynch 2004, p.20) In addition, they show another statistical examination which suggests that the G3 basket is a reasonable approximation for the trade-weighted index. The tracking error between the G3 basket and the trade-weighted renminbi basket is manageable. By running a regression of the trade weighted renminbi against the G3 basket in natural logarithms, and then evaluating the pattern of the historical error, the “optimal basket” is indicated to be the G3 basket with 5% band.

¹¹ A principal component (PC) of a set of variables is a weighted average of these variables. It reflects the maximum possible proportion of the total variation in the set. The rationale of the principal component method is not to include all of the principal components in the final approach.

¹² G3 here refers to US, Euroland and Japan.

The view of John Williamson

According to Williamson (2003b, 2004), China is in a situation such that both internal and external considerations point to the desirability of a currency revolution based on five pieces of evidence. The first piece of evidence is that China's economy is overheating with obvious inflation. The second one is that Bank loans in China are expanding at a feverish rate and the level of investment is too high, which recalls what happen in other Asian countries before the financial crisis. Thirdly, China has been in current account surplus for a long time. Fourthly, China is a net capital importer. Fifthly, the reverse of China have growth to a point where they are the second highest in the world (now already beyond Japan and become the highest in the world).

Then he explains why the reasons that have been advanced for rejecting an appreciation are unpersuasive. Although import liberalization via entering WTO has helped to boost imports, WTO will also give scope for a substantial expansion of China's exports because of abolition of some arrangements related to protectionism. Also, the problem of high risk of massive capital outflow can be solved by delaying liberalization of capital outflows at least until the banking system has been cleaned up. Moreover, while refusing to depreciate during the 1997-1998 Asian Financial Crisis was a noble act, refusing to appreciate now in the face of big gains in exports and current account surplus is still unjustifiable. At last, he believes a RMB revaluation would encourage the expansion of consumption and it would also slow down the reserve accumulation that underlies the rapid credit expansion. This will sustain economic growth rather than threaten Chinese growth.

He also adopted the FEERs approach and proposed that China should have an objective of a current account deficit of 1% of GDP in 1996 because he thought that China would have no difficulty in importing enough capital to finance such a deficit. However, in 2003, he was intellectually convinced that China ought not to be

targeting a current account deficit. With suggestion from Goldstein and Lardy's calculation that a revaluation of 15% to 25% should take place, he thinks that even 20% revaluation may be somewhat conservative. "I think it important that any adjustment be big enough to convince market participants that the change is complete, not a first step, since otherwise a revaluation may simply serve to encourage more speculative inflows." (Williamson, 2003b) However, he also points out that "none of us has a satisfactory macro-econometric model at our disposal to back up our estimates or guesses."

At last, he agrees with Goldstein and Lardy that China should operate its exchange rate with a wider band and should change its peg from the U.S. dollar to a basket of the three major currencies. At the same time, he proposes a "BBC" approach (a Basket peg, a Band and a Crawling mechanism) that should be adopted by China after the first step of revaluation. And the logic behind the crawling mechanism is that, "keeping each individual change in the peg small so as to avoid creating strong speculative pressures" (Williamson, 2003b) In addition, his paper in 2004 pointed out that, even "if the attempt to cool the economy through administrative measures succeeds, then the currency will still be undervalued. Overheating will return (though perhaps only after a time of slowdown), and there will again be a need to cool the economy in which market measures (currency appreciation and a higher interest rate) will still remain out of bounds." (Williamson, 2004)

The view of Jeffery Frankel

Frankel (2005) believes that both fixed and flexible exchange rate regimes each have advantages. Each country should choose its regime according to its own situation. He explains that the *de facto* peg which prevailed before July 2005 was not suitable for China anymore. First, China's economy is overheated, inflation caused by

internal imbalance could be helped by the appreciation of RMB. Second, even though foreign exchange reserves are a useful shield against currency crisis, the current level of that of China is already more than enough. In addition, U.S. treasury securities do not offer a high return. Third, sterilization by China was becoming more and more difficult, and the inflows overtime had been exacerbating inflation. Fourth, the existence of the policy goals (internal balance and external balance) generally requires the use of the real exchange rate and the interest rate. Fifth, as China is a large economy, adjustment in the real exchange rate can achieve via flexibility in the nominal exchange rate easier than via price flexibility. Sixth, lessons from other emerging markets points toward exiting from a peg when the economic environment are good and the currency is strong, rather than when it is bad and the currency is weak. Seventh, by the standards of a Balassa-Samuelson relationship estimated across countries, the prices of goods and services are low in a longer-run perspective. Also, these seven arguments for increasing exchange rate flexibility do not necessarily imply a free float. 'China is a good counter-example to the popular "corners hypothesis" prohibition on intermediate exchange rate regimes.' (Frankel, 2005)

Then he adopts relative PPP approach to estimates the Balassa-Samuelson relationship in year 1990 and year 2000 across 118 countries. The logarithm of real exchange rate (normalized to 100) is regressed against the logarithm of real GDP per capita in constant price. The result shows that China is an outlier, which apparently was undervalued by 42% in logarithm terms, or by 34% in absolute term in 1990 and the RMB was undervalued by 44.8% in logarithm terms, or by 36.1% in absolute term in 2000. Finally, he believes that the RMB was undervalued by approximately 35% in 2000, and may be by at least as much today. The correction could take the form of either inflation or nominal appreciation, and it is clear that the latter is preferable. Also, a nominal appreciation needs not imply a free float. An intermediate regime is

more appropriate. Finally, although China announced a new regime in 2005, he believes the RMB remained the *de facto* peg to the U.S. dollar with a slow appreciation.

In short, all four foreign literatures—Goldstein and Lardy (2003), Merrill Lynch (2004), Williamson (2003b, 2004) and Frankel (2005) agree that China should not adopted “corners hypothesis” while reforming the RMB exchange rate regime. Neither “fix” nor “flex” will be in China interest. All of them urge appreciation of the RMB and suggest an initial step appreciation in one fell swoop and then followed by move to a band around a basket.

Review of literature related to the topic

Naoyuki Yoshino, Sahoka Kaji and Ayako Suzuki (2003) wrote a paper focusing on the optimal exchange rate regime for a small open economy and they had compared the loss function of the basket-peg, dollar-peg and floating. They argue that the best exchange rate regime depends on the policy goal. Small open economies, such as those that experienced the recent currency and economic crises in Asia, should decide for themselves what their policy goals are, and then choose the exchange rate regime that is most conducive to achieving those goals. Adopting a basket-peg with trade weights will not in general be the optimal choice. In comparison to the dollar-peg, the basket peg at least has three possible advantages to the peg. First, “if the dollar and the yen move in opposite directions against the domestic currency, and if the weights on these exchange rates are such that the weighted average of the movements cancel each other out, then there will be no need for intervention. There will be no loss of foreign exchange reserves, and the country regains monetary policy autonomy.” Second, “the weights in the basket may be used as an additional policy tool to achieve a given policy goal. Authorities could minimize the deviation from

their policy goal by choosing the values for these weights appropriately.” Third, “if the dollar and the yen move in opposite directions against the domestic currency, then the effect of a given change in the yen-dollar rate on the current account and aggregate income will be smaller under the basket-peg than the dollar-peg.” (Yoshino, Kaji and Suzuki, 2003) Finally, if the policy goal is the stability of the exchange rate against one currency, say the dollar, and then the dollar-peg is the best choice. If the policy objective is to maintain monetary policy autonomy and eliminate government intervention, then the best regime should be free floating exchange rate regime.

Kawai (2007) argues that it is desirable for East Asian countries to appreciate collectively in order to maintain intraregional exchange rate stability. To achieve these goals and to begin the process, China should increase its exchange rate flexibility and accept the market-driven appreciation of the RMB, thereby ending its de facto U.S. dollar-based stabilization policy. He believes that by allowing greater flexibility of the RMB vis-à-vis the USD, it can significantly slow the volume and pace of reserve accumulation. Also China should acquire the ability of setting its own independent monetary policy in order to prudently manage domestic macroeconomic and financial conditions. At last, he promotes a managed floating to the all East Asian countries and China, which is “a formal, common G3-plus currency basket system, with transparent rules of parity, band and interventions”. (Kawai, 2007)

Review of literature related to other concepts

For the concept and operation of basket currency, studies of Branson and Katseli (1981), Brandson and Healy (2005), Ho (1988), Edison and Vardal (2001), Williamson (2001), Fujiki and Otani (2002), Ranjan (2002), Yu Yong-ding (2005) and the description about currency basket from the website of Bank of Israel¹³ are

¹³ Retrieve from <http://www.bankisrael.gov.il/deptdata/mth/curbaske.htm>

reviewed in order to understand the theoretical frameworks and the operation of a currency basket. Especially from the study of Yu Yong-ding (2005) and the website of Bank of Israel, which demonstrate how new bilateral exchange rate of home currency against other currencies can be calculated under a currency peg. On the other hand, the concept and calculation of World Currency Unit (WCU) are directly reviewed from Ho (2000), Ho (2002) and Ho (2004).

For the concept and calculation of real effective exchange rate index, studies of Ho (1988), Philip and Jozef (1993), Robert, Patrick and Pierre (1998), Ha and Fan (2003), Klau and Fung (2006) are reviewed in order to understand the implication of REER and choices on weights and composition of REER.

For the methodology, Johansen and Katarina (1990), Johansen (1991), Han (2000), Hung and Tam (2002), Ho (2004), Williamson (2005) and the user guide of Eviews are reviewed in order to find out the models adopted in the paper and understand econometric skills and knowledge of different testing methods such as ADF unit root test, Johansen cointegration test and Vector error correction estimation.

At last, studies of Fung and Lau (2001), Schindler and Beckett (2005), the website of WTO and database of United Nation Comtrade are reviewed in order to understand the adjustment of re-export of Hong Kong on China's trade data.

Chapter 3 Evolution of China's exchange rate regime

In this chapter, some background information on the evolution of China's economy and exchange rate regime is provided. Since the founding of the People's Republic of China, China's economy had experienced three stages (Guo and Han, 2004). The three stages are the planned economy stage from 1950 to 1978, the economic transition stage from 1978 to 1994 and the socialist market economy stage from 1994 to the present. After the founding of the People's Bank of China (PBOC) on 1st December 1948, the first Chinese Yuan (RMB) exchange rate was announced in Tianjin on 18th Jan 1949. At that time, the exchange rate might vary from region to region within a band, probably reflecting different regional economic situations and objectives. On 13th March 1979, the State Administration of Foreign Exchange (SAFE) was established with the support of the State Council to manage and supervise China's foreign exchange rate. Over these five decades, China had implemented various foreign exchange policies and had adopted various arrangements for foreign exchange rate regime. A brief review on China's exchange rate regime evolution and reformation is as follows.

3.1 Evolution and reformation of China's exchange rate regimes

Since the 1950s, the foreign exchange reform can be mainly classified as five phases. In each phase, China had used different foreign exchange regimes such as a fix peg to different major trading currencies from 1955 to 1974 in phase 1, a basket link with 15 currencies from 1974 to 1980 in phase 2 according to the description of the World Currency Yearbook, a dual-exchange rate system from 1980 to 1993 in phase 3, a managed float from 1994 to 2005 in phase 4 and a trade-weighted basket link again from 2005 to present in phase 5, to match up China's exchange rate policies and goals in that period.

Phase 1 (1955-1974): a fixed peg

In the phase 1 from March 1955 to July 1974, a fixed peg to major trading currency is adopted. After the strict currency reform¹⁴ in 1955, a fixed official rate of Renminbi (RMB) against the U.S. dollar (USD) was established and the rate was kept overtime until 1971, with the floating of the USD in August, the RMB began to appreciate against the USD. As a result of the devaluation of the USD, in December 1971, China changed the old peg to the new one and used British Pound Sterling as the anchor instead of USD until 1974.¹⁵

Phase 2 (1974-1980): a trade-weighted basket link of 15 currencies

In phase 2 from August 1974 to December 1980, the effective rate of RMB was pegged to a trade-weighted basket of 15 currencies. However, the composition of which was undisclosed, and the rate was fixed almost daily against that basket. (WCY 1990-1993, p.416)

Phase 3 (1981-1993): a dual-exchange rate system

In phase 3 from January 1981 to January 1993, a dual-exchange-rate system was introduced. In August 1979, the State Council decided to reform China's foreign exchange system in order to encourage export and constrain import appropriately, aimed at strengthen the foreign trade without affecting non-trade foreign exchange earning. (Guo and Han 2004) Therefore China adopted a dual-exchange rate system in 1981 and there were two types of exchange rates, the official rate (the effective rate) and the internal settlement rate. The official rate was used for non-trade-related

¹⁴ Under a draconic currency reform, 10,000 Jen Min Piao became equal to one new Yuan and a fixed Official Rate against the U.S. Dollar was established. The Chinese currency was renamed the Renminbi, divided into 10 Tsiao and 100 Fyng. The old name, "Yuan", continued to be use. (WCY 1984, p.171)

¹⁵ Following the devaluation of the U.S. Dollar, Peking announced that the Renminbi's exchange value against the Hong Kong Dollar and Pound Sterling would remain unchanged, and that all trade transactions would be channeled via these two units. With the Renminbi's theoretical gold content unaltered, a new Official rate resulted. (WCY 1984, p.171) At that period of time, Hong Kong Dollar was also pegged to Pound Sterling.

transaction, which was 3.08 units of RMB per USD. On the other hand, the internal settlement rate was used for authorized current account transactions, which was 2.8 units of RMB per USD.

In January 1985, the internal settlement rate was discontinued, thereby the official rate became the only rate in the market and all trade was governed by the effective rate.¹⁶ Following the establishments of special economics zones since the end of 1985, the dual-exchange rate system was reintroduced with the first formation of Foreign Exchange Adjustment Center (FEAC) in Shenzhen, a swap center with swap rate fluctuated around 5.2 - 5.7 units of RMB per USD at the end of 1993.

Phase 4 (1994-2005): a managed float (a de facto peg to U.S. dollar)

In phase 3 from January 1994 to July 2005, a managed float regime was claimed to be adopted by China, however, most of the scholars would say that the RMB was in fact a *de facto* peg to the USD. On the first of January 1994, the exchange rate was unified and the China Foreign Exchange Trade System (CFETS)¹⁷ in Shanghai came into operation, which adopted a single managed floating regime with a narrow band (RMB8.7/USD $\pm$ 0.25%). By May 1995, the exchange rate had appreciated to 8.3 units of RMB per USD. The rate appreciated further in October 1997 and reached 8.28 units of RMB per USD, meanwhile the band was narrowed further more during the Asian financial crisis. Then the exchange rate of RMB to USD was kept around at 8.277, and this was maintained over an extended period. The common assertion by many scholars that the RMB followed a *de facto* peg to USD from 1994 to 2005 is not quite accurate as the RMB had appreciated against the USD in this period of time.

¹⁶ In January 1986, the trade-weighted basket of currencies was abandoned and the Effective Rate was placed on a controlled float based on developments in the balance of payments and in costs and exchange rates of China's major competitors. (WCY 1990-1993, p.416)

¹⁷ The China Foreign Exchange Trade System (CFETS) in Shanghai was an integrated electronic system for inter-bank foreign exchange trading. 22 cities were linked to this system by the end of 1994. (IMF 1995, p.114)

From the Graph 3.1, the monthly middle rate of RMB against the USD shows that RMB had depreciated sharply by 33% in a very short period of time at the end of 1993. But this can be very misleading as the swap rate at that time is much closer to the newly merged official rate. After slightly appreciating from January 1994 to April 1995, the bilateral exchange rate of the RMB against the USD almost kept constant from May 1995 to October 1997 and looked like a horizontal line since the end of 1997 until reformation in July 2005.

Graph 3.1 The monthly exchange rate of RMB against USD from Jan 93 to Dec 05

Phase 5 (2005-present): a trade-weighted basket link of 11 currencies

On 21st July 2005, the People's Bank of China (PBOC) announced that RMB would immediately appreciate by 2% against the USD (the rate became RMB 8.11 per USD) and China would adopt "a managed floating exchange rate system" with "market demand and supply as foundation", which will "adjust with reference to a trade-weighted basket of currencies" and "adopt a steadily appreciating mechanism for the RMB against the U.S. dollar". After half of a month, on the 10th August, China revealed the composition of the basket. The USD, Euro, Japanese Yen and Korean won were the four major currencies and the other seven minor currencies were currencies of Singapore, Britain, Malaysia, Russia, Australia, Canada and Thailand.

Twenty months later, on the 21st May 2007, the central parity rate of RMB against the USD had accumulatively appreciated by 5.54 percent since the 21st July 2005 and the U.S. dollar price of the RMB became higher than that of the Hong Kong dollar.¹⁸ China widened the floating band of RMB against US dollar for daily spot trading on the inter-bank market from 0.3 percent to 0.5 percent.

From the Graph 3.2, the daily middle rate of RMB against the USD shows that the RMB appreciated by 2% in a day in the middle of July 2005. Also, the RMB kept appreciating steadily and slowly after the reformation in 2005. Moreover, the speed of appreciation seems to be increased after the third quarter of 2006.

Graph 3.2 The daily exchange rate of RMB against USD from Jan 05 to May 07

¹⁸ Hong Kong adopted a currency board and pegged to U.S. dollar since October 17, 1983. The bilateral exchange rate of Hong Kong dollar against U.S. dollar was kept at 7.8 units of H.K. dollar per U.S. dollar with a band of 0.05.

Chapter 4 The concept of linking to a currency basket

As the focus of the paper is currency basket, the basic theoretic framework and the mechanism of maintaining a link to a currency basket should be introduced. Conceptually, adopting a currency basket is like adopting a fixed exchange rate regime. However, the home country currency is not linked to a single foreign currency but the combination of several currencies in a basket instead, implying the possibility of varying bilateral exchange rate against any currency. Under a fixed exchange rate regime to the USD, whatever the relationship of the demand and the supply between the home currency and the USD, and the cross exchange rates of USD to other major currencies in the world are, the exchange rate of home currency to USD is kept at the pre-assigned level. When a country's currency is linked to a well defined currency basket including the USD, the performance or fluctuation of exchange rate of home currency may be seen as relating not only to the bilateral exchange rate between the home currency and the USD, but also the cross exchange rates of USD to other major currencies in the defined basket. In practice, the cross exchange rates of USD to other major currencies may be considered given, so that it is possible to maintain the link to a basket by adjusting the bilateral USD-home currency exchange rate, as proposed in Ho (1990). In short, currency basket usually is the sum of several weighted currencies and the value of the basket and the weight of each currency in the basket are given and then fixed at the time when the basket is set up.

4.1 Theoretical framework of currency basket

Consider a basket currency including n countries' currencies and using currency n as the unit of valuation, the basket equals the sum of y_i units of currency i . This means at the time of the launch of the basket, value of the basket suggested by Ho is:

$$V = \sum_{i=1}^n y_i \cdot e_i$$

where V is the value of the basket in currency n

y_i is the number unit of currency i in the basket

e_i is the exchange rate of currency i , which represents the number of units of currency n per currency i

$\frac{y_i \cdot e_i}{V}$ is the weighting (share of basket) of currency i in term of currency n

Obviously, over time the weighting (value share in the basket) will change according to the changes in exchange rates e_i .

As the weights of currency i should equal its share of basket at the time of the launch of the basket:

$$\frac{y_i \cdot e_i}{V} = w_i$$

Then the number of unit of each currency, y_i , can be calculated by follow equation:

$$y_i = (w_i \cdot V) / e_i$$

If we set the V equals x units of home country 0, then:

$$x_0 = V = \sum_{i=1}^n y_i \cdot e_i$$

From the specification above, x units of currency 0 is linked to a basket of several currencies (currency i). The specific number of units of each currency (y_i) is determined by the given weights on the currency (w_i) and the bilateral exchange rate of the currency (e_i) at the time when the basket is set up (base year 0). Moreover, x is given to set the value of the basket and which is then fixed at the base year 0.

For a basket currency of RMB worth 1 USD that includes 3 countries' currencies (USD, JPY and EUR):

$$x_0RMB = w_{US} \cdot 1USD / e_{USD / USD} + w_{JP} \cdot 1USD / e_{USD / JPY} + w_{EU} \cdot 1USD \cdot e_{USD / EUR}$$

$$x_0RMB = y_1USD + y_2JPY + y_3EUR$$

Therefore, x units of RMB equals to the sum of y_1 units of USD, y_2 units of JPY and y_3 units of EUR and the values of y_1 , y_2 and y_3 depend on weights of each currency (w_{US} , w_{JP} and w_{EUR}) in the basket and their cross rates ($e_{USD/USD}$, $e_{USD/JPY}$ and $e_{USD/EUR}$) with USD at the base year 0.

4.2 Operation of currency basket

In this section, how a currency basket operates in the reality will be discussed by using a 3 currency basket as an example.

To adopt the exchange rate policy of linking to a currency basket, first of all, the weighting method of the basket should be determined. Indeed, there are lots of weighting method used to use by different countries such as bilateral trade weights, global trade weights, gross domestic product weights, double weighting and even model based weights¹⁹. For the example in this section, bilateral trade weighting is adopted.

Then the composition of the basket (how many currencies and which currencies should be included in the basket) should be designed. There is not any rule to limit how many currencies should be included in a basket. It can be a 2 currency basket, 3, 4, 6, 11 and even more. But generally the number of currencies must not be too large; let say no more than 20. The reason behind is that if there are many currencies in a

¹⁹ The Multilateral Exchange Rate Model (MERM) used to introduce by IMF, but the MERM index has not been publish since 1992.

basket, the weights of those minor currencies may not be large enough to have any significant effect. For the example in this section, a 3 currency basket included the USD, the JPY and the EUR is adopted.

Thirdly, the weight of each currency in the basket should be calculated according to the chosen weighting method and designed basket composition. In the example used in this section, the calculated bilateral trade weights of China for the USD, the JPY and the EUR are 34%, 38% and 28% respectively.

The next step is to calculate the number of units of each currency in the basket by its own given weight and the international cross rates at the time when the basket's composition is fixed. For example, assuming that the basket is worth one USD, we can simply calculate the number of units of USD in the basket by setting that 34% of USD equals 0.34 units of USD. Then the number of units of JPY can be calculated by converting 0.38 units of USD to JPY by using the bilateral exchange rate of JPY to USD at the time 0. By the same logic, the number of units of EUR can be calculated by converting 0.28 units of USD to EUR. After calculation, the basket equals the sum of 0.34 units of USD, 47.5 units of JPY and 0.23 units of EUR.

Finally, the value of the basket in term of home currency should be assigned. For simplicity, the bilateral exchange rate of RMB to USD at time 0 can be simply used as the valuation of the basket. Therefore, 8.285 units of RMB equals the sum of 0.34 units of USD, 47.5 units of JPY and 0.23 units of EUR. That is:

$$8.285\text{RMB} = 0.34\text{USD} + 47.5\text{JPY} + 0.23\text{EUR}$$

It should be noted that once the basket is fixed, the number of units of each currency becomes constant whereas the relative share of basket of each currency can change daily according to those changes in international cross exchange rates. If a currency in the basket gains strength, its basket share will rise, and vice versa.

4.3 Calculation of bilateral exchange rates under a currency basket

In this section how to calculate bilateral exchange rates of home currency against other currencies under a currency basket is shown by using a 2 currency basket as an example. Consider a 2 currency basket of RMB with equation:

$$8.285\text{RMB} = 0.5\text{USD} + 0.3\text{EUR}$$

From above equation, 8.285 units of RMB equals to 0.5 units of USD plus 0.3 units of EUR. If we assume the exchange rate of USD against EUR at time t is 1, then:

$$1\text{USD} = 1\text{EUR}$$

The exchange rate of RMB against the USD at time t can be calculated by converting 0.3 units of EUR in the basket to the USD using the exchange rate of USD against EUR at time t. At the same time, the exchange rate of RMB against EUR at time t can be calculated by converting 0.5 units of USD in the basket to the EUR. Therefore, RMB/USD at time t:

$$8.285\text{RMB} = 0.5\text{USD} + 0.3\text{EUR} \times 1\text{USD}/1\text{EUR}$$

$$8.285\text{RMB} = 0.5\text{USD} + 0.3\text{USD} = 0.8\text{USD}$$

$$10.356\text{RMB} = 1\text{USD}; \text{ and } 10.356\text{RMB} = 1\text{EUR}$$

So the RMB/USD at time t equals to 10.356. For the RMB/EUR at time t, it also equals 10.356 as USD/EUR at time t equals to 1.

Now considering a new exchange rate of USD against EUR at time t+1 is equal to 2, that is:

$$2\text{USD} = 1\text{EUR}$$

Thereby, RMB/USD at time t+1:

$$8.285RMB=0.5USD+0.3EUR \times 2USD/1EUR$$

$$8.285RMB=0.5USD+0.6USD=1.1USD$$

$$7.532RMB=1USD; \text{ and } 15.064RMB=1EUR$$

So the new RMB/USD at time t+1 becomes 7.532, and the new RMB/EUR at time t+1 becomes 15.064.

From the above example of 2 currency basket, we can see that when the cross exchange rates of USD to other currencies change, a new bilateral exchange rate of RMB to these currencies can be calculated at any given time t. In addition, it shows that if the USD depreciates against EUR, the RMB under a 2 currency basket will also depreciate against EUR. Because under a currency basket included the USD, the RMB equals to a portion of the USD. At the same time, as the USD depreciates against EUR simply means the EUR appreciates against the USD, therefore RMB will also appreciate against the USD.

Moreover, a higher weight of a currency in the basket is, a lower fluctuation of RMB against this currency would be found and a higher fluctuation of RMB against other currencies would be the result. With the above implications, a currency basket shows a property of balancing the fluctuations of cross exchange rates of currencies inside the basket. In opposite, although peg to the USD means nearly zero fluctuation in the bilateral exchange rate of RMB against the USD, the bilateral exchange rates of RMB against currencies other than the USD must be much higher than the one generated by currency basket theoretically.

Chapter 5 Exchange rate volatilities under different baskets

In this chapter, the volatilities of exchange rates are examined. One way of seeking to answer the question of the implications of different currency baskets for stability of the exchange rates is to simulate how exchange rates would have moved under alternative exchange rate regimes. One of the criteria to distinguish a superior basket is the behavior of exchange rates under the currency basket. A basket is deemed superior if its volatility of an index of weighted bilateral exchange rate against other currencies is lower, or if a relatively more stable exchange rate movement obtains.

Why volatility can be used as a measurement of various baskets?

First of all, it makes sense as a relative stable exchange rates behavior is more welcome by merchandisers. Because when merchandisers do business with their foreign trading partners, there is always a time lag (general speaking two to three months) between the times when they sign the contracts and when they pay for or deliver the goods. If the bilateral exchange rate between two countries fluctuates seriously in this period, one side may suffer severely from the fluctuation, which depends on which country's currency the contract is written in. Hence a relatively more stable exchange rate behavior should be advantageous in term of merchandise trade. (Yu Qiao, 1998)

Moreover, in terms of the international division of labour, many local manufacturers in developing countries need to import raw materials, semi-finished goods or machinery and equipment. If the exchange rate fluctuates violently, they will have difficulties in cost control and production may therefore be disrupted.

Also, a stable exchange rate behavior generates a higher confidence from foreign investors. This may directly affect the long run foreign direct investment. Investors

feel more secure when the risks of exchange loss are smaller. A rational investor will not invest to a foreign country if they can only make profit in term of foreign currency, but suffer lose when they convert that profit to home country currency. As an exchange rate with higher volatility simply implies higher risks, they will seek for other alternatives associated with equal returns but lower risks.

Data and methodology

To calculate volatility of exchange rates under different currency baskets, we should firstly define the weighting method of a basket and then the composition of the basket. After calculating the weights of currencies in basket with its own composition, we can simulate the effects of linking to that currency basket by setting the bilateral exchange rate of RMB vis-à-vis each of the other currencies at the rates implied by that basket. Since diverse baskets may have distinct method to calculate their weights, details of data and methodology will be given under their specific descriptions. Under each basket, bilateral exchange rates against 13 major trading countries, nominal effective exchange rate index (NEER) and real effective exchange rate index (REER) are simulated correspondingly. All simulated exchange rates will cover the period from January 1993 to February 2007 with 170 observations. Then all bilateral rates are converted to indices with base period (January 1993) indices set to 100. Following by calculating the standard deviation of each series, the average and overall weighted standard deviation of 13 countries and NEERs and REERs are estimated.

Weighting schemes and basket compositions

As mentioned before, four types of weighting schemes are widely accepted nowadays. They are model-based weights, bilateral trade weights, global trade weights and double weighting schemes. (Philip and Jozef, 1993) This paper mainly

focuses on bilateral trade weights of China with her major trading partners.

Time varying weights

All our simulation exercises adopt time varying weights, in order to accommodate the rapidly changing international trade environment and pattern. For example, with intra-regional co-operation among Association of Southeast Asian Nations (ASEAN) and other countries of Asia, intra-regional trade has expanded dramatically over the years, economy integration of Euro Area, and noticeable emergences (financial crises) in Asia and Latin America, cause great changes in China's trade weights against these countries.

More specifically, for all weights from 1993 to 2006, three year average weights are introduced. Weights are defined for four sub-periods, namely 1993 to 1995, 1996 to 1998, 1999 to 2001 and 2002 to 2004. As some trade data of 2006 and 2007 are still not available, for the year 2005 and 2006, the average weights of 2002 to 2004 will be used as proxy.

In addition, the use of a three-year based time varying weights has another advantage in smoothing out the potentially deviating year-to-year variations. Similar practices are also implemented by some central banks and international organizations, such as the Federal Reserve, the Bank of England and OECD, in their calculation of weights of various effective exchange rate indices, which are usually updated yearly.

5.2.1 Bilateral trade weights of China

As the paper mostly focuses on the bilateral trade weights of China, both the original and the modified ones are figured out for comparison. Data used and calculating methods are going to be explained below.

Original trade weights of total ordinary trade and manufacture goods

For the original trade weights, the bilateral trade weights can be based on total trade or trade in manufacture goods. Data used in total ordinary trade of China are annual data of her total export to and total import from 52 trading partners from 1993 to 2004, and are collected from the UN Commodity Trade Statistics Database (UN Comtrade) and OECD International Trade by Commodity Statistics. For the manufacture goods trade, annual data between China and her 52 trading partners are also collected from UN Comtrade and OECD. Manufacture goods are defined as exports and imports under sections 5, 6, 7, 8 minus division 68 and group 891 of the Standard International Trade Classification Revision 3 (SITC Rev. 3).²⁰ This definition is also used by World Trade Organization (WTO) to define “Manufactures” in its world trade database²¹.

Modified trade weights of total ordinary trade and manufacture goods

For modified trade weights, the bilateral trade weights are also based on total trade and trade in manufacture goods. I use data set as same as the original trade weights, whereas the modified trade weights have been adjusted to take account of Hong Kong’s re-export trade. This procedure is needed as there is consensus that the official trade statistics published by China give a distortion view of trade relationship between China and her trading partners. It is because a substantial portion of China’s exports to and imports from the rest of the world are in fact re-exports²² via Hong

²⁰ SITC Rev.3 section 0 to 9 are “Food and live animals”(0), “Beverages and tobacco”(1), “Crude materials, inedible, except fuels”(2), “Fuels, lubricants and related materials”(3), “Animal and vegetable oils, fats and waxes”(4), “Chemicals and related products, n.e.s.”(5), “Manufactured goods”(6), “Machines and transport equipment”(7), “Miscellaneous manufactured articles”(8), and “Goods not classed by kind”(9) respectively. Division 68 is “Non-ferrous metals” and group 891 is “Arms and ammunitions”.

²¹ For details please read the technical notes of WTO statistical data sets on the internet, <http://stat.wto.org/StatisticalProgram/WSDBStatProgramTechNotes.aspx?Language=E>

²² Re-exports are defined as “foreign goods exported in the same state as previously imported...directly to the rest of the world” (United Nations, 1998)

Kong. From 2003 to 2005, the total value of Hong Kong re-exports from China to the world increased from US\$ 124 billion to US\$ 168 billion. Within a decade, it had been doubled from 88 US\$ billion in 1996 to US\$ 168 billion in 2005. While comparing China's total exports to United States are US\$ 593 billion in 2004 and US\$ 660 billion in 2005, these trade flows seem to be significant to China's trade weighting calculation. To give a clearer picture of China's export via Hong Kong, table 5.1 below shows Hong Kong's top 5 re-exports by major origins by major destinations in 2005.

Table 5.1: Hong Kong's top 5 re-export ²³ by major origins by destinations in 2005					
VALUE : USDMN			2005	2005	05/04
RANKING	Origins (Base on 06)	Destination	VALUE	%SHARE	% CHANGE
	CHINA		168360	100	15.7
1	CHINA	CHINA	45985	27.3	32.2
2	CHINA	USA	38170	22.7	7.6
3	CHINA	JAPAN	13033	7.7	8.9
4	CHINA	GERMANY	8319	4.9	20.6
5	CHINA	UNITED KINGDOM	7351	4.4	7.4
	JAPAN		23854	100	-4.2
1	JAPAN	CHINA	19834	83.1	-3.8
2	JAPAN	USA	643	2.7	-29
3	JAPAN	JAPAN	456	1.9	6.4
4	JAPAN	KOREA REP	411	1.7	-22.3
5	JAPAN	TAIWAN	313	1.3	-11.9
	TAIWAN		19551	100	13.9
1	TAIWAN	CHINA	17056	87.2	15.5
2	TAIWAN	TAIWAN	938	4.8	0.4
3	TAIWAN	KOREA REP	494	2.5	41.1
4	TAIWAN	SINGAPORE	208	1.1	12.6
5	TAIWAN	USA	161	0.8	-20.1
	KOREA REP		9491	100	15
1	KOREA REP	CHINA	7856	82.8	16.9
2	KOREA REP	TAIWAN	444	4.7	9.9
3	KOREA REP	KOREA REP	280	2.9	0.7
4	KOREA REP	USA	173	1.8	22.9
5	KOREA REP	SINGAPORE	127	1.3	-2.1
	USA		8244	100	4.1
1	USA	CHINA	6011	72.9	4
2	USA	USA	521	6.3	42.7
3	USA	KOREA REP	392	4.8	-2.4
4	USA	TAIWAN	225	2.7	-38.1
5	USA	SINGAPORE	217	2.6	-4.7

Source: Hong Kong Census and Statistics Department.

²³ Re-exports are defined by Hong Kong Census and Statistics Department as follow. "Re-exports of goods are products which have previously been imported into Hong Kong and which are re-exported without having undergone in Hong Kong a manufacturing process which has changed permanently the shape, nature, form or utility of the product. Their values are recorded on f.o.b. (free-on-board) basis." http://www.censtatd.gov.hk/hong_kong_statistics/statistics_by_subject/concept/external_trade/index.jsp

It shows that China which is ranked as number 1 as a supply source of Hong Kong's re-exports sells seven times as much of her products via Hong Kong to the world as does Japan, which is ranked as number 2, and equals 8.5 times as does Taiwan, 17.7 times as does Korea, 20.4 times as does the United States. Furthermore, all the annual percentage changes compared with 2004 shows an increasing trend. More and more products of China are expected to be exported to the rest of the world via Hong Kong in the form of re-exports. Therefore, adjustments for Hong Kong's re-exports trade to China are necessary for calculating relative more precise bilateral trade weights of China. Otherwise, an incorrect relative importance of each country to China would assign. More precisely, in a trade basket of China with an unrefined Hong Kong's re-exports, the basket would overweight Hong Kong whereas all other trading partners would be underweighted.

Adjustments to Re-export via Hong Kong and Re-import of China

In order to adjust the re-exports of Hong Kong from China reasonably, more detailed bilateral re-export data are obtained from the Trade Analysis Section of Hong Kong Census and Statistics Department. Usually, China's exports via Hong Kong to the rest of the world are recorded as Hong Kong's exports to these countries by raw trade statistics (here also refer to the case of UN Comtrade), which should be assigned back to China. With detailed re-export data, correction is possible since the data on Hong Kong's re-exports are broken down and categorized with respect to both origin and final destination.²⁴ In principle, China's exports to Hong Kong minus Hong Kong's re-exports from China are equal to the China's "actual exports to Hong Kong" (Hong Kong's retained imports from China). On the other hand, China's exports to

²⁴ Hong Kong statistics department did an excellent job. Beside of monthly re-export data by origins by destinations are published, re-exports are also broken down to different divisions and groups under both SITC and HS codes. For the case of Singapore, where is an entrepot for South East Asia, re-exports data are published by final destinations only. Therefore adjustments for Singapore's re-exports are not feasible at all.

other countries plus Hong Kong re-exports from China to other countries, net of Hong Kong's re-export margins, is equal to the China's total exports to other countries.

During the correction, attention should be paid to three more issues, first, the re-export margins earned by Hong Kong. Since figures of re-export data published include Hong Kong's export margins, it should be subtracted as value of this proportion was earned by Hong Kong but not China.

Adjustments to Re-import of China

Second, there are re-exports from Hong Kong back to China, which are also re-imports of China²⁵. The existence of re-imports of China is mainly consequence of a loophole in China's tax policy. Due to the fact that exports of China enjoy a refund of 13 to 17 percent value-added tax (VAT) from the central government, some products for domestic consumption are also exported to Hong Kong and then re-exported back to China just within one day. Within 26 years, the value of re-import rapidly increased 3056 times.²⁶ The fourth row fourth column of Table 5.1 shows Hong Kong's re-exports originated from and destined for China. It is necessary to subtract this value from China exports to Hong Kong. If not so, Hong Kong will be overweighted even more in China's basket.

Adjustments related to the f.o.b. to c.i.f. ratio

The third issue is that the re-export data are reported by Hong Kong on "free on broad (f.o.b.) basis". Although China's exports to world are also reported on f.o.b. basis, the 'cost, insurance and freight' (c.i.f.) of exports from China to Hong Kong should also be considered.

²⁵ Re-imports indeed are goods firstly exported from China to Hong Kong, and then re-exported from Hong Kong back to China.

²⁶ Detailed discussion on China's re-imports is given at the website of NanFang Daily, <http://www.nanfangdaily.com.cn/jj/20070314/zh/200703130004.asp>

Data used in adjustments

Re-export adjustments of Hong Kong from China were done with following data. First, annual data of Hong Kong re-exports from China export to herself 52 trading partners from 1993 to 2004 (both total trade and manufacture good defined by SITC Rev.3). Second, annual data of Hong Kong rate of re-export margin (RRXM) from China from 1993 to 2004.²⁷ Third, annual data of Hong Kong's imports at f.o.b. to c.i.f. value ratio (f.o.b/c.i.f. ratio) in 1996, 1998, 2003 and 2005, data are obtained from the Trade Surveys and Research Section of Hong Kong Census and Statistics Department. Table 5.2 shows Hong Kong RRXM²⁸ by origin of country/territory from 1990-2005, whereas table 5.3 shows Hong Kong's imports at f.o.b. to c.i.f. value ratio analyzed by main supplier from 1993 to 2005.

Table 5.2: Hong Kong's Rate of Re-export Margin by Origin of Country/Territory			
Year	The mainland of China	Others	Overall
1990	17.4	11.3	14.8
1991	20.5	9.3	15.9
1992	22.9	9.3	17.2
1993	26.1	7.8	18.3
1994	24.9	5.7	16.7
1995	24.7	5.6	16.5
1996	25.6	6.2	17.3
1997	25.7	6.9	17.8
1998	26	7.9	18.7
1999	27.7	8.8	20.3
2000	28.5	9.5	21.1
2001	27	9.6	20.2
2002	25.5	9.3	19.1
2003	23.9	9	17.9
2004	23.5	8.1	17.3
2005	23.5	7.8	17.5
Source: Hong Kong Monthly Digest of Statistics			

²⁷ Regular survey on average re-export margin (with goods originating from China and from the rest of the world) is conducted annually by Hong Kong Census and Statistics Department, and the data were obtained directly from the Department.

²⁸ RRXM is defined as the re-export margin expressed as a percentage of value of re-exports. The re-export margin (RXM) refers to the difference between the value of re-exports (RX) and the value of re-exports at import prices (RX_{IM}) of the same goods. RXM includes trader's profit and costs incurred by the trader in arranging the good for re-exportation. (Hong Kong Monthly Digest of Statistics, 2000)

It should be noted that author uses proxy for data of Hong Kong's f.o.b/c.i.f. ratio for 1993 to 1995, 1997, 1999 to 2002 and 2004. In the case of China, nevertheless, the estimation should be far more accurate than the practice did by Fung and Lau (2001) and the International Monetary Fund (IMF).²⁹ Which is a 10 percent discount is subtracted from the c.i.f. basis values to obtain the f.o.b. basis value. The data of Hong Kong's f.o.b/c.i.f. ratio shows that for the exports from China to Hong Kong, the percentage increase because of c.i.f. was only 0.99 percent of the original value in 1996 and decreased to 0.77 percent in 2005. For the exports from Hong Kong to United States it was only 4.23 percent in 1996 and decreased to 2.27 percent in 2005. For all countries, it was only 1.88 percent and 1.31 percent respectively. All of them are much smaller than 10 percent.

Table 5.3: Hong Kong's imports at f.o.b. to c.i.f. value ratio analyzed by main supplier³⁰

Year	Mainland China	Japan	European Union	Taiwan	United States	Korea	Singapore	Malaysia	Others	Total
1993	99.02	98.44	-	98.40	95.94	98.51	97.75	-	96.45	98.16
1994	99.02	98.44	-	98.40	95.94	98.51	97.75	-	96.45	98.16
1995	99.02	98.44	-	98.40	95.94	98.51	97.75	-	96.45	98.16
1996	99.02	98.44	-	98.40	95.94	98.51	97.75	-	96.45	98.20
1997	99.11	98.39	-	98.52	96.38	98.38	98.03	-	96.45	98.27
1998	99.19	98.33	97.88	98.64	96.81	98.26	98.30	98.11	96.45	98.33
1999	99.19	98.33	97.88	98.64	96.81	98.26	98.30	98.11	96.45	98.33
2000	99.19	98.33	97.88	98.64	96.81	98.26	98.30	98.11	96.45	98.33
2001	99.21	98.87	98.04	99.22	97.85	98.73	98.73	98.51	97.64	98.77
2002	99.21	98.87	98.04	99.22	97.85	98.73	98.73	98.51	97.64	98.77
2003	99.21	98.87	98.04	99.22	97.85	98.73	98.73	98.51	97.64	98.77
2004	99.23	98.66	97.96	99.15	97.82	98.76	98.78	98.42	97.62	98.74
2005	99.24	98.45	97.87	99.07	97.78	98.78	98.83	98.32	97.60	98.71

Source: Hong Kong Monthly Digest of Statistics

To sum up, refinement can be done by first adjusting the value of re-exports of Hong Kong from China by subtracting Hong Kong's RRMX, and then subtracting

²⁹ In Fung and Lau (2001), it mentions that "applying a 10% discount is the conventional method of conversion" for c.i.f. basis value to f.o.b. basis value.

³⁰ Data of 1993, 1994 and 1995 take value of 1996 as proxy. Data of 1997 takes the average value of 1996 and 1998. Data of 1999 and 2000 take value of 1998 as proxy. Data of 2001 and 2002 take value of 2003 as proxy. Data of 2004 takes the average value of 2003 and 2005.

again by 0.99 to 0.77 percent from the c.i.f. basis values to obtain the f.o.b. basis value. Finally, the adjusted value of re-exports of Hong Kong can be added to the China's exports to others countries and subtracted from China's export to Hong Kong, including the re-exports of Hong Kong from China.

Bilateral trade weights calculations

For calculating trade weights of China, the formulae shown below are applied.

I. Export weight:

$$W_{xi} = X_i/X$$

II. Import weight:

$$W_{mi} = M_i/M$$

III. Simple average weight:

$$W_{si} = (W_{xi} + W_{mi})/2$$

IV. Weighted average weight:

$$W_{wi} = W_{xi}(X/(X+M)) + W_{mi}(M/(X+M))$$

where: W_{xi} (W_{mi}) = weight of China's exports (imports) to country i

X_i (M_i) = China's exports (imports) to country i

X (M) = China's total exports (imports)

W_{si} = Simple average weight of country i in China's basket

W_{wi} = Weighted average weight of country i in China's basket

First of all, the original total trade data and the Hong Kong re-exports adjusted trade data will be used to calculate both W_{xi} and W_{mi} of country i . Then W_{si} and W_{wi} of country i are calculated according to W_{xi} and W_{mi} , and W_{wi} will be used as trade weights in the basket.

Trade baskets compositions

For bilateral trade weighted basket, basket compositions include 1, 3, 4, 6, 11

and 13 major currencies respectively. The 1 currency basket contains the U.S. Dollar (USD) only, which is used to simulate the situation of a fixed dollar peg. The 3 currency basket contains USD, Japanese Yen (JPY) and Euro, which are the most common currencies in the world. The 4 currency basket contains USD, JPY, Euro and Korean Won (KRW), which are the 4 major currencies out of 11 currency basket revealed by China's central bank. The 6 currency basket contains USD, JPY, Euro, KRW, Hong Kong dollar (HKD) and the New Taiwan Dollar (TWD). Such of these countries accounted for more than 5 percent of China's total trade from 1993 to 2004. The 11 currency basket is the basket exactly revealed by China's central bank. Finally, the 13 currency basket³¹ contains currencies of all those countries which accounted for more than 1 percent of China's total trade from 1993 to 2004.

5.2.2 Linking to World Currency Unit (WCU)

The "World Currency Unit" (WCU) as proposed by Ho (2000), which is an "indexed unit of account" representing stable purchasing power against a global basket of goods and services. It is believed that if one country's currency is linked to an index representing steady global purchasing power against a basket of real world output, the real value its currency will more be stable and its real exchange rates will no longer experience intense fluctuation. In addition, both domestic and foreign traders and investors will have higher confidence in local currency, which benefit not only international trade but domestic and foreign direct investments. Also pointed out by Ho (2000), "...the currency in linked to a stable unit of real and 'global' purchasing power, issuing debt instruments in the domestic currency will sharply reduce worries about devaluation for the creditors, and will also relieve debtors of

³¹ 13 currency basket contains USD, JPY, Euro, KRW, HKD, TWD, Australian dollar (AUD), Canadian dollar (CND), Malaysian (MYR), Russian (RUR), Singapore dollar (SGD), Thailand Baht (THB), Great British Pound (GBP).

worries about devaluation increasing the servicing cost of their debts.” This means that it will help the economy to reduce interest rate, thus encourages investment.

Basic concepts of WCU³²

The World Currency Unit is defined as a basket of the GDPs of the world’s key market economies in the base year, and in Ho’s illustrative exercise the key economies included the United States, the Euro area, the United Kingdom, Japan, Canada and Australia³³ scaled down to equal US\$100 during the base year. Let Q_{i0} be the GDP of country i in base year 0. Thus in the base year 0:

$$1WCU = \lambda \sum Q_{i0} \cdot e_{i0} = \text{US\$100} \dots (1)$$

$$V_{0\text{US\$}t} = \lambda \sum Q_{i0} \cdot P_{it} / P_{i0} \cdot e_{it} \dots (2)$$

where: λ is the scaling factor,

i is any of the six major economies,

Q_{i0} is the GDP of country i in the base year 0

e_{i0} is the exchange rate converting one unit of the currency of i into US\$ in the base year 0.

P_{it} / P_{i0} is the change in country i ’s price level in time compared with its price level in the base year 0

e_{it} is the exchange rate at time t to convert into current USD

³² The basic concept and definition of WCU are cited from Ho (2000).

³³ These economic zones are representative in that they comprise the world’s major industrial zones as well as major producers of primary goods, which also encompass around 75 percent of the world output. Furthermore, all currencies of them are fully and freely convertible in the international market.

*WCU calculations*³⁴

For this exercise 2000 GDP weights are used throughout. Ideally every so many years they should be updated too, and the new series is spliced onto the old series much as new CPI series is spliced into the old CPI series after a new household expenditure survey has been completed. Thus the GDPs in 2000 price of United States, the Euro area, the United Kingdom, Japan, Canada and Australia form the WCU basket. Data are sourced from International Financial Statistics (IFS) database. Then monthly data of CPIs (2000=100) of six regions are also collected from IFS database are used to convert the GDP of each country into current prices. After this the current price GDPs are converted into USD. Since the USD has lost real purchasing power over the years if the RMB were pegged to the WCU it would appreciate rather significantly against the USD.

The concept of real exchange rate and real effective exchange rate

Before going through the calculation of real effective exchange rate index (REER), the concept of real exchange rate in the literature of purchasing power parity will be discussed.

The long-run equilibrium exchange rate in purchasing power parity

Following the literature of purchasing power parity (PPP),³⁵ the real exchange rate is the ratio of the price level of overseas country to that of domestic country expressed in the same currency. That is:

$$RE_t = E_t \cdot P_{dt}/P_{ft}$$

³⁴ For a more detail description of WCU calculation, please refer to Ho (2000).

³⁵ The Purchasing power parity (PPP) theory was developed by Gustav Cassel in 1920. It is the method of using the long-run equilibrium exchange rate of two currencies to equalize the currencies' purchasing power. At microeconomic level PPP is also known as the law of one price (LOOP), the idea is that the price of the same good in different countries with their own currencies should be the same when the domestic price of the good is converted to a common currency.

where REt is the real exchange rate between China and country i

Et is the nominal exchange rate (the foreign price of a domestic currency)

Pdt is the domestic price level

Pft is the overseas price level in units of the foreign currency

When Pdt is multiplied by Et , domestic price level is converted to price level in foreign currency and therefore is directly comparable with Pft , the foreign price level. If the PPP holds and there is only one goods in the world, then the ratio (REt) must be equal to 1. For example, suppose Pdt equals to 8 RMB and Pft equals 1 USD, then the absolute PPP implied that the nominal exchange rate, Et , must equals to 1/8. Therefore, the real exchange rate between China and United States also equals to 1 ($REt = Et \cdot Pdt/Pft = 1/8 \cdot 8/1 = 1$). When the ratio is large than one, that is, the nominal exchange rate is larger than *the ratio of foreign price level to domestic price level*:

$$REt > 1, \text{ that is, } Et > Pft/Pdt$$

In this case, the RMB is said to be overvalued. It is because the PPP implied nominal exchange rate should be 1/8 but now the actual nominal exchange rate is, let say, 1/4, then the USD cost of RMB is 100 percent higher than one implied by PPP (0.25USD:0.125USD). That is, people can use the same amount of the RMB in past (8RMB) to exchange double amount of the USD (0.25USD) compared to the amount in past (0.125USD). Whereas the RMB cost of USD is 50 percent lower than one implied by the PPP (4RMB:8RMB). That is, people can use half amount of the RMB (4RMB) compared to the amount in past (8RMB) to exchange for 1 units of USD. The REt equals to 2 ($REt = 1/4 \cdot 8/1 = 2=100/50$). In other words, the cost of RMB is too high and the RMB is overvalued by 50 percent.

Beside of overvaluation, there is another possibility that the RMB is undervalued. When the real exchange rate is smaller than one, that is, the nominal exchange rate is smaller than *the ratio of foreign price level to domestic price level*:

$$RE_t < 1, \text{ that is, } E_t < P_f/P_d$$

In this case, the RMB is said to be undervalued. It is because the PPP implied nominal exchange rate should be 1/8 but now the actual nominal exchange rate is, let say, 1/12, then the RMB cost of US dollar is 50 percent higher than one implied by PPP (12RMB:8RMB). That is, people need to use half of the amount more of the RMB (12RMB) compared to the amount in past (8RMB) to exchange for 1 units of the USD. The RE_t equals to ($RE_t = 1/12 \cdot 8/1 = 2/3 = 100/150$). In other words, the cost of RMB is too low and the RMB is undervalued by 50 percent.

After knowing the concept of real exchange rate which is assumed there are only two countries with single goods, let move on the concept of real effective exchange rate (REER), which is an indexed real exchange rate of more than two countries.

The concept of REER and its calculation

For a world with N countries, the REER of a country can be expressed as:
(Artus, Rhomberg, 1973 adopted from Branson, 1981)

$$I = \sum_i^N w_i (T_i \cdot q_i / p_0); \sum_i^N w_i = 1$$

where I = real effective exchange rate index of home country

w_i = weights for 0's basket peg; i = index over N countries, $i = 1, 2 \dots N$.

With home country as 0 and numeraire country as N

T_i = units of 0 currency per unit of i currency

q_i = foreign country's cost index; p_0 = home country's cost index

Actually the logic behind REER is more or less the same as the one of real exchange rate. It is because REER is a weighted average of bilateral real exchange rate index, which provides information about the competitiveness of an economy.

Calculation of REER

To calculate the REER, the weighting method of the index must be firstly determined. Although there are different weighting methods for calculating the REER, which method should be adopted depends on the objective of REER (what information would like to get from the index). Generally, trade of goods weights, trade of services weights and FDI weights are commonly used. In this paper, the weighted average weights of exports and imports are adopted in calculating REER.

After the weighting method is determined, the composition of the index should be designed. In other words, we should design how many exchange rate series are there in the REER. The REER of China used in simulation includes bilateral exchange rates of RMB against the currencies of 13 countries

To calculate REER, those bilateral nominal exchange rate series should be deflated to the bilateral real exchange rate index. On the other hand, those exchange rate series do not need to be deflated if we are going to calculate nominal EER. Consumer Price Indices (CPIs) are commonly used as deflators in calculating REER, even though Export Prices Indices (EPIs) or Producer Price Indices (PPIs) ought to be a better choice. It is due to the fact that not every country publishes EPIs and PPIs and therefore price deflators of different countries become incomparable.

Finally, the proposed REER used in this thesis is calculated by summing up those weighted real bilateral exchange rate index, which equals the weight of each currency times real bilateral exchange rate of that currency. In this paper, REERs are calculated by the equation below.

$$I = \sum_1^{13} w_i \cdot \left(\frac{e_{it}}{e_{i2000}} \cdot \frac{CPI_{CHINA_t}}{CPI_{it}} \right) \cdot 100; \sum_1^{13} w_i = 1$$

where I = real effective exchange rate index of home country

i = index over 13 countries, $i = 1, 2 \dots 13$. With home country as 0 and

$\left(\frac{e_{it}}{e_{i2000}} \cdot \frac{CPI_{CHINA_t}}{CPI_{it}} \right) \cdot 100$ = the real bilateral exchange rate index of RMB

against currency i

$$e_{it} = \frac{curr_i}{RMB}_t$$

According to the equation above, when the value of REER index increases, RMB appreciates, vice versa.

Results and analysis

In this section, first, it will go through the calculated weights of different weighting schemes.³⁶ Then the simulated exchange rate movements of various baskets will be observed and finally, the volatilities of various baskets will be discussed.

Findings on calculated weights

Calculated weights of China's bilateral trade

Table 5.4 shows calculated bilateral trade weights of 3 currency basket. In the third row, “Ex” stands for the export weights and “Im” stands for the import weights. On the other hand, “S.Avg” stands for the simple average weights and “W.Avg” stands for the weighted average weights. In the first column, Type I, II, III, IV stand for the modified trade weights of total ordinary trade, the original trade weights of total ordinary trade, the modified trade weights of manufacture goods, the original trade weights of manufacture goods respectively. In the second column, abbreviations of name of trading partners whose currencies formed the basket are given. For

³⁶ Bilateral trade weights of the 3 currency basket and the 6 currency basket will show in Table 5.4 and table 5.5 later respectively, whereas summary of the modified weights of 4, 11, 13 currency baskets will be given in Table 5.6.

example, currencies of Japan, United States and Euro area are in China's 3 currency basket, therefore JP, USA and ER are abbreviated in the second column named "Partner". Moreover, bilateral weights are divided into four periods and each period covers 3 years, from 1993 to 2004.

Table 5.4: Bilateral trade weights of 3 currency basket (in percent)																	
	Period	1993-1995weights				1996-1998weights				1999-2001weights				2002-2004weights			
Type	Partner	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg
I	JP	30.0	51.0	40.5	41.1	30.3	49.7	40.0	39.8	28.7	47.6	38.2	38.0	26.0	49.5	37.8	38.0
I	USA	44.9	23.2	34.0	33.5	44.9	25.6	35.3	35.4	46.1	25.7	35.9	36.0	46.3	22.2	34.3	34.0
I	ER	25.1	25.8	25.5	25.5	24.8	24.7	24.8	24.8	25.2	26.7	25.9	25.9	27.7	28.3	28.0	28.0
II	JP	39.5	47.3	43.4	43.4	37.3	47.0	42.2	41.7	33.6	45.5	39.5	39.1	28.0	47.7	37.9	37.3
II	USA	37.9	24.5	31.2	31.2	39.4	26.8	33.1	33.7	41.9	26.2	34.1	34.6	44.5	22.8	33.6	34.3
II	ER	22.6	28.2	25.4	25.4	23.3	26.2	24.8	24.6	24.5	28.3	26.4	26.2	27.5	29.5	28.5	28.5
III	JP	25.1	53.0	39.1	39.7	26.4	51.4	38.9	38.3	25.7	49.4	37.5	36.9	23.6	51.8	37.7	37.3
III	USA	48.9	20.7	34.8	34.2	48.1	23.2	35.6	36.3	48.7	23.6	36.1	36.8	48.2	19.1	33.7	34.0
III	ER	26.0	26.3	26.1	26.1	25.5	25.5	25.5	25.5	25.6	27.0	26.3	26.3	28.2	29.1	28.7	28.6
IV	JP	33.2	49.6	41.4	41.4	32.5	49.0	40.7	39.7	30.0	47.5	38.7	37.8	25.2	50.2	37.7	36.3
IV	USA	43.2	21.3	32.2	32.2	43.4	23.6	33.5	34.8	45.0	23.6	34.3	35.5	46.7	19.1	32.9	34.4
IV	ER	23.6	29.1	26.3	26.4	24.0	27.4	25.7	25.5	25.0	28.8	26.9	26.7	28.1	30.7	29.4	29.3
I = Modified trade weights of total ordinary trade II = Original trade weights of total ordinary trade III = Modified trade weights of manufacture goods IV = Original trade weights of manufacture goods Source: Author's calculation																	

China's second trading pattern is changing

After calculating bilateral trade weight, we can see that the international trading pattern of China is changing overtime. Let us focus on row 6, 7, and 8 of Table 5.4 first, which is the trade weight of total ordinary trade without any adjustment (Type II). Within a decade, the percentage share of total trade with Japan has decreased by about 6.1 percentage point³⁷ from 43.4 percent in 1993-1995 to 37.3 percent in 2002-2004. However, the percentage share of import from Japan was kept at around 47 percent all over the time, which means that the percentage share of export to Japan decreases steadily (from 39.5 percent to 28 percent). In contrast, the percentage share of total

³⁷ In the practice of Bank of Israel, "the final trade figures for the previous year would be reviewed, and if these showed a *different of two percentage* points or more between a currency's weight in the basket and its share of trade, the composition of the basket would be amended accordingly."

trade with the Euro area was kept increasing from 24.6 percent to 28.5 percent from the period of 1996-1998 to the period of 2002-2004, which increases almost 4 percent in total and both percentage share of export to and import from Euro area is increasing smoothly. In the case of United States, all percent change of bilateral trade change slightly over the time.

Differences between manufacture goods and total ordinary trade weights

Now let us compare rows 6, 7, and 8 (Type II) with rows 12, 13 and 14 of Table 5.4, which show the trade weights of total manufacture goods³⁸ without any adjustment (Type IV). The table shows that the trade weights of manufacture goods are a bit different from that of total ordinary trade. Nevertheless, the effects of using manufacture goods data to calculate the trade weights should be noted. For Japan, all trade weights drop 2 percent in the first two periods (1993-1995 and 1996-1998) and 1 percent in the last two periods (1999-2001 and 2002-2004). For the United States, all trade weights increases about 1 percent besides the period of 2002-2004. For the Euro area, there are approximately 1 percent increases in weighted average trade weights, excepted the period of 1999-2001.

Differences between modified trade weights and original trade weights

Table 5.5 shows calculated bilateral trade weights of the 6 currency basket. Beside of Japan, the United States and the Euro area, Hong Kong (HK), South Korea (KR) and Taiwan (TW) were also included in the basket. In original trade weights (non-adjusted) of the total ordinary trade of China to other 53 countries³⁹, Hong Kong, South Korea and Taiwan are countries or regions with percentage share of trade over 5 percent, with an average of weighted average trade weight 14.4 percent, 7.3 percent

³⁸ Manufacture goods are defined as exports and imports under sections 5,6,7,8 minus division 68 and group 891 of the Standard International Trade Classification Revision 3 (SITC Rev. 3).

³⁹ These 53 countries (12 of them are in Euro area) consist around 90% of China's total trade from 1993 to 2004.

and 7.2 percent accordingly. Again, Table 5.5 shows all four types of weighting of China's 6 currency basket, also weighting are divided into 4 time periods, from 1993 to 2004.

Table 5.5: Bilateral trade weights of 6 currency basket (in percent)																	
	Period	1993-1995weights				1996-1998weights				1999-2001weights				2002-2004weights			
Type	Partner	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg
I	HK	5.0	13.7	9.4	9.6	3.9	14.0	9.0	8.9	4.5	10.0	7.2	7.2	1.2	6.1	3.7	3.7
I	JP	26.0	30.5	28.2	28.3	26.3	28.0	27.2	27.1	24.7	27.9	26.3	26.3	22.7	28.	25.7	25.8
I	KR	5.2	8.5	6.9	6.9	5.9	12.4	9.1	9.1	6.2	13.8	10.0	9.9	7.6	16.0	11.8	11.9
I	TW	3.2	18.1	10.6	11.0	3.3	17.2	10.2	10.2	3.2	17.6	10.4	10.3	3.8	19.8	11.8	11.9
I	USA	38.8	13.9	26.3	25.7	39.1	14.5	26.8	26.9	39.7	15.1	27.4	27.6	40.5	12.9	26.7	26.4
I	ER	21.7	15.4	18.6	18.4	21.6	13.9	17.8	17.8	21.7	15.7	18.7	18.7	24.2	16.4	20.3	20.2
II	HK	32.5	11.0	21.8	21.8	29.2	7.2	18.2	19.3	24.2	6.1	15.2	15.8	24.2	4.3	14.2	14.8
II	JP	23.7	30.3	27.0	27.0	23.3	29.1	26.2	25.9	22.5	28.0	25.3	25.1	18.6	28.3	23.4	23.1
II	KR	5.0	8.9	6.9	6.9	5.8	14.3	10.0	9.6	6.0	15.1	10.6	10.3	6.5	17.1	11.8	11.5
II	TW	2.5	16.1	9.3	9.3	2.5	16.6	9.6	8.8	2.7	17.2	9.9	9.4	3.0	19.4	11.2	10.7
II	USA	22.7	15.7	19.2	19.2	24.6	16.6	20.6	21.0	28.1	16.2	22.1	22.6	29.5	13.5	21.5	22.0
II	ER	13.6	18.1	15.8	15.8	14.5	16.2	15.4	15.3	16.4	17.4	16.9	16.9	18.2	17.5	17.9	17.9
III	HK	3.2	9.4	6.3	6.4	2.1	8.8	5.4	5.2	3.2	7.2	5.2	5.1	0.6	4.5	2.5	2.5
III	JP	22.5	33.1	27.8	28.0	23.8	30.7	27.2	27.1	22.8	29.9	26.3	26.1	21.0	30.3	25.7	25.6
III	KR	4.1	8.8	6.4	6.5	4.8	12.7	8.7	8.5	5.1	13.6	9.4	9.1	6.5	16.2	11.4	11.2
III	TW	2.9	19.5	11.2	11.6	3.1	18.8	11.0	10.6	3.1	18.7	10.9	10.5	3.6	20.8	12.2	12.0
III	USA	43.9	12.9	28.4	27.7	43.3	13.8	28.6	29.3	43.1	14.3	28.7	29.5	43.0	11.2	27.1	27.5
III	ER	23.3	16.4	19.9	19.7	22.9	15.2	19.1	19.3	22.7	16.3	19.5	19.7	25.2	17.0	21.1	21.2
IV	HK	34.3	11.0	22.7	22.6	30.2	7.5	18.9	20.3	24.9	6.3	15.6	16.6	24.7	4.3	14.5	15.6
IV	JP	19.8	31.6	25.7	25.7	20.4	30.2	25.3	24.7	20.3	29.3	24.8	24.3	16.9	29.4	23.2	22.5
IV	KR	3.9	8.6	6.3	6.3	4.6	13.7	9.2	8.6	4.8	14.4	9.6	9.1	5.5	17.0	11.2	10.6
IV	TW	2.3	16.6	9.5	9.5	2.4	17.0	9.7	8.8	2.5	17.8	10.1	9.3	2.8	20.1	11.4	10.5
IV	USA	25.7	13.6	19.6	19.6	27.2	14.6	20.9	21.7	30.5	14.6	22.5	23.4	31.3	11.2	21.2	22.4
IV	ER	14.0	18.6	16.3	16.3	15.1	16.9	16.0	15.9	16.9	17.8	17.4	17.3	18.8	18.0	18.4	18.5
I = Modified trade weights of total ordinary trade II = Original trade weights of total ordinary trade III = Modified trade weights of manufacture goods IV = Original trade weights of manufacture goods Source: Author's calculation																	

To see the divergence between modified trade weights and original trade weights, we should first compare rows 15 to 20 (Type III) with rows 21 to 26 (Type IV) of Table 5.5. According to row 21, there is a decreasing trend in Hong Kong's trade share. The original trade weight of manufacture goods of Hong Kong has fallen by 7 percentage points over twelve years. From 22.6 percent decreases to 20.3 percent and then drops to 16.6 percent and 15.6 percent respectively. However, the actual

bilateral trade value between China and Hong Kong in fact are indeed increasing continuously. This phenomenon can be explained by the fact that the gross value of China bilateral trade with the world are growing rapidly in this dozen of year and the growth rates of China's trade with other countries are faster than the growth rate of China's trade with Hong Kong, such as China's trade with Euro area and South Korea.

If we look at the export weight of Hong Kong in row 21, we will find that the export percentage shares of Hong Kong in all four periods are unreasonably high. It is impossible and unbelievable that Hong Kong, just a small dot on a world map with seven million populations, almost got the highest export weights in all four periods (the highest export weights from 1993 to 1998 and the second high export weights from 1999 to 2004). And this phenomenon can be explained by Hong Kong's geographical location makes herself as an entrepot of China and re-exports billion tons of goods to the rest of the world after China adopting the open door policy in early 1990s. To correct these false weights, adjustments to Hong Kong's re-exports from China to the world and re-import of China are needed. The adjusted data are shown in row 15 to 20 (Type III) of Table 5.5. After correction, the export weight of Hong Kong in the first period (1993-1995) drops obviously from 34.3 percent to 3.2 percent, meanwhile, the weighted average weight of Hong Kong also falls sharply from 22.6 percent to 6.4 percent. At the same period, the weighted average weights of remained 5 countries increase and the degree of increasments are depended on the extent that China did export to those countries via Hong Kong in the form of re-exports. For instances, the weighted average modified trade weight of manufacture goods of the United States increases the most from 19.6 percent to 27.7 percent (8.1 percent in total) in the period of 1993-1995, the ones of Euro area and Japan rise moderately by 3.4 and 2.3 percent accordingly, whereas the one of South Korea steps

up merely 0.2 percent in total.⁴⁰ In the paper, trade weights after refinements must be superior to the original ones to reflect the actual situation of China. Hence, in the later parts, it will mainly focus on the modified trade weights for calculations.

Relationship between basket composition and relative size of weights

Table 5.6 summarizes the modified trade weights of manufacture goods of 4-currencies, 11-currencies and 13 currency baskets.⁴¹

Table 5.6: Modified manufacture goods trade weights of 4, 11, and 13 currency baskets (in percent)																	
	Period	1993-1995weights				1996-1998weights				1999-2001weights				2002-2004weights			
Type	Partner	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg	Ex	Im	S.Avg	W.Avg
II	JP	24.0	46.5	35.3	35.7	25.1	42.4	33.7	33.3	24.3	40.3	32.3	31.9	22.0	40.6	31.3	31.0
II	KR	4.3	12.3	8.3	8.5	5.0	17.5	11.3	11.0	5.5	18.3	11.9	11.6	6.8	21.7	14.2	14.1
II	USA	46.8	18.1	32.5	31.8	45.7	19.1	32.4	33.1	46.0	19.3	32.6	33.4	44.9	14.9	29.9	30.3
II	ER	24.8	23.1	24.0	23.9	24.2	21.0	22.6	22.7	24.2	22.1	23.1	23.2	26.3	22.8	24.5	24.6
II	AU	2.4	0.7	1.5	1.5	2.3	0.7	1.5	1.5	2.3	0.6	1.5	1.5	2.4	0.6	1.5	1.5
II	CN	2.5	1.3	1.9	1.9	2.3	1.3	1.8	1.8	2.4	1.5	1.9	1.9	2.3	1.1	1.7	1.7
II	JP	20.0	40.8	30.4	30.9	20.8	36.1	28.5	28.1	20.2	33.7	26.9	26.5	18.0	33.4	25.7	25.5
II	KR	3.6	10.8	7.2	7.4	4.2	14.9	9.6	9.3	4.5	15.3	9.9	9.6	5.6	17.9	11.7	11.6
II	MY	1.2	1.3	1.2	1.2	1.4	2.4	1.9	1.9	1.5	3.7	2.6	2.5	2.1	5.3	3.7	3.7
II	RU	1.5	3.7	2.6	2.7	1.2	3.0	2.1	2.1	1.0	2.3	1.7	1.6	1.8	1.7	1.7	1.7
II	SG	3.0	2.1	2.6	2.5	3.5	3.2	3.4	3.4	3.3	3.3	3.3	3.3	3.3	4.1	3.7	3.7
II	TH	1.4	0.9	1.1	1.1	1.2	1.9	1.6	1.6	1.3	2.7	2.0	1.9	1.5	3.2	2.4	2.3
II	UK	4.8	2.4	3.6	3.5	5.0	2.2	3.6	3.7	5.2	2.6	3.9	3.9	4.8	1.6	3.2	3.2
II	USA	39.0	15.9	27.4	26.9	38.0	16.3	27.1	27.7	38.2	16.1	27.1	27.7	36.8	12.3	24.6	24.9
II	ER	20.7	20.3	20.5	20.5	20.1	17.9	19.0	19.1	20.1	18.4	19.3	19.3	21.5	18.8	20.2	20.2
II	AU	2.3	0.5	1.4	1.4	2.2	0.5	1.4	1.4	2.2	0.5	1.3	1.4	2.3	0.4	1.4	1.4
II	CN	2.4	0.9	1.7	1.6	2.2	1.0	1.6	1.6	2.3	1.1	1.7	1.7	2.3	0.9	1.6	1.6
II	HK	2.7	8.5	5.6	5.7	1.7	7.8	4.8	4.6	2.7	6.3	4.5	4.4	0.5	3.8	2.2	2.1
II	JP	19.0	30.1	24.5	24.8	19.9	27.3	23.6	23.4	19.1	26.0	22.6	22.4	17.4	26.2	21.8	21.6
II	KR	3.4	8.0	5.7	5.8	4.0	11.3	7.6	7.5	4.3	11.8	8.1	7.9	5.4	14.0	9.7	9.6
II	MY	1.1	0.9	1.0	1.0	1.3	1.8	1.6	1.6	1.4	2.9	2.1	2.1	2.0	4.2	3.1	3.1
II	RU	1.4	2.8	2.1	2.1	1.1	2.3	1.7	1.7	1.0	1.8	1.4	1.4	1.7	1.3	1.5	1.5
II	SG	2.9	1.5	2.2	2.2	3.4	2.4	2.9	2.9	3.2	2.6	2.9	2.9	3.2	3.2	3.2	3.2
II	TW	2.5	17.8	10.1	10.5	2.6	16.7	9.7	9.3	2.6	16.3	9.5	9.1	3.0	17.9	10.4	10.3
II	TH	1.3	0.6	1.0	0.9	1.2	1.4	1.3	1.3	1.2	2.1	1.7	1.6	1.5	2.5	2.0	2.0
II	UK	4.5	1.7	3.1	3.1	4.8	1.7	3.2	3.3	4.9	2.0	3.4	3.5	4.6	1.3	2.9	3.0
II	USA	37.0	11.7	24.3	23.8	36.3	12.3	24.3	24.9	36.2	12.4	24.3	24.9	35.5	9.6	22.6	22.9
II	ER	19.6	14.9	17.3	17.2	19.2	13.5	16.4	16.5	19.0	14.2	16.6	16.8	20.8	14.7	17.7	17.8
Source: Author's calculation																	

Source: Author's calculation

⁴⁰ In the case of 3 currency basket, the adjustment effects on weighting are not as strong as 6 currency basket as HKD is not inside the basket.

⁴¹ The 4 currency basket consists of the four major currencies out of eleven announced by China's Central Bank on August 2005. The 11 currency basket consist of the eleven major currencies exactly the same as what announced by China's Central Bank

It is clear that with the number of currencies in the basket increases, the relative importance, that is, the relative size of weighting of each currency decreases. Let look United States as an example, in the 4 currency basket, the weights of USA is in an average of 32 percent. When the number of currencies increases to eleven and thirteen respectively, the weight of USA drops to 26.8 percent and 24.1 percent accordingly.

Behaviors of simulated exchange rates

In the following section, the behaviors of simulated exchange rate of each basket with unique weighting method and distinct basket composition are examined. Graph 5.1 shows behaviors of the actual and simulated exchange rates from January 1993 to February 2007. It compares the historical exchange rate movement with those simulated under various currency baskets. The Y axis is the exchange rate of RMB against the USD, that is, “CNY⁴²/USD”, and the X axis is the time line. In the legend, “Hist” refers to the actual exchange rate, “1cur” stands for a fixed peg, “3cur” stands for 3 currency basket, “4cur” stands for 4 currency basket, “6cur” means six currency basket, “11curr” means 11 currency basket⁴³, “13cur” stands for 13 currency basket and “WCU” refers to the WCU link. All currency baskets adopt weighted average modified trade weight of manufacture goods and the basket compositions of them are explained before.

⁴² In the reality, abbreviation “CNY” is used for RMB, which in fact abbreviates the word “Chinese Yuan”.

⁴³ Both “4curr” and “11curr” use weighted average weight of modified trade weight of manufacture goods to simulate their exchange rates.

Similar patterns of exchange rate fluctuations in currency baskets

After looking at the Graph 5.1, it seems that all simulated exchange rates of RMB against the USD of currency baskets generate a similar pattern in exchange rate fluctuation, with the WCU link showing a distinctly different pattern after 2001. The reason behind is conspicuous, with adopting a currency basket, the exchange rate of RMB against the USD will no longer only depend on the foreign demand of RMB in foreign exchange market, but also by the cross exchange rate of USD against other currencies. Since here we assumed all historical exchange rates of USD against other currencies are the same whatever what exchange rate policy was adopted by China, all simulated exchange rates' variations may have more or less parallel patterns.

Why are relative drastic fluctuations found in China's exchange rate against United States when currency baskets are adopted?

From both graph 5.1, it is easy to found that there are relatively drastic fluctuations in China's exchange rate against the United States when the currency

baskets are adopted in all cases. Definitely, it is true that the actual exchange rate against US dollar in the history was far more stable than any simulated exchange rate because it just looks like a horizontal line. However, it should be reminded that the stability of exchange rate of RMB against the USD is totally different from the stability of exchange rate of RMB. In past under the peg of US dollar, the exchange rate of RMB against the USD was extremely stable, however, exchange rate of RMB against other countries became relative unstable. Indeed the stability of RMB against other currencies are said to be sacrificed for the stability of RMB against the USD and the overall exchange rate of RMB may become very unstable and vulnerable for foreign attack. For the sake of concreteness, how the RMB becomes unstable against other currencies is shown by Graph 5.2 and 5.3. Graph 5.2 shows the actual exchange rate of USD against CNY, JPY and EUR and Graph 5.3 shows that of CNY against the USD, JPY and EUR. From the Graph 5.2, it shows that there was a severe devaluation of JYP against the USD, the index drops from 100 points in the mid of 1995 to 60 points in the mid of 1998.⁴⁴ That is, within 3 years, the currency of Japan lost more than 40 percent of its value against the USD. As the RMB was pegged to the USD at that time, a 40 percent depreciation of Japanese Yen against RMB can also be found in Graph 5.3 at the same period. Similar case also applied to Euro⁴⁵, from the mid of 1995 to the third quarter of 2000, Euro depreciated more than 35 percent against the USD, meanwhile, Euro also depreciated against RMB by almost the same amount.

⁴⁴ All exchange rates shown in Graph 5.2, 5.3, 5.4 and 5.5 are indexed to 100 in June 1995.

⁴⁵ The exchange rate of European Currency Unit is used to substitute that of Euro before 1999. The European Currency Unit, ECU for short, was an artificial "basket" currency that was used by the member states of the European Union (EU) as their internal accounting unit. The ECU was also the precursor of the new single European currency, the Euro, which was introduced on January 1, 1999.

Graph 5.2: Actual exchange rates of USD to CNY, JPY and EUR

Graph 5.3: Actual exchange rates of CNY to USD, JPY and EUR

Graph 5.4: Simulated exchange rates of CNY under 3 currencies basket

Nevertheless, when we compare Graph 5.3 with Graph 5.4 which shows the simulated exchange rates under the 3 currency basket link, it tells a completely different story in bilateral exchange rate's fluctuations. As the basket link balances the overall fluctuations of the RMB to every currency in the basket and let the RMB appreciates or depreciates against the USD instead of pegging stably. Therefore, if the RMB had adopted the 3 currency basket link, Japanese Yen and the Euro would only depreciate against RMB for 22 percent and 20 percent respectively instead of 40 percent and 35 percent at the same period of time. Therefore under a currency basket, RMB is able to get rid of neither too severe depreciation nor appreciation against any major currencies. The simulated exchange rates of 3 currency basket showed in Graph 5.4 adopts bilateral trade weight. The pattern of fluctuations of exchange rate in other baskets looks like what in Graph 5.4, which indicates that currency basket balances the overall fluctuations of RMB in whatever weighting schemes and basket composition.

Volatilities of simulated exchange rates

Calculation of volatility

With the simulated exchange rates of RMB against USD of various baskets in previous sections, the volatility of each basket can be calculated. First of all, the cross rates of USD against 13 other countries' currencies are used to determine the new exchange rate of RMB against these currencies. Then all series of exchange rates are indexed to be 100 in January 1993 and the standard deviations of each series are calculated. After all, the simple average and the weighted average of standard deviation of a distinct basket can be found. The simple average standard deviation is simply the average of 13 series' standard deviations and those weights used in the

weighted average standard deviation are both of the modified trade weights of total ordinary goods and of manufacture goods.

Calculated volatilities of bilateral nominal exchange rate

Table 5.7 shows the volatilities of China's exchange rates to 13 foreign currencies of different baskets.

Table 5.7: Volatilities of simulated exchange rate of different currency basket																	
Type	Basket	AUD	CND	HKD	JPY	KRW	MYR	RUR	SGD	TWD	THB	GBP	USD	EUR	a.v.	w.v1	w.v2
-	Hist	21.7	14.3	11.3	20.2	22.0	22.3	15.4	17.1	14.0	25.1	17.9	11.4	18.3	17.8	17.1	17.1
-	1curr	12.9	8.9	0.4	10.5	15.6	15.8	14.5	8.4	8.8	18.0	9.0	0.0	11.0	10.3	8.7	8.6
I	3curr	9.5	7.4	5.6	5.1	12.2	13.0	14.1	5.9	6.5	14.9	8.7	5.8	7.4	8.9	7.4	7.3
II	3curr	9.5	7.5	5.8	4.9	12.0	12.8	14.0	5.8	6.4	14.7	8.9	6.0	7.4	8.9	7.4	7.3
III	3curr	9.4	7.4	5.6	5.2	12.2	13.0	14.1	5.9	6.6	14.9	8.6	5.8	7.4	8.9	7.4	7.3
IV	3curr	9.4	7.5	5.7	5.1	12.1	12.9	14.1	5.8	6.5	14.8	8.7	5.9	7.4	8.9	7.4	7.3
I	4curr	9.3	7.9	6.9	5.2	11.1	12.0	14.1	5.2	5.5	14.0	10.2	7.1	7.5	8.9	7.5	7.4
II	4curr	9.3	8.0	7.1	5.1	10.9	11.8	14.1	5.2	5.4	13.8	10.4	7.3	7.5	8.9	7.6	7.5
III	4curr	9.3	7.8	6.7	5.3	11.3	12.1	14.1	5.2	5.6	14.1	10.0	6.9	7.5	8.9	7.5	7.4
IV	4curr	9.3	7.9	6.9	5.2	11.1	12.0	14.1	5.2	5.5	13.9	10.2	7.1	7.5	8.9	7.5	7.4
I	6curr	9.7	8.2	6.4	5.7	11.4	12.0	14.2	4.8	5.2	14.2	10.5	6.6	8.0	9.0	7.6	7.6
II	6curr	9.9	8.2	6.0	5.9	11.6	12.2	14.2	4.8	5.2	14.3	10.4	6.3	8.2	9.0	7.6	7.5
III	6curr	9.5	8.1	6.6	5.8	11.4	12.1	14.2	4.9	5.2	14.2	10.3	6.8	7.8	9.0	7.7	7.6
IV	6curr	9.9	8.1	5.8	5.9	11.8	12.3	14.2	4.9	5.4	14.5	10.2	6.1	8.2	9.0	7.6	7.5
I	11curr	9.2	8.1	7.3	6.3	11.0	11.7	14.3	4.6	5.1	13.8	10.7	7.6	7.6	9.0	7.8	7.7
II	11curr	9.2	8.1	7.5	6.2	11.0	11.7	14.3	4.7	5.1	13.8	10.9	7.8	7.6	9.1	7.9	7.8
III	11curr	9.2	7.9	7.0	6.1	11.2	12.0	14.3	4.7	5.3	14.1	10.3	7.2	7.5	9.0	7.7	7.6
IV	11curr	9.2	7.9	7.1	6.0	11.2	12.0	14.3	4.8	5.3	14.1	10.4	7.3	7.5	9.0	7.8	7.7
I	13curr	9.6	8.4	6.9	6.6	11.3	11.8	14.3	4.4	4.8	14.0	10.9	7.2	8.1	9.1	7.9	7.8
II	13curr	9.8	8.3	6.5	6.7	11.6	12.0	14.4	4.5	5.0	14.3	10.8	6.7	8.2	9.1	7.9	7.8
III	13curr	9.6	8.2	6.7	6.4	11.4	12.0	14.3	4.5	5.0	14.2	10.7	7.0	8.0	9.1	7.8	7.7
IV	13curr	9.8	8.1	6.1	6.5	11.8	12.3	14.4	4.7	5.2	14.5	10.4	6.3	8.2	9.1	7.8	7.7
-	WCU ⁴⁶	6.5	3.9	8.1	8.5	9.0	8.9	20.9	7.0	8.6	11.0	4.2	8.2	6.6	8.6	8.2	8.1
I = Modified trade weights of total ordinary trade II = Original trade weights of total ordinary trade III = Modified trade weights of manufacture goods IV = Original trade weights of manufacture goods Source: Author's calculation																	

In the first row, 13 capital lettered abbreviations represent 13 unique currencies⁴⁷

and the small lettered abbreviations “a.v.” stands for the simple average volatility,

⁴⁶ The volatility of bner of WCU link are not directly comparable with the volatilities of currency baskets, as the volatility of WCU is the standard deviation calculated only from Jan. 1998 to Aug 2006 due to data limitation whereas those of currency baskets is calculated since 1993.

⁴⁷ “AUD” stands for Australian Dollar; “CND” stands for Canadian Dollar; “MYR” stands for Malaysian Ringgit; “RUR” stands for Russian Federation Rouble; “SGD” stands for Singaporean Dollar; “TWD” stands for New Taiwan Dollar; “THB” stands for Thai Bhat; “GBP” stands for Great British Pound.

“w.v.1” refers to the weighted average volatility with using modified trade weight of total ordinary trade (w.v.1) and “w.v.2” refers to the weighted average volatility with using modified trade weight of manufacture goods (w.v.2). In the second column named “Basket”, “Hist” stands for the actual (historical) behavior of exchange rate, “1cur” refers to simulation of the one currency basket, that is, peg to at 8.28 RMB to 1 US dollar all over the time, “3cur” represents the 3 currency basket and so on, and “WCU” refers to a link of home currency to the WCU.

From Table 5.7, all figures of volatilities are shown. Figures will be underlined if they are one out of three of the smallest numbers in that column. On the other hand, figures will be italicized if they are one out of three of the largest numbers in that column. From column 3 to 15, the volatilities of exchange rates of RMB against other currencies are shown. It finds that in general, the figures will be smaller if the currency referred by the column is one of the currencies in the basket, and vice versa. For example, the 3 currency basket performs better relatively in columns “JPY”, “USD” and “EUR”, whereas 11 and 13 currency baskets perform relatively better in columns “AUD”, “KRW”, “MYR”, “SGD”, “TWD” and “THB”. For the currency basket linked to the WCU as it consists of five industrial countries’ currencies, “AUD”, “CND”, “JPY”, “USD” and “EUR”, all the volatilities of them are relatively smaller than other baskets, excepted the one of the USD. When we look at column 16, it shows that the WCU performs the best with the smallest value of 8.6. Meanwhile, the 3 and the 4 currency basket perform the second best, with the value of simple average volatility 8.9. The 6 and the 11 currency baskets have the value of simple average volatility 9.0, which is the third best. However, the ones of actual exchange rate and fixed exchange are very poor compared with currency baskets, which are in average 17.3 and 10.3 respectively. Although the volatilities of fixed exchange rate shows an excellent figure, only 0.4 in “HKD” column and 0.0 in “USD” column,

volatilities in other columns are too much higher than other baskets. When we look at the weighted average volatility under two partly different weighting methods, they both generate similar result with that of simple average. However, the volatility of WCU link has a quite special performance while comparing with those of currency baskets. The WCU link performs the best in AUD, CND, KRW, MYR, THB, GBP and EUR, but nearly the worst in HKD, JPY, RUR, SGD, TWD and USD. In addition, The WCU one of the best in average volatility (a.v.), but also one the worst in both weighted average volatilities.

In general, the regime linked 3 currency basket performs the best and the actual and fixed exchange rate regimes perform the worst while examining their volatility. Further, it seems to have a trend in currency basket that the smaller the number of currencies inside in basket, the better performance in its simple average and weighted average volatilities and vice versa. For instance, the 3 currency basket performs better than the 4 currency basket, while the one of 4 performs better than the one of 6. At the same time, the one of 6 also have a better performance than the one of 11 and the one of 13 performs the worst among all. Nevertheless, the actual and fixed exchange rate regimes always have the highest volatility in every column. Therefore in term of volatilities of nominal bilateral exchange rate, currency baskets must be superior.

Calculated volatilities of nominal and real effective exchange rate indices

The Graph 5.5 and 5.6 below show the real effective exchange rate (REER) indices and the nominal effective exchange rate (NEER) indices respectively. In both NEER and REER, indices with scenarios adopting a currency basket again show a relative lower fluctuation. On the other hand, the WCU link shows a substantial increase in both REER and NEER.

Graph 5.5 Real Effective Exchange Rate Indices of various scenarios

Graph 5.6 Nominal Effective Exchange Rate Indices of various scenarios

From the Table 5.8 below, it shows the volatilities of REERs and NEERs of various scenarios. Once more time, REERs and NEERs of scenarios adopted a currency basket shows much lower standard deviations of both indices. “RE3cur” and “RE4cur” represent the REERs of scenarios adopted the 3 currency basket and the 4 currency basket perform the best with the lowest volatility of REER, meanwhile “NE11cur” and “NE4cur” perform the best with the lowest volatility of NEER. However, the scenario of WCU link generates very high standard deviations of both indices relatively.

Table 5.8 The volatilities of REERs and NEERs of various scenarios								
	REhist	RE1cur	RE3cur	RE4cur	RE6cur	RE11cur	RE13cur	REwcu
Mean	99.290	98.970	99.414	98.756	97.971	98.921	98.376	108.896
Maximum	110.083	110.061	104.446	103.310	103.197	104.046	103.999	137.990
Minimum	91.110	91.081	95.331	94.534	93.729	94.310	93.724	87.436
Std. Dev.	4.584	4.840	2.143	2.119	2.291	2.262	2.432	14.482
	NEhist	NE1cur	NE3cur	NE4cur	NE6cur	NE11cur	NE13cur	NEwcu
Mean	100.058	99.737	100.184	99.516	98.721	99.681	99.128	107.504
Maximum	110.046	110.027	102.756	100.745	100.613	100.671	100.318	118.004
Minimum	91.491	91.480	97.738	97.905	97.485	98.155	98.059	99.301
Std. Dev.	4.461	4.703	1.096	0.699	0.704	0.619	0.773	5.986
Source: Author's calculation								

In short, currency baskets generally lead to much lower volatilities in BNER, REER and NEER. We can conclude that all scenarios of currency baskets are superior to the historical regime, a fixed peg, as well as a WCU link in term of exchange rate volatility.

Chapter 6 Compare various baskets' effects on China's trade balance and export growth

In this chapter, the effects of various baskets on China's economic fundamentals such as export, import and trade balances are examined. Besides of exchange rate volatility, another standard to determine a superior basket can be done by comparing their effects on one country's trade balance correspondingly. In general, if a basket is associated with relative stable growth in exports and a more stable trade balance, it is deemed to have desirable properties. For the sake of having a concrete empirical answer of the question of the implications of diverse currency baskets for sustainability of the China's trade balances with her major trading partners, simulations on China's export, import and trade balance with her major 13 trading partners are carried out to explore how exchange rate would shift the these variables.

Why is it critical to simulate the long run effect on the trade balance?

To begin with, many countries nowadays always struggle to achieve a sustainable trade balance and always set it as the ultimate goal of exchange rate policy. Then a question should be asked. Why is it so important for a country to have a sustainable total trade balance? And indeed there are not many countries able to achieve this in reality.

In the first place, a huge gap between trade balances of countries will trigger off trade quarrels. If negotiations had calcified and broken down, trade sanctions or even economic threats against each other would always be the result. For example, trade quarrels related to the United States in past two decades had never been stopped. While trade quarrel and protectionism appeal, the economic growth of involved countries must shows down and even goes backwards as real economic output

declines because of trade barriers such as import licenses, quotas, tariffs or even embargo. Further, neighbor countries may also be negatively affected.

In addition, with raising pressure from trading partners, one country's monetary policy and exchange rate policy may also be affected, which can be a disaster for a country. In 1985, as the US was experiencing a large and growing trade deficit, the US "persuaded" the G-5 nations⁴⁸ to coordinate a multilateral intervention,⁴⁹ for the purpose of allowing for a controlled depreciation of the USD and a controlled appreciation of the main anti-dollar currency, which were mainly the Deutsche Mark and the Japanese Yen. After the Plaza Accord was signed by finance ministers and central bank governors of the G-5 nations on September 22nd 1985 in the Plaza Hotel of New York, Japan implemented a looser monetary policy, raised the interest rate and reformed the financial sector. As a result of the Accord, the Yen appreciated against the USD for more than 50 percent within two years. By the end of 1987, the USD had fallen against the Japanese Yen by 54 percent. This dramatic appreciation became a hint foreshadow for the Japanese asset price bubble⁵⁰, which some scholars argued that the break out of the bubble led to the "lost decade" of Japan.⁵¹

In the worst case, regional stability may sacrifice and the all countries in that region become victims. For instance, as trade quarrel between the US and Japan became intense in 1993, Asia-Pacific countries which relied heavily on the US and Japan for trade, technology and investment, worried that quarrels between two countries would undermine the multilateral free trade system, which was the source of

⁴⁸ The G-5 nations at that time were the United States, Japan, West Germany, France and the United Kingdom.

⁴⁹ At that time, great pressure was given by Unites States, which argued that the Accord was agreed and signed by Japan because of political pressures.

⁵⁰ Lasting from 1986 to 1990, the Japanese asset price bubble was a time of skyrocketing land and stock prices in the Japanese economy.

⁵¹ Here referred to the Japanese economy in the 1990s, a decade of economic stagnation.

sustainable economic growth of their countries. Moreover, Asian officials feared that hard lines of both countries on the negotiation table might lead to a trade war, which would weaken the security tie between the US and Japan,⁵² and unsettle stability in Asia and the Pacific.

It should be reminded that what suggested here is not to pursue an absolute balance in trade balance in long run, but an “acceptable” and “correctable” trade discrepancy between countries and their major trading partners, in order to avoid excessive trade quarrels and political pressures.

6.1 Theoretical framework

In this section, a general demand model is applied to both export and import of China for simulating the export, import and thereby the trade balance of China.⁵³ As trade balance simply equals export minus import, it is possible to simulate the trade balance of China by simulating both export and import of China.

Demand model used to simulate bilateral trade balance of China

For the aggregated export of China, it is postulated that the foreign demand of China's export depends on China's real effective exchange rate and the economy size of foreign countries.

$$X_t = f(RE_t, Y_{ft})$$

where X_t is China's real aggregated export to foreign countries at time t

RE_t is the real effective exchange rate index of China at time t

Y_{ft} is the real aggregated GDPs of foreign countries at time t

⁵² The Treaty of Mutual Cooperation and Security between the United States and Japan was signed between the United States and Japan in Washington DC on January 19, 1960. The US-Japan security alliance has been the key to the balance of power in East Asia since the defeat of Japan in World War II.

⁵³ It is assumed that value the export and import is mainly driven and determined by demand side.

For the aggregated import of China, it is postulated that the domestic demand of China's import depends on the economy size of China and the foreign demand of China's export.

$$M_t = f(Y_t, X_t)$$

where M_t is China's real aggregated import from foreign countries at time t

Y_t is the real GDP of China at time t

X_t is China's real aggregated export to foreign countries at time t

For calculating the real trade balance of China, it simply equals the aggregated volume of real export minus the aggregated volume of real import.

$$TB_t = X_t - M_t$$

where TB_t is China's real trade balance with foreign countries at time t

X_t is China's real aggregated export to foreign countries at time t

M_t is China's real aggregated import from foreign countries at time t

*Empirical export and import demand models used in simulations*⁵⁴

With export and import demand functions developed in the last section, the empirical export and import demand models below are used in empirical tests.

V. Export demand model:

$$\ln X_t = \alpha_0 + \alpha_1 \ln RE_t + \alpha_2 \ln Y_t + \varepsilon_t$$

where X_t is China's real aggregated export to 13 foreign countries at time t

RE_t is the real effective exchange rate index of China at time t

⁵⁴ Indeed the export and import demand model had been tested rigorously with different independent variables. Since this paper is the first attempt to apply cointegration test in simulation of China's real exchange rates, exports, imports and trade balances under various currency baskets, there are still lots of deficiencies in the equations, and export and import are assumed to be determined by the demand only.

Y_t is the real aggregated GDPs of 13 foreign countries at time t

ε_t is the error term

In the export demand model, α are coefficients of independent variables. In the model, RE_t is expected to have an inverse relation with X_t . Increase in the real effective exchange rate index indicates an appreciation in RMB. As the RMB appreciates, the volume of export should decrease. Y_t is expected to have a positive relation with X_t , as increase in GDPs of foreign countries simply means increases of their incomes, foreign demand of China's export increases when their incomes increase.

VI. Import demand model⁵⁵:

$$\ln M_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln X_t + \varepsilon_t$$

where: M_t is China's real aggregated import from 13 countries at time t

Y_t is real GDP of China at time t

X_t is China's real aggregated export to 13 foreign countries at time t

ε_t is the error term

In the import demand model, β are coefficients of independent variables. Y_t is expected to positively relate to M_t , as increase in GDP of China simply means an increase in income, demand of import increases when income increases. X_t is also expected to positively relate to M_t . As there are lots of processing industries in China,

⁵⁵ According to the testing results of Johansen cointegration test, it concludes that there is not any statistical significant long run relation (cointegrating relation) between China's historical exchange rate and her import. In addition, some other independent variables had been tested in both equations such as producer price index and import price index. However, the results were still statistically insignificant. The composition of China's import may be able to explain why the import of China is not so sensitive to the real effective exchange rate. This may be due to the fact that consumption goods (which are sensitive to price and exchange rate) only contribute a minor portion of China's import. In contrast, industrial imports like raw materials, components and machineries contribute the major portion of China's import, which are not sensitive to price and exchange rate.

when their outputs (export) increase, their inputs (import) of raw materials, machineries, components and spare parts need to be increased.

6.2 Data description

To do empirical tests, the monthly data of China's exports to and imports from 13 countries/area are firstly collected. They are the United States, Japan, the Euro Area⁵⁶, the United Kingdom, Australia, Canada, Hong Kong, South Korea, Malaysia, Thailand, the Russia, Singapore and Taiwan, from January 1998 to August 2006. They are all collected from the CEIC China Premium database. For converting nominal export to real export, the producer price index (PPI)⁵⁷ of China is used as a proxy of the domestic price level for export. Originally, export price index of China should be used rather than the PPI, however, due to the data limitation of the monthly data of China's export price index which is only available started from 2001, PPI is used. For converting nominal import to real import, the retail price index (RPI)⁵⁸ of China is used as a proxy of the domestic price level for import. Although import price index must be the best choice, it seems that China does not have details statistics on import price. On the other hand, consumer price index (CPI) is also commonly used for the adjustment, but RPI is a better choice. It is because the basket of CPI includes prices of not only commodities, but also services. Meanwhile, the basket of RPI merely includes prices of commodities during a given period, so it does match the data of import which also include commodities only. With above adjustments, China PPIs and

⁵⁶ The Euro area includes 12 countries: Austria, Belgium, Finland, France (except Pacific territories using CFP franc), Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain.

⁵⁷ Producer Price Index (PPI) refers to the *ex-factory price index* of industrial products. It reflects the trend and degree of changes in general ex-factory prices of all industrial products during a given period, including sales of industrial products by an industrial enterprise to all units outside the enterprise, as well as sales of consumer goods to residents.

⁵⁸ Retail Price Indices reflect the trend and degree of change in retail prices of commodities during a given period. The change in retail prices of commodities directly affect the living expenditure of urban and rural residents, government revenue, purchasing power of residents and the equilibrium of market supply and demand, and the ratio of consumption to accumulation.

RPIs with previous year equals 100 from January 1998 to August 2006 are also collected from the CEIC.

To calculate real effective exchange rate index (REER), the bilateral nominal exchange rate of RMB and USD to other 13 currencies from January 1998 to August 2006 are collected from the Pacific Exchange Rate Service⁵⁹. For the price series used to deflate the bilateral nominal exchange rates, China's CPI with previous year and month equals 100 from January 1998 to August 2006 are collected from the CEIC, meanwhile, CPIs of 13 counties/area from January 1998 to August 2006 are collected from the International Financial Statistics (IFS) database.

Before doing empirical tests, all GDPs are converted to real GDPs by using their own GDP deflator in order to deflate to real GDPs. After that, all quarterly data of GDP are disaggregated to monthly data.⁶⁰ For above purpose, quarterly data of China's GDP and GDP deflator from Q1 1998 to Q3 2006 are again collected from CEIC. Meanwhile, quarterly data of 13 countries' GDPs and GDP deflators from Q1 1998 to Q3 2006 are also collected from IFS database.

Finally, all data excluded REER are seasonal adjusted by the method of Census X12⁶¹, which the procedure used by the United States Census Bureau.

6.3 Empirical tests and results

Engle and Granger (1987) pointed out that a linear combination of two or more

⁵⁹ The Pacific Exchange Rate Service is located in Vancouver, Canada, and provided by Werner Antweiler, University of British Columbia at <http://fx.sauder.ubc.ca/>

⁶⁰ GDP are disaggregated to monthly data by assuming the value of second month in a quarter is equal to one third the value of that quarter. Then it is assumed that the growth rate of each month between the "second" month of each quarter is the same. For example, the value of February is calculated by dividing the first quarter by three and the value of May is calculated by dividing the second quarter by three. After that, it is assumed that the growth rate of all months from February to May is the same.

⁶¹ EViews provides a convenient front end to the United States Census Bureau's X12-ARIMA seasonal adjustment software. <http://www.eviews.com/eviews5/eviews5/censusx12.html>

non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. And this stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relation among variables. The purpose of the cointegration test is to determine whether there is cointegrating equation or not and the presence of relation forms the basis of Vector Error Correction (VEC)⁶² specification.

As the focus is the long run effects of different currency baskets on China's export growth and trade balance, a long run equilibrium relation among variables must be proven statistically significant before doing any further simulation. Therefore, the Johansen maximum likelihood cointegration estimation⁶³ will be applied. Note that since this is a test for cointegration, the test result is only valid when those tested series are known to be non-stationary when tests on level and stationary when tests on the 1st difference in the unit root test. For above reason, the Augmented Dicky Fuller (ADF) unit root test will be first applied to each series.

To summarize, the ADF unit root test will be first applied to each series on both level and the 1st difference for testing stationarity. Then the Johansen cointegration test will be applied to test for the presence of a cointegrating relation. After the presence of a cointegrating relation is confirmed, Vector Error Correction estimation will be applied to test the convergence of endogenous variables to check the short run dynamics for the long run cointegrating relations. Finally, estimated equation derived from the VEC model will be used to do the simulation exercise.

⁶² A vector error correction (VEC) model is a restricted VAR designed for use with non-stationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relations while allowing for short-run adjustment dynamics.

⁶³ In this paper, VAR-based cointegration tests using the methodology developed in Johansen (1991, 1995) will be applied.

6.3.1 ADF Unit Root Test

In Table 6.1, it shows the result of Augmented Dicky Fuller (ADF) unit root test of tested series on level and 1st difference. Augmented Dickey Fuller (ADF) Test is run to test for the stationarity properties of the series. The equation is:

$$\Delta X_t = \alpha_0 + \alpha_1 t + \beta_1 X_{t-1} + \sum_{i=1}^k \delta_i \Delta X_{t-i} + \varepsilon_t$$

It is assumed there is intercept but no trend in those series and the optimal lag intervals in the test are determined by Akaike Information Criterion (AIC). Indeed, Schwarz Information Criterion (SIC) has been also applied and similar results were found.

Table 6.1: ADF Unit Root Test (Intercept, Automatic AIC lag intervals)					
	<i>lnX</i>	<i>lnRE</i>	<i>lnYf</i>	<i>lnM</i>	<i>lnY</i>
level	1.2028 (4)	-2.105 (1)	-1.728 (0)	-0.686 (5)	0.306 (6)
1st diff.	-7.755 *** (3)	-8.123 (0)	-8.950 *** (0)	-8.104 *** (4)	-5.763 *** (6)
Conclusion	I(1)	I(1)	I(1)	I(1)	I(1)
Lag interval is determined automatically by AIC					
* indicates 10% significant level; ** indicates 5% significant level; *** indicates 1% significant level					

From Table 6.1, the first row shows those tested series and the second row shows the test result on level, while the third row shows the result on the 1st difference. The numbers insides brackets are lag intervals automatically selected by AIC. In the second row, the result shows that all tested series are non-stationary on level as all of them are insignificant and thereby cannot reject the null hypothesis of having a unit root. In contrast, the result in the third row shows that all tested series are stationary on the 1st difference as all of them are significant at 1% significant level and therefore reject the null hypothesis of having a unit root. In conclude, all tested series used in the export and import model are I(1), a non-stationary time series that is stationary on its 1st difference, which can fulfill the prerequisite of being tested by Johansen cointegration test for cointegrating relation.

6.3.2 Johansen Maximum Likelihood Cointegration Estimation

In Table 6.2, it shows the result of Johansen maximum likelihood estimation testing for cointegration on both export and import model of China.

The cointegrating regression of export model is:

$$\ln X = f(\ln RE, \ln Y)$$

And the cointegrating regression of import model is:

$$\ln M = f(\ln Y, \ln X)$$

It is assumed that there are intercepts but no deterministic trend in both cointegrating regressions and error correction estimations.⁶⁴ And the lag intervals are selected according to AIC.

Table 6.2: Johansen Maximum Likelihood Cointegration Estimation					
	H ₀	H _a	Eigenvalue	Trace Statistic	5% Critical Value
Export Model:	r=0	r>0	0.170	32.536**	29.797
	r≤1	r>1	0.132	14.108	15.495
Import Model:	r=0	r>0	0.183	35.025**	29.797
	r≤1	r>1	0.137	14.780	15.495
**Trace test indicates 1 cointegrating relation at the 5% significant level					
Lag interval is determined by AIC					
Cointegrating regression of Ex: $\ln X = f(\ln RE, \ln Y)$					
Cointegrating regression of Im: $\ln M = f(\ln Y, \ln X)$					

In Table 6.2, the first and the second columns are the null and alternative hypothesis of the cointegration test, which denote the number of cointegrating relations. The third column is the ordered eigenvalues of the Π matrix, the fourth is the Trace test statistic and the fifth column is the 5% critical value⁶⁵.

⁶⁴ As the asymptotic distribution of the LR test statistic for cointegration does not have the usual χ^2 distribution and depends on the assumptions made with respect to deterministic trend. Therefore, assumption should be made regarding the trend underlying tested series, in order to carry out the test.

⁶⁵ The (nonstandard) critical values are taken from MacKinnon-Haug-Macheils (1999), which differ slightly from those reported in Johansen and Juselius (1990).

To determine the number of cointegrating relations (r conditional on the assumptions made about the trend), testing can be proceed sequentially from $r=0$, $r=1$... to $r=k-1$ until the test is failed to reject. The result of this sequential testing procedure is reported at the bottom of the table.

To be more precise, testing on $H_0: r=0$ and $H_a: r>0$ will take place first, it means there is no cointegrating relation when null hypothesis cannot be rejected; when null hypothesis is rejected, it means there is cointegrating relation. If null hypothesis of $r=0$ is rejected, further test on null hypothesis of $r=1$, $r=2$, etc. will take place. Then test on $H_0: r=1$ and $H_a: r>1$ will take place, it means there is one cointegrating relation when null hypothesis cannot be rejected; when null hypothesis is rejected, it means there is more than one cointegrating relation.

From Table 6.2, it shows that in both export and import model the $H_0: r=0$ are rejected and $H_0: r=1$ are not able to be rejected according to the Trace test statistics⁶⁶. Therefore, it is concluded that the Trace test indicates 1 cointegrating relation at the 5% significant level.

In Table 6.3, it shows the estimations of the cointegration relations. As is well known, the cointegrating vector is not identified unless arbitrary normalization is imposed. Since both $\ln X$ and $\ln M$ are dependent variables, cointegrating vectors of them are normalized to 1. The numbers insides brackets are standard error and * denotes the level of significance.

Table 6.3: Normalized Cointegrating Vectors					
Export Model:			Import Model:		
$\ln X$	$\ln RE$	$\ln Y_f$	$\ln M$	$\ln Y$	$\ln X$
1	2.176*** (0.673)	-7.318*** (0.539)	1	-1.671*** (0.464)	-0.309* (0.197)
This table presents the cointegrating vectors with coefficients on dependent variables normalized to 1 * indicates 10% significant level; ** indicates 5% significant level; *** indicates 1% significant level					

⁶⁶ The Trace statistic reported tests the null hypothesis of r cointegrating relations against the alternative hypothesis of k cointegrating relations, where k is the number of endogenous variables.

The vectors presented by Table 6.3 are statistically significant and make economic sense that the estimated coefficients are close to and have same signs as those predicted by economic theory. In the export model on the left hand side of the table, $\ln RE$ is negatively related with $\ln X$ as increase in real effective exchange rate index means RMB appreciated against other countries' currencies relatively which will harm China's export. $\ln Y_f$ is positively related with $\ln X$ as the larger economies size of foreign countries, the higher demand for China's export. In the import model on the right hand side, $\ln Y$ has a positive relation with $\ln M$ as economy size/income of China increase, China's demand of foreign goods (import) rise. $\ln X$ also has a positive relation with $\ln M$ because of large amount of the processing industries in China.

6.3.3 Vector Error Correction Estimates

After obtaining the long-run cointegration relations using the Johansen estimation, the short-run dynamics of the long run export and import model of China are examined by estimating their error-correction model. In Table 6.4, it shows the result of vector error correction estimates of both export and import model of China. It is assumed that there are intercepts but no deterministic trend in both cointegrating regressions and error correction estimations, and the lag intervals 2 are selected according to AIC.

In Table 6.4, the first and the third columns are the independent variables in error correction model (ECM) of China's export and import respectively. *CointEr* demotes the error correction term which is estimated by Johansen estimation. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments, which can be obtained from the normalized cointegrating relation. In addition, the coefficient of the error correction term is an estimate of the speed of

adjustment back to the long-run equilibrium relation, which must be negative and significantly different from zero. The letter D denotes variable taking first difference. The second and the fourth columns are coefficients of independent variables against dependent variables $D(\ln X)$ in the export model and $D(\ln M)$ in the import model, and the numbers inside the brackets are standard error.

Table 6.4: Vector Error Correction Estimates			
Export model		Import model	
Independent variable:	Coefficient $D(\ln X)$	Independent variable:	Coefficient $D(\ln M)$
<i>CointEr</i>	-0.126 ** (0.060)	<i>CointEr</i>	-0.364 *** (0.133)
$D(\ln X(-1))$	-0.643 *** (0.101)	$D(\ln M(-1))$	-0.259 * (0.152)
$D(\ln X(-2))$	-0.310 *** (0.094)	$D(\ln M(-2))$	0.026 (0.134)
$D(\ln RE(-1))$	0.322 (0.411)	$D(\ln Y(-1))$	-1.991 *** (0.654)
$D(\ln RE(-2))$	-1.041 *** (0.417)	$D(\ln Y(-2))$	-0.294 (0.683)
$D(\ln Yf(-1))$	2.028 * (1.216)	$D(\ln X(-1))$	-0.280 (0.177)
$D(\ln Yf(-2))$	-1.785 (1.200)	$D(\ln X(-2))$	-0.375 ** (0.172)
<i>Constant</i>	0.027 *** (0.006)	<i>Constant</i>	0.046 *** (0.011)
Adj. R^2	0.421	Adj. R^2	0.382
<i>CointEr</i> denotes the error correction term which is estimated by Johansen Estimation D denotes variable taking first difference Lag interval is determined by AIC * indicates 10% significant level; ** indicates 5% significant level; *** indicates 1% significant level			

From the second and the fourth columns in Table 6.4, it shows that the coefficients of the error correction term in both models are negative and statistically significant at 5% significant level and 1% significant level respectively. At the same time, those coefficients of variable other than the error correction term which represents the short-run dynamics are also satisfactory and therefore both the ECMs are valid with adjusted R^2 equal 0.421 and 0.382.

6.4 Simulation results based on the ECMs

After confirming the results of error correction models (ECMs) of both China's export and import are satisfactory, simulation on China's export and trade balance can be carried out. Based on the ECMs shown in Table 6.4, simulation exercises can be performed and the estimating equations derived from the ECMs are shown below.

From the ECM of China's export:

$$\begin{aligned} D(\ln X) = & -0.127*(\ln X(-1) + 2.176*\ln RE(-1) - 7.318*\ln Yf(-1) + 86.862) - 0.643* \\ & D(\ln X(-1)) - 0.310*D(\ln X(-2)) + 0.322*D(\ln RE(-1)) - 1.040*D(\ln RE(-2)) \\ & + 2.028*D(\ln Yf(-1)) - 1.785*D(\ln Yf(-2)) + 0.027 \end{aligned}$$

From the ECM of China's import:

$$\begin{aligned} D(\ln M) = & -0.364*(\ln M(-1) - 1.671*\ln Y(-1) - 0.309*\ln X(-1) + 4.627) - 0.259* \\ & D(\ln M(-1)) + 0.026*D(\ln M(-2)) - 1.991*D(\ln Y(-1)) - 0.294*D(\ln Y(-2)) \\ & - 0.280*D(\ln X(-1)) - 0.375*D(\ln X(-2)) + 0.046 \end{aligned}$$

With above equations, simulation exercises are performed by substituting the real effective exchange rate index ($\ln RE$) of China by that of China under various scenarios (linking to different currency baskets as the exchange rate policy) into the export equation and to obtain a simulated export under the new scenario. Then this new export can be regarded as the new independent variable, $\ln X$, in the import equation. And it should be noted that the simulation exercises are performed dynamically.

After simulating the export and import of China under, for instance, scenario 1, the trade balance of China under scenario 1 is also able to be simulated by subtract the exponential-log of the logarithm of simulated import from that of simulated export. Therefore, the equation of the real trade balance will be shown as below.

$$TB = \exp(\ln X) - \exp(\ln M)$$

TB refers to the real trade balance of China with her 13 major trading partners.

Explanations of how the 8 scenarios would be simulated

The real effective exchange rates of China as measured against 13 currencies under eight different scenarios are firstly simulated. (from 0 to 7) As the ECMs only covered the period of February 1998 to August 2006 due to limitation of data, all simulation results are shown from July 1998 to June 2006 only.

The scenario 0 provides the baseline case, indicating the empirical real exchange rate index. Historical data are used in simulations.

The scenario 1 assumes China had adopted a single currency basket (1cur) since 1994, that is, a fixed link to US dollar.

The scenario 2 assumes China had adopted a three currency basket (3cur) that includes USD, JPY and EUR in the basket, which are the most common currencies.

The scenario 3 assumes China had adopted a four currency basket (4cur) that includes USD, JPY, EUR and KRW in the basket, which are the 4 major currencies in the currency basket revealed by China herself.

The scenario 4 assumes China had adopted a three currency basket (6cur) that includes USD, JPY, EUR, KRW, HKD and TWD in the basket, which are the currencies of countries where its share of total trade of China is more than 5 %.

The scenario 5 assumes China had adopted an eleven currency basket (11cur) that includes USD, JPY, EUR, KRW, AUD, CND, GBP, SGD, THB, MYR, and RUB, which is the composition of currency basket exactly reveal by China in August 2005.

The scenario 6 assumes China had adopted a thirteen currency basket (13cur) that includes USD, JPY, EUR, KRW, HKD, TWD, AUD, CND, GBP, SGD, THB, MYR, and RUB, which are the currencies of countries where its share of total trade of China is more than 1 %.

At last, the scenario 7 assumes China had adopted a regime with the RMB tied to World Currency Unit (WCU).

Calculated real effective exchange rate indices (REERs) of various scenarios

The Graph 6.1 shows calculated real effective exchange rate indices of China in different scenarios. To do the simulations, REERs of China of different scenarios are substituted for the original REER of China. In the Graph 6.1, the bold black line with legend “REhist” denotes the original REER calculated by using historical RMB cross exchange rates with other 13 currencies. The dotted line with circle named “RE1cur” denotes the REER calculated by using simulated cross exchange rate assumed China adopted a single currency basket, that is, a fixed exchange rate against the USD. Two lines are so close to each other, indeed the difference is found only at the period after July 2006, when the revolution of China exchange rate regime took place and the RMB kept appreciating slowly against the USD. According to these 2 lines, the RMB was linked to the USD indeed from the period July 1998 to June 2005, therefore almost the same REERs can be found in this period.

On the other hand, if we look at lines with legend “RE3cur”, “RE4cur”, “RE6cur”, “RE11cur” and “RE13cur”, we will find that all relative lower fluctuated and more stable REERs calculated by different currency baskets look like each other, especially two pairs, the pair of “RE4cur” and “RE11cur”, and the pair of “RE6cur” and “RE13cur”. But they look a little bit different when comparing two pairs.

For the pair of “RE4cur” and “RE11cur”, “RE4cur” includes 4 currencies which are major currencies in the basket revealed by China, whereas “RE11cur” includes 4 major currencies plus 7 minor currencies, which the basket is exactly the same as what revealed by China. As the weights on those 7 minor currencies are relatively so low comparing with those 4 major currencies in the 11 currency basket, therefore they cannot make a significant variation nor change to the REER.

The similar case appear in the pair of “RE6cur” and “RE13cur”, since the weights on those 6 major currencies (countries with a trade share of China more than 5%) are relatively very high comparing with those 7 minor currencies (countries with a trade share of China more than 1%) in the 13 currency basket, therefore they predominate the movement and the pattern of the REER.

Then what makes the difference between two pairs is that the currency baskets of “RE6cur” and “RE13cur” both include currencies of Hong Kong and Taiwan in their baskets, but these 2 currencies are not included in the currency baskets of both “RE4cur” and “RE11cur”. The basket revealed by China does not include Hong Kong dollar and the New Taiwan dollar may be because the Mainland regards Hong Kong SAR and Taiwan as a part of China and thus the currencies of these two regions should not be included in her own currency basket.

Finally, the bold dotted line denotes the REER calculated by assuming that the RMB was linked to WCU. This will lead to quite a different behavior in comparison with that under other regimes.

Simulation results of China's real export

The Graph 6.2 shows simulated real exports of China in different scenarios. The lines “Xhist” and “X1cur” show the lowest value of real export in the middle of the period from January 2001 to July 2003, but they show the highest value at the end of the period from October 2004 to June 2006. In contrast, the line “Xwcu” shows the highest value in the middle but the lowest value at the end of the period. Typically after the mid of 2003, it shows a much lower value of real export and this can be explain by the movement of “REwcu” in Graph 6.1. As a continuous increase of REER means appreciation of RMB, and a steady appreciation of RMB started from 2002 to 2006 would hurt the export because of increasing in international price.⁶⁷

On the other hand, simulated real exports of different currency baskets generally show a stable growth and similar fluctuation along the whole period of time. “X3cur”, “X4cur”, “X6cur”, “X11cur” and “X13cur” are closely packed together.

⁶⁷ It should be noted that the simulation has ignored the effects of a WCU link on Chinese domestic price, therefore it may exaggerate the negative effects on export during this period. For a more detailed explanation, please refer to page 88.

Simulation results of China's real import

The Graph 6.3 shows simulated real imports of China in different scenarios. Although the lines of “Mhist” and “M1cur” again show the lowest value of real import in the middle of the period and show the highest value at the end of the period, this time in the import side all lines excepted “Mwcu” at the latter period show an alike movement and pattern. It is because in the cointegration test a significant and make economic sense cointegrating vector between China's total import and REER could not be found. Someone may think such a result is non-sense or unbelievable, but it really makes some sense because of that, a very high proportion of the import of China is not final consumption goods but instead intermediate goods imported by the prosperous processing industry and manufacturing industry in China. Once there are still having profits for firms to produce, firms will import raw materials, parts and machineries for production and disregard the fluctuation of import price caused by exchange rate.

Simulation results of China's trade balance

The Graph 6.4 shows simulated trade balances of China in different scenarios. From the graph, “TB1cur” shows the highest value of trade surplus after 2003 whereas the value of trade surplus of other period of time is as same as “TBhist”. It means that if China has kept her linkage of the RMB with the USD, the trade surplus in these years would even higher than the one in reality and of course the same case will appear in international pressure. This is because in reality the RMB keeps appreciating against the USD after revolution of exchange rate regime in July 2005.

On the other hand, although all 5 trade-weighted currency baskets show a bit higher trade surplus from 2001 to 2003, they show a much lower trade surplus from 2004 to 2006, typically in 2005 and 2006. Moreover, all these baskets generally generate a relative more stable trade balance with slower growth, especially the 3 currency basket (“TB3cur”), which shows the lowest trade surplus and the lowest growth in trade balance overtime.

Finally, it is quite amazing that if China is linking to WCU, she will have a trade deficit from January 2004 to 2006. The trade deficit would appear is understandable and reasonable, due to the fact that REER of WCU shows a remarkable appreciation of RMB which causes a relative dramatic decrease of export after 2002. However, this result seems to be non-sense as the trade deficit is extremely large. Actually, this problem may be caused by misspecification of the China's import model. If total import has been separate to two parts (consumption goods and intermediate goods), it would be possible that a long-run relation can be found between of import of consumption goods and real exchange rate index. Therefore, the total import would increase as the RMB kept appreciating, but in this paper it would not happen as the cointegration test showed that there was no such a long-run relation between China's total import and her REER.

Comparing the export growths of various scenarios

From the view of export growth, a scenario is said to be superior if it can perform the most stable export growth. As the growth rate of export is exactly the rate of change of export, therefore the best scenario can be determined by choosing a scenario implied the lowest standard deviation on the rate of change of export.

Table 6.5: Standard Deviations of Rate of change of Export (Xroc) of various scenarios								
	Xrochist	Xroc1cur	Xroc3cur	Xroc4cur	Xroc6cur	Xroc11cur	Xroc13cur	Xrocwcu
Mean	0.01499	0.01540	0.01439	0.01444	0.01473	0.01444	0.01468	0.00945
Max.	0.06683	0.06691	0.03924	0.03969	0.03939	0.04145	0.04445	0.08996
Min.	-0.03594	-0.03608	-0.02452	-0.01720	-0.01046	-0.01813	-0.01647	-0.11104
Std.Dev.	0.01931	0.01944	0.01099	0.01088	0.01036	0.01085	0.01095	0.03335

For the objective of having the most stable growth in export, all scenarios with trade-weighted currency basket show a much lower standard deviation in rate of change of export than the other scenarios. Scenario 4, with a link to the 6 currency

basket, performs the best with the lowest standard deviation. This means that a country adopting a trade-weighted currency basket will perform a relative more stable export growth. Meanwhile, the standard deviations of various scenarios adopted trade-weight currency basket seem to have an optimal level of basket composition. It is clear that increasing the number of currencies in a currency basket will not necessarily lead to a better result. From Table 6.5, "Xroc3cur" has a higher standard deviation than "Xroc4cur", whereas "Xroc4cur" has a standard deviation higher than "Xroc6cur", "Xroc6cur" has a lower standard deviation than "Xroc11cur" and "Xroc11cur" has a standard deviation lower than "Xroc13cur". (the Standard deviations of "Xroc3cur" > "Xroc4cur" > "Xroc6cur" < "Xroc11cur" < "Xroc13cur"). In opposite, the scenario 7 linked to WCU performs an extremely large standard deviation, which can be explained by the simulation result that "Xwcu" in Graph 6.2 shows export growth nearly become zero after the mid of 2002.

In short, that a country adopted a trade-weighted currency basket generally will perform a relative more stable export growth and a more stable trade balance with a lower surplus. In term of trade balance, the scenario 2 with the 3 currency basket peg performs the best. In term of stable growth of exports, scenario 4 with the 6 currency basket peg performs the best.

Chapter 7 Conclusion and summary

Findings from chapter 4

After discussing the theoretical framework and operation of a currency basket with example in chapter 4, currency basket shows a property of balancing the fluctuations of cross exchange rates of currencies inside the basket. The example shows that,

(1) if the USD depreciates against EUR, the RMB under a 2 currency basket will also depreciate against EUR with a lower level than that of the USD. Meanwhile, as the USD depreciates against EUR simply means the EUR appreciates against USD, thereby the RMB will also appreciate against USD with a lower level than EUR.

(2) the higher the weights of a currency in the basket, the lower the fluctuation of RMB against this currency would be found, however, the higher the fluctuation of RMB against other currencies would be the result.

In contrast, although a peg to the USD means nearly zero fluctuation in the bilateral exchange rate of RMB against USD, theoretically the bilateral exchange rate of RMB to currencies other than the USD must be much higher than the one generated by currency basket. Therefore, if the RMB has linked to a currency basket instead of a fixed peg to the USD, a much stable trade-weighted real effective exchange rate would be found.

In short, the exchange rate of the RMB adopted a currency basket will be even more stable in terms of its overall competitiveness in the international market when comparing with other regimes, and it is a wise choice for China to link to a currency basket rather than the peg to the USD in serving China's interest in current circumstance.

Findings from calculated bilateral trade weights in chapter 5

After calculating bilateral trade weights of the 3 currency basket included the USD, JPY and the EUR, it shows that the international trading pattern of China is changing overtime. For example, the percentage share of total trade with Japan decreases totally 6.1 percent from 43.4 percent to 37.3 percent within a decade. However, the percentage share of import from Japan keeps at 47 percent all over the time, which means that the percentage share of export to Japan decreases steadily from 39 percent to 28 percent over this period. In contrast, the percentage share of total trade with Euro area keeps increasing from 24.6 percent to 28.6 percent from 1998 to 2004, which increases 4 percent in total and both percentage share of export to and import from Euro area is increasing smoothly.

After calculating bilateral trade weights of the 6 currency basket included Hong Kong, the divergence between modified trade weights and original trade weights can be seen. The export weights of Hong Kong in all four periods are unreasonably high. It is impossible and unbelievable that Hong Kong, just a small dot on a world map with seven million populations, can import and consume in average 28 percent of China total export in average in all four periods. And this phenomenon can be explained by Hong Kong's geographical location makes herself as an entrepot of China and re-exports billion tons of goods to the world after China adopting the open door policy in early 1990s.

To correct these false weights, adjustments to Hong Kong's re-export from China to the world and re-import of China are needed. After correction, in the period of 1993-1995, the export weight of Hong Kong drops obviously from 34.3 percent to 3.2 percent, meanwhile, the weighted average weight of Hong Kong also falls sharply from 22.6 percent to 6.4 percent. At the same period, the weighted average weights of remained 5 countries increase and the degree of increasments are depended on the

extent that China did export to those countries via Hong Kong in the form of re-exports. For instances, the export weight of United States increases the most from 19.6 percent to 27.7 percent (8.1 percent in total), the ones of Euro area and Japan rises moderately by 3.4 and 2.3 percent.

To conclude, the trade weights after refinements must be superior and more accurate than the original one to reflect the actual situation of China. Without adjusting re-export via Hong Kong and re-import of China, the trade weights are distorted and become inaccurate. Therefore, attention on these two issues must be paid in calculating either the trade weights of a basket currency or real effective exchange rate index with composition included Hong Kong.

Findings from exchange rates' volatilities in chapter 5

The examination result in chapter 5 shows that under all scenarios where the RMB links with a currency basket, volatilities of bilateral nominal exchange rates (BNER), nominal effective exchange rates (NEER) and real effective exchange rates (REER) tend to be lower than the scenarios of historical regime, a fixed peg and a WCU link.

In term of BNER, the 3 currency basket performs the best and the actual and fixed regimes perform the worst while examining their volatility of BNER. In term of NEER, the 4 currency basket and 11 currency basket perform the best with the lowest volatility of NEER, but the WCU peg and the fixed peg perform the worst with the highest standard deviation. In term of REER, the 3 currency basket and 4 currency basket perform the best with the lowest volatility of REER, whereas the WCU peg and the fixed peg perform the worst again.

Therefore, the conclusion of that all scenarios of currency baskets are superior in term of exchange rates volatility can be drawn.

Findings from simulated real exports in chapter 6

For the result of simulated real exports of China in different scenarios shown in Graph 6.2, the lines of the historical regime and the fixed peg show the lowest value of real export in the middle of the period from January 2001 to July 2003, but they show the highest value at the end of the period from October 2004 to June 2006. In contrast, the line of WCU link shows the highest value in the middle but the lowest value at the end of the period. Typically after the mid of 2003, it shows a much lower value of real export and this can explain by the movement of REER of WCU in figure 6.1. As a continuous increase of REER means appreciation of RMB, and a steady appreciation of RMB started from 2002 to 2006 does hurt the export of China because of increasing in international price. On the other hand, simulated real exports of different currency baskets generally show a stable increasing trend and similar fluctuation along the whole period of time.

For the objective of having the most stable growth in export, all scenarios adopted trade-weighted currency basket show a much lower standard deviation in rate of change of export than the other scenarios, and the 6 currency basket performs the best with the lowest standard deviation.

This means that a country adopted a trade-weighted currency basket will perform a relative more stable export growth. Meanwhile, the standard deviations of various scenarios adopted trade-weight currency basket seem to have an optimal level of basket composition. It is clear that increasing the number of currencies in a currency basket will not necessarily lead to a better result. On the other hand, scenario 7 simulating the effects of linking to WCU produces an extremely high standard deviation, which reflects the simulation result that under the WCU link, as Graph 6.2 shows, an initial growth in exports was followed by negative growth after the mid of 2002. Quite apart from the fact that the simulations were performed only on

manufacturing exports and imports, this probably is not a fair simulation of the effects of a WCU link. A WCU link is expected to lead to lower inflation and thus enhance China's competitiveness. However, we ignore these effects and simply assume that prices in China will be the same as in other scenarios. Therefore the conclusions about a WCU link being so negative to export are probably exaggerated.

Findings from simulated trade balances in chapter 6

From the result of simulated trade balances of China in different scenarios, the fixed peg to USD shows the highest value of trade surplus. It means that if China had kept her linkage of the RMB with USD, the trade surplus and international pressure received in these years would even higher than the one in reality, since the RMB keeps appreciating against USD after revolution of exchange rate regime in July 2005 in reality.

On the other hand, although all 5 trade-weighted currency baskets show a bit higher trade surplus from 2001 to 2003, they show a much lower trade surplus from 2004 to 2006, typically in 2005 and 2006. Moreover, all these baskets generally generate a relative more stable trade balance with slower growth, especially the 3 currency basket, which shows the lowest trade surplus and the lowest growth in trade balance overtime.

Overall conclusion and short summary

To summarize, a country adopted a trade-weighted currency basket generally will generate much stable, less fluctuated nominal and real exchange rates. Also it will perform a relative more stable export growth and a more stable trade balance with a lower surplus.

In term of volatility of exchange rates, the 3 currency basket performs the best with the lowest volatility of BMER. In term of NEER, the 4 and 11 currency basket

perform the lowest volatility. In term of REER, the 3 and 4 currency basket perform the lowest volatility. In term of export growth, the 6 currency basket performs a most stable growth. In term of trade balance, the 3 currency basket performs the best with the lowest growth and the most stable trade surplus.

While a country decides to adopt a basket link, beside of selection of weights and basket composition, the subject of transparency versus secrecy of the basket should also be concerned. With complete transparency, central bank can enjoy advantages of having excellent reputation because people have high confidence in the bank and believe that the bank is fully responsible and accountable for its currency. These will induce domestic and foreign long term investments. However, as these foreign exchange policies and regulations should be announced as rules and even as laws, when there is any crisis or unexpected situation which needs intervention, possible actions can be taken by the bank are restricted by these rules and response by the bank may become slow and rigid. Further more, those rules must be good enough to follow. Otherwise, the rule itself may induce speculative attack like those cases of Argentina, Thailand and Indonesia during the Asian Financial Crisis. In contrast, if the basket is running in full of secrecy, lots of discretions can be taken by the bank and response becomes more flexible. Nevertheless, as the basket just like operating inside a black box, people may lack of confidence in the currency, may question about the regime and even have panic selling during crisis.

In the case of China, I would argue that China is trying to balance the transparency and secrecy. Unlike the Russia, whose basket is completely transparent with the basket composition and weights are well spelt out. In contrast, China chooses to proclaim just those currencies inside the basket but not the weights of each currency. Since the weights of the currency basket are unknown, people wonder that what those weights are and they even think that China had never changed her

exchange rate regime. More importantly, China announced that she is now “making reference to” a basket link but she has never said the word “adopt”. Therefore, China almost has the maximum flexibility in policy implementation. However, China also paid for that. People and countries lack of confidence in China’s exchange rate reform. They put pressure on China continuously and they keep asking for a higher flexibility in the RMB exchange rate. Some foreign scholars even blamed China on manipulation of exchange rate. The most important problem is that speculation and hot money are threatening the health of economy by causing bubble and inflation, because speculators can simply bet on the appreciation of RMB against USD.

To conclude, there is no “single best” basket or regime for China, and which regime or basket is preferable depends on what the government wants or needs to achieve and the situation at that time. Although the nominal anchor in the past had appeared to perform very well in promoting exports, it has also led to an accumulation of foreign exchange and large current account surplus. For China in the current situation with a surplus in both current and capital accounts and a huge, increasing foreign reserve causing inflationary pressure on the economy, there is consensus that China should move to a new exchange rate regime with higher flexibility and sustainability. Linking to a currency basket, an intermediate regime between the fixed peg and the free floating, is definitely one of the solutions.

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