"Analysis of the exchange rate of the Chinese Renminbi"

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Eidesstattliche Erklärung

Ich declare on oath that I have composed the present diploma thesis independently and without the help of others, other than the specified sources and aids, and have clearly marked any sentences which were taken verbatim or in substance from the used sources.
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Abstract

Since 21 Century, a consortium of countries, mainly led by the United States of America (America), has criticized the People’s Republic of China (China) for its RMB exchange rate policy, which it claims is controlled by the Chinese government to restrain import and encourage export. This paper will explore whether the real RMB exchange rate against a basket of currencies is underestimated and to what degree. Econometric models, including FEER, BEER and ERER, have been applied in this paper to realize that goal.

The first chapter is the introduction; the second chapter will discuss the theories of purchasing power parity, international indebtedness, and interest rate parity; the generation and development of the RMB exchange rate will be described in the third chapter along with the current status of the RMB exchange rate; important models and financial theories including Balassa-Samuelson effect, FEER, ERER, and BEER are applied to explore the degree of RMB undervaluation in the fifth chapter; the internationalization of RMB as well as the influence of fluctuations in RMB exchange rate on the Chinese Economy is discussed in the sixth chapter and seventh chapter.
**Zusammenfassung**


In der dritte Kapitel wird die Entwicklung des chinesischen Wechselkurssystems beschrieben. Im vierten Kapitel wird auf den aktuellen Stand der Chinesische RMB dargestellt.

Für die Frage, dass inwieweit wird Renminbi unterbewertet, müssen einige wichtigste Modelle und Finanztheorien beschreiben werden. Der Balassa-Samuelson Effekt, Fundamental Equilibrium Exchange Rates (FEER), Equilibrium Real Exchange Rate (ERER), Behavioral Equilibrium Exchange Rate (BEER) werden in Kapitel 5 diskutiert.

In Kapitel 6 und Kapitel 7 sollen das Internationales Problem der RMB und das Einfluss der Änderung des Wechselkurses der RMB vermittelt werden.
1 Introduction

*Objective:* A call for appreciation of the RMB from the international community has grown stronger since Japan took the stance followed by American support in 2003. While the global financial crisis has increasingly worsened since 2008, the issue of RMB exchange rate has simultaneously changed from one of simple economic into a more complex one infused with social and political elements. As such, opinions on this issue are numerous and vary widely: some scholars suggest the RMB should appreciate; others suggest that the RMB should maintain stability; and some have even suggested that the RMB is overvalued. Various mathematical tools should be applied to explore whether the RMB exchange rate is problematic and in turn whether the RMB is undervalued or overvalued. Furthermore, what attracts our attention the most is the influence of future fluctuations in RMB exchange rate on the global economy and world economic pattern, which will be discussed in depth in this paper.

*Structure and Methods:* several of the most important theories of currency exchange rate in current economics have been introduced in this paper, including exchange rate determination theory, theory of international indebtedness, theory of purchasing power parity, theory of interest rate parity, balance of payment theory, and theory of capital market.

In the mean time, due to the political mechanism (excessive intervention in market from the government), Communist ideology and other issues rooted in history, it is impossible for China to have a monetary system identical with western countries. The history of the monetary system of the PRC from its foundation (Oct 1, 1949) has been introduced in this paper to give a better elaboration on the situation of the RMB. Furthermore, the current situation of RMB exchange rate will be discussed in the framework of similarities and differences between RMB and other currencies in the world.

Based on previous research, several of the most commonly used mathematical models internationally have been applied in this paper to measure the realities of RMB exchange rate including FEER, BEER, and ERER. After the calculation, comparisons with other papers of the same methods have been made to diagnose the RMB exchange rate.
It should be noted that RMB is not an international and market oriented currency in all our discussions about the fluctuation of RMB exchange rate. As the RMB is still strictly controlled by the PRC government, the issue of internationalization of the RMB is discussed profoundly in this paper before the discussion of the influence of RMB exchange rate fluctuations on the international society. The issue of whether the RMB should be internationalized and the results of internationalization, specifically the influence of RMB internationalization on both the Chinese domestic market and world market, are analyzed.

In conjunction, a hypothesis on future appreciation of the RMB has been made in this paper according to the most prevalent theories of RMB appreciation. Its influence on both the Chinese economy and world economy is subsequently considered.

**Conclusion:** Based on exchange rate calculation through several different exchange rate analyzing math models and comparison with conclusions of numerous researches, it has been found that most methods reveal the RMB to be undervalued. However, different methods and different parameters/variables lead to various degree of undervaluation, which are all less than the undervaluation reported by the financial media. Furthermore, the RMB exchange rate value is a moveable target changing with time, depending on the changes of economic fundamentals. During recent years, the exchange rate level has risen gradually over time. In the opinion of the author, the issue of RMB exchange rate is no longer an economic issue. Instead, with the integration of social and political opinions, different countries and economists at different development levels have reached different conclusions on the issue of RMB exchange rate. As a result, the issue is far more complex than one simply solved through economics or mathematics. Based on the positive influence of fluctuation in the RMB exchange rate system on various aspects of society, the author has suggested that the limited appreciation of RMB in certain degree will be beneficial to both the Chinese and world economy.
2 Basic theories of currency exchange rate

The basic theories of currency exchange rate are introduced in this paper. As a core content of international financial theory, the exchange rate determination theory is mainly applied to analyze what factors determine and influence the exchange rate. Developed along with the development of economic status and economic theory, the exchange rate determination theory provides currency authority with theoretical evidence for the formulation of exchange rate policy. The exchange rate determination theories mainly include the theory of international indebtedness, theory of purchasing power parity, theory of interest rate parity, balance of payment theory, and theory of asset market.

2.1 Theory of international indebtedness

Theory of international indebtedness was a popular theory in the gold standard period. In the *Theory of Foreign Exchange* published in 1861, English economist, G.J. Goschen, systematically explained the main reason of exchange rate fluctuation under the gold stand system, and put forwards the theory of international indebtedness. According to the theory, the supply and demand of foreign exchange determined the exchange rate, and the supply and demand of foreign exchange came from international indebtedness. As a result, the relation of international indebtedness was the main factor influencing the fluctuations in exchange rate. The international indebtedness herein was not only involved with trade contacts, but also with the movement of capital. The theory consisted of fixed indebtedness and current indebtedness. The former referred to the indebtedness that was not paid yet though with indebtedness relation; the latter referred to the indebtedness in the actual settlement stage. According to theory of international indebtedness, only when the current financial claims were equal to current debts, the supply of foreign exchange was equal to the demand of foreign exchange, resulting in stable foreign exchange rate; when the current financial claims were greater than current debts, the supply of foreign exchange was greater than the demand of foreign exchange, resulting in depreciation of foreign exchange rate; when the current financial
claims were smaller than current debts, the foreign exchange supply was smaller than foreign exchange demand, resulting in appreciation of foreign exchange rate (Williamson, 1985).

Goschen firstly made a systematic explanation on the changes of foreign exchange supply and demand from the view of the balance of payments, and analyzed the reason of fluctuation in exchange rate. Therefore, his theory was named the theory of balance of payments, or the theory of foreign exchange supply and demand. It was popular in the gold standard monetary system period before the First World War. Currently, the balance of payments still belongs as one of the most direct and important factors influencing the fluctuation in exchange rate. However, due to its historical limitations, the theory of international indebtedness fails to introduce the determination basis of exchange rate and other important influencing factors (Granger & Newbold, 1974).

2.2 Theory of Purchasing Power Parity

The theoretical origin for theory of purchasing power parity can be dated back to the 16th century. Due to the onset of the First World War in 1914, the gold standard system broke down, and issuances of paper money in various countries renounced the limitations, resulting in soaring prices and severe exchange rate fluctuations. In *The Currency and Foreign Exchange after 1914* published in 1922, Swedish scholar Cassel systematically expounded the theory of purchasing power parity. According to the theory, the exchange rate between two currencies was determined by the ratio of purchasing powers possessed by two currencies (theory of absolute purchasing power parity), and the fluctuation in exchange rate was also determined by the changes of two currency purchasing powers (theory of relative purchasing power parity). It is assumed that the price level in Country A is $P_A$; the price level in Country B is $P_B$; and $e$ is the exchange rate of Country A’s currency (direct quotation). Based on the theory of absolute purchasing power parity:

1. $e = P_A / P_B$

It is assumed that the price level in Country A during the period $t_0$ is $P_{A0}$; the price level in Country B is $P_{B0}$; $e_0$ is the exchange rate of Country A’s currency; the price level in Country A during the period $t_1$ is $P_{A1}$; the price level in Country B is $P_{B1}$; $e_1$ is the exchange rate of Country A during the period $t_1$. The change in exchange rate is given by:

2. $e_1 = e_0 \left( \frac{P_{A1}}{P_{A0}} \right)$

Thus, the change in exchange rate can be expressed as:

3. $e_1 = e_0 \left( \frac{P_{A1}}{P_{A0}} \right)$

This relationship shows that the change in exchange rate is directly proportional to the change in the price level of Country A relative to Country B, given the constant exchange rate of the base currency.
Country A’s currency. $P_A$ is the price index of Country A during t1 period compared with the base period of t0 period, and $P_B$ is the price index of Country B during t1 period compared with the base period of t0 period. According to theory of relative purchasing power parity: 

$$e_1 = \frac{P_{A1}}{P_{B1}} = \frac{P_{A0}P_A}{P_{B0}P_B} = \frac{P_A}{P_B}e_0$$

According to relative purchasing power parity, appreciation and depreciation of exchange rate are determined by deflation rates in the two countries (Anderson, 2005) (Jonathon, 2008).

- The main defects in the theory of purchasing power parity: the theory is only involved with tradable goods, and has neglected non-tradable goods, trade cost and trade barrier. Moreover, natural environment (including: completion degree of environmental protection, forestation and infrastructure) and social environment of human beings (including: system, degree of social stability, and degree of social civilization) have not been taken into account;

- The impact of increasingly enormous capital flow on exchange rate has not been taken into account;

- It is difficult to calculate common price levels (price index), because it is hard to determine price indexes among consumer price index, GDP deflator and other indexes. Even if the price index is determined, it is difficult to choose sample products;

- The role of price on exchange rate has been overestimated. However, the role is not absolute, for the price may also be influenced by the fluctuation in exchange rate;

- The premise in theory of relative purchasing power parity is that the exchange rate $e_0$ during period t0 is the equilibrium exchange rate. If the exchange rate during period t0 is not the equilibrium exchange rate, then it is impossible for $e_1$ to be an equilibrium exchange rate.

### 2.3 Theory of Interest Rate Parity
The theoretical origin for the theory of interest rate parity can be dated back to the second half of the 19th century, expounded systematically by Keynes in 1923. According to the theory of interest rate parity, the relation between spot rate and forward rate in two countries was closely related to interests in two countries. The main starting point of this theory was that the income obtained by investors from their investment on domestic short term interest rate should be equal to income obtained by investors from their investment of spot rate on foreign countries and purchased back by forward rate. The investors would seek for interest arbitrage at the sight of differences in investment income generated from interest differences between two countries, resulting in stable forward rate at a certain equilibrium level. Compared with spot rate, the forward rate of in country with low interest rate decreased, and forward rate in country with high interest rate increased. The difference between forward rate and spot rate was almost the same with the difference between interest rates in two countries. The theory of interest rate parity consisted of cover interest rate parity and uncovered interest rate parity (Anderson, 2005).

Covered interest rate parity: it is assumed that \( i_A \) is currency interest rate of Country A, \( i_B \) is currency interest rate of Country B, \( p \) is appreciation and depreciation for the spot rate and forward rate. It is assumed that when investors perform covered transaction with forward contract, the following relation between interest rate and exchange rate would finally emerge in the market:

\[ p = i_A - i_B. \]

The economic meaning is: the future depreciation or appreciation of exchange rate is equal to the difference of currency interest rate in the two countries. Based on the covered interest rate parity, if interest rate of Country A is greater than interest rate of Country B, then the forward rate of Country A will inevitably appreciate, and the currency of Country A will depreciate in forward market, and vice versa. The difference in interest rates between two countries will be offset by the fluctuation in exchange rate, resulting in the equilibrium status in financial market.

Uncovered interest rate parity: it is assumed that investors perform investment activities by calculating expectant income according to their expectation on future exchange rate fluctuation and undertaking certain exchange rate risk. It is assumed that \( E_p \) represents the expectant forward rate of change in exchange rate, then
\[ Ep = i_A - i_B. \]

The economic meaning is: the expectant forward rate of change in exchange rate is equal to the difference of currency interest rate in the two countries. Based on the uncovered interest rate parity, if interest rate of Country A is greater than interest rate of Country B, then the forward rate of Country A will depreciate in the future according to market expectation (Bridgen, Martin, & Salmon, 1997).

Theory of interest rate parity has pointed out the close relation between exchange rate and interest rate from the point of view of capital flow, which is helpful for us to understand the generation mechanism of exchange rate in real foreign exchange market. With special practical value, the theory is mainly applied to determine the short term exchange rate. As a dependent exchange rate determination theory, theory of interest rate parity is complementary to other theories. (Willms, 1992) (Williamson, 1985).

The defects in the theory of interest rate parity include:

- Transaction cost of foreign exchange has been neglected;
- The barrier of capital flow is assumed to be none. However, capital flow around the world will be blocked by factors including foreign exchange rate control and undeveloped foreign exchange market;
- The scale of arbitrage capital is assumed to be unlimited, which is almost impossible in the real world;
- It is artificially assumed that investors pursue equal income from short term investments in two countries. In the real world, a lot of hot money pursues the huge excess earnings from the short term fluctuation in exchange rate.

2.4 International balance of payment theory

During the implementation of the Bretton Woods System from 1944 to 1973, various countries implemented fixed exchange rates. The exchange rate determination theory mainly explained the adjustment of exchange rate in terms of international balance of payment, which
referred to the determination of appropriate exchange rate. While the theory of international indebtedness was the early form, it is now collectively named international balance of payment theory. During this period, influential exchange rate theories mainly included: elasticity approach of Partial equilibrium theory, absorption approach of general equilibrium analysis, and Mundell Flemming Model of internal and external equilibrium analysis, and currency theory focusing on the important role of currency in the determination of exchange rate.

International balance of payment theory has explained the main factors influencing international balance of payments, and analyzed how these factors influence exchange rate through international balance of payments (Cline & Williamson, 2007). It is assumed that Y and Y' represent the domestic national income and foreign national income respectively; P and P' represent common domestic price level and foreign price level respectively; i and i' represent domestic interest rate and foreign interest rate; e is domestic interest rate; Eef is expected exchange rate. It is assumed that the international balance of payments mainly consists of current account (CA) and capital and financial account (K). As a result, \( BP = CA + K = 0 \). CA is determined by domestic import and export, relying on Y, Y', P, P' and e. Therefore, \( CA = f_1(Y, Y', P, P', e) \). K is mainly determined by i, i', e, and Eef. Therefore, \( K = f_2(i, i', e, Eef) \). As a result \( BP = CA + K = f_1(Y, Y', P, P', e) + f_2(i, i', e, Eef) = f(Y, Y', P, P', i, i', e, Eef) = 0 \)

If other variables except exchange rate are regarded as given exogenous variables, then the exchange rate will move to a certain degree under the mutual effect of these factors, resulting in a role to balance the international balance of payments.

\[ e = g(Y, Y', P, P', e, i', Eef) \]

The close relationship between exchange rate and international balance of payments has been proposed in international balance of payments, which is good for the overall analysis on short term fluctuation in exchange rate and determination. As a flow theory about the determination of exchange rate, international balance of payments has not performed profound analysis on the relationship among various factors influencing international balance of payments and their relation with exchange rate, and has not made a conclusion with clear causality.

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1 Partial equilibrium theory, also named Partial equilibrium analysis.
2.5 Theory of asset market

In 1973, after the breakdown of the Bretton Woods System and the collapse of the fixed exchange rate system, a floating exchange rate system was implemented, resulting in further development in exchange rate determination theory. The theory of asset market became the mainstream of exchange rate theories in the late 1970s. Compared with traditional theory, the theory of asset market in exchange rate determination theory greatly stressed the role of capital flow in exchange rate determination theory, and regarded exchange rate as the price of assets determined by supply and demand of assets.

According to different hypothesis on alternative between domestic currency assets and foreign currency assets, the theory of asset market is divided between monetary approach and asset portfolio approach. In the monetary approach, the domestic currency asset and foreign currency asset can be completely replaced with each other. However, in the asset portfolio approach, the two assets can never be replaced with each other. Based on different hypothesis of price elasticity, the monetary approach can be further divided into flexible price monetary approach and sticky price monetary approach (Dunaway & Li, 2005).

In the flexible price monetary approach, it is assumed that prices of all commodities have ideal elasticity. In this way, only equilibrium of currency market should be considered. The basic model is:

$$\ln e = (\ln Ms - \ln Ms') + a (1n y' - 1ny) + b (1n i' - 1ni) \quad a, b > 0$$

The model is deduced based on currency demand function of Cagan, equilibrium condition of currency market, $MD/P = L(y, i) = ky^a i^b$, $MD = MS$, and theory of purchasing power parity. According to this model, the exchange rate levels are determined by corresponding influence of domestic and foreign national income, interest rate, and money supply level on price levels (Ericsson, Hendry, & Mizon, 1998).

In 1976, sticky price monetary approach, which was the so-called overshooting model, was put forwards by Dornbuseh. In his opinion, the adjusting speed in commodity market was different from that in capital market for the price in commodity market was sticky. As a result,
it was impossible to establish the purchasing power parity in the short term, resulting in a process for economic transition from short term equilibrium to long term equilibrium. In the overshooting mode, due to the existence of sticky price in commodities, the degree of instant deprecation in domestic currency was greater than the degree of its long term deprecation when the money supply increased at one time. This phenomenon was named overshooting of exchange rate.

In 1977, Branson proposed the asset portfolio approach of exchange rate. Compared with monetary approach, the approach was featured by the hypothesis that domestic currency asset and foreign currency asset were incomplete substitution. In addition, with factors including risk, it was impossible to establish the uncovered interest rate parity. Therefore, supply and demand equilibrium between foreign currency asset and domestic currency asset should be investigated in two independent markets (Goldstein, 2008). On the other hand, the quantum of domestic assets was introduced to the model, and the quantum of domestic assets directly limited the volume of various assets. Furthermore, the changes of current account would influence the quantum of assets. As a result, the model connected flow factors with stock factors.

It is assumed that domestic residents have three assets, including domestic currency M, bond B issued by domestic governmental with face value priced by domestic currency, and bond F issued by foreign government with face value priced by foreign currency. The monetary aggregates in one country: \( W = M + B + e'F \). The monetary aggregates are distributed in domestic currency, domestic bond and foreign bond. Seen from the money market, the money supply is controlled by the government, the currency demand is the decreasing function of domestic interest rate and foreign interest rate, and the increasing function of total assets (Obstfeld & Kenneth, 1996). Seen from the domestic bond market, the supply of domestic bond is also controlled by domestic government, and the demand of domestic bond is the increasing function of domestic interest rate, decreasing function of foreign interest rate, and the increasing function of total assets. Seen from the foreign bond market, the supply of foreign bond is from the current account surplus, which is stable in the short term. The demand of foreign bond is the decreasing function of domestic interest rate, the increasing function of foreign interest rate, and the increasing function of total assets.

In the three markets, the unbalance in supply and demand of different assets will lead to adjustment in corresponding variables (mainly domestic interest rate and exchange rate). Only
when the three markets are in a balance, the asset market in this country will be in a state of equilibrium in the whole. As a result, in the short term, as the supply of various assets is fixed, the balance of asset market will determine the domestic interest rate and exchange rate. In the long term, with fixed money supply and domestic bond supply, the unbalance in current account will lead to the changes in foreign bonds held by the country, and the changes will further lead to adjustment in capital market. Therefore, in the long term, the balance of domestic asset market should be based on the current account balance (Lütkepohl, 2007) (Williamson, 1985).

2.6 The latest developments of exchange rate determination theory

The exchange rate determination theory is both broad and profound. Currently, various theories have studied the determination and fluctuation of exchange rate in terms of money factor, macro fundamentals, real market factor, stock factor, and flow factor. All of these theories have their advantages and disadvantages. One theory can only performed profound and detailed explanation on one aspect of exchange rate determination. Meanwhile, the same theory may have different explanatory ability in different periods. To date, there is not a universally accepted exchange rate determination theory. However, the existed exchange rate determination theories are complementary to and substitutive with each other, forming the colorful exchange rate determination system.

A new development in exchange rate theory under the fixed exchange rate system is that the exchange rate adjustment is integrated with the framework of governmental policy optimization approach for study. A new development in exchange rate theory under the floating exchange rate system is that the newest developments of modern economics are applied in the research on exchange rate determination theory including prospect theory, incomplete information, game theory, efficient market hypothesis, GARCH model, behavioral finance and micro market determination theory (Krugman & Obstfeld, 2003).
3 Review on RMB exchange rate system

The RMB exchange rate system went through three periods of development from the foundation of PRC to its current form: the planned economy period (1949-1978), economic transition period (1978-1993), and market economy period (1994-Now). Research on exchange rate cannot be separated from social, political and historical backgrounds. Hence, it is important to review the history of the generation and development of the RMB exchange rate system for current researches.

3.1 Planned economy in planned economy period (1949-1978)

During the planned economy period, the evolution of RMB exchange rate system can be divided into three stages: the first stage is the national economic recovery period (1949-the end of 1952). The exchange rate of RMB against USD was firstly listed in Tianjin on Jan 18, 1949. During this period, the formulation of RMB exchange rate was largely tied to the price of goods. As foreign trade then was mainly led by private business, the fluctuation in RMB exchange rate played a positive regulating action in export and overseas remittance to allow for overseas remittance and profit for private business. The exchange rate system in this period was mainly adjusted by the market to find equilibrium in a state of unceasing fluctuations. However, the exchange rate still tended to be stable. Due to the decreasing inflation rate in China during the time period, the exchange rate appreciated gradually in response. The second stage was the period from the beginning of socialist construction to the end of 1967 (1953-the end of 1967). In this stage, China completed the socialist transformation on industry and commerce. Foreign trade was under the unified management of commercial companies responsible for losses and profits, which were in turn subordinated to the Ministry of Foreign Trade. As a result, there was no need to adjust import and export through exchange rate. The significant feature in this stage was that the exchange rate was constant with planned fixed price and the requirement of the planned price management.
system. The exchange rate in China was essentially stable. Starting from 1955, the exchange rate was set at 2.46 RMB/USD. The RMB exchange rate gradually separated from price of goods, turning into an accounting tool for the formulation of internal accounting plan. The third stage was the period from RMB in foreign price quotations and in settlements to the year that western countries applied floating exchange rate system (1968-the end of 1978). In this period, as the British Pound depreciated greatly in Nov, 1967 and major western countries applied floating exchange rate in succession in 1972, China applied RMB in foreign price quotation and settlement and determined the weight to avoid exchange rate risk. The RMB exchange rate was calculated on weighted basis according to depreciation and appreciation of these currencies in international market. In this period, the RMB exchange rate mainly ranked above average among exchange rates of various countries. After the exchange rate deviated from 2.46 RMB/USD in 1972, RMB appreciated rapidly, and reached 1.5 RMB/USD in 1980. While the appreciation of exchange rate became more serious, China failed to grasp the opportunity to adjust foreign exchange level (Wang Zhenzhong, 1986). In the planned economy, RMB exchange rate was determined by government according to certain principle and was applied as the regulating tool of planned economy. The problems of this exchange rate system included: exchange rate could not reflect the insufficient foreign reserve in China at the time; market power had nearly no influence on exchange rate in the rigid exchange rate system; the influencing mechanism of exchange rate on the real economy could not play a role in optimum distribution of resources (Chen Biaoru, 1992). Under these conditions, in order to determine a reasonable exchange rate, promote the lever action of exchange rate in national economy, and gradually push the RMB towards free convertibility, China undertook reforms on the RMB exchange rate system, aiming to build and manage a floating exchange rate system (Zhang Zhichao, 2001).

3.2 Economic transition period (1978-1993)

Economic transition period: in November 1978, after the Third Plenary Session of the 11th Central Committee, China entered the transition period of reform and openness (1978-1993). The RMB exchange system went through two stages, of which the first was the period of RMB internal settlement price and official exchange rate coexistence (1981-the end of 1984)
and the second was the period of coexistence of the official exchange rate and the exchange rate of foreign exchange swap market after the cancellation of internal settlement price (1985-the end of 1993).

3.2.1 The first stage: coexistence of RMB internal settlement price and official exchange rate (1978-1984)

In August, 1978, the State Council made the decision to reform of current Chinese RMB exchange rate system to extend foreign trade, strengthen economic accounting, and satisfy the demand of foreign trade system reform. Not only was the listed price still open to foreign countries for non-trade settlement, but also the internal settlement price for foreign trade was formulated. During this period, the non-trade exchange rate open to foreign countries was mainly applied in foreign relation, and the trade settlement price was mainly applied in internal relation.

From China’s point of view, the implementation of non-trade listed price was mainly aimed at increasing foreign currency earnings (supply) instead of limiting foreign currency expenditure (supply). The purpose of which was to achieve the greatest surplus after the offset between income and expenditure, and not to achieve a non-trade balance of payments. Therefore, the non-trade official exchange rate in this period stayed at a low level, and moved towards the internal trade settlement price from the beginning of 1984 (Anderson, 2005) (Ericsson, Hendry, & Mizon, 1998).

The implementation of internal trade settlement price aimed to create more foreign exchange reserve for China by encouraging export, restraining import, and promoting economic accounting in enterprises. The internal trade settlement price implemented in 1981 actually led to the depreciation of the RMB by 50%. The exchange rate was determined by adding appropriate cost and profit (10%) on export cost in term of foreign exchange. However, the settlement price stayed at the level of 2.8RMB/USD for an extended period. Chinese authority recognized the overvaluation of RMB exchange rate for the first time, and attempted to amend the overvalued exchange rate by implementing internal settlement price (Barro & Sala-i-Martin, 1995).
3.2.2 The second stage: coexistence of the official exchange rate and the market exchange rate of foreign exchange swap (1985-1993)

Although the internal settlement price had certain positive function in promoting foreign trade and export, due to the chaotic application scope of the two exchange rates, the export cost in term of foreign exchange exceeded 2.8RMB/USD. Additionally, the internal settlement price was not adjusted along with increasing domestic price, resulting in greater losses in foreign trades and increasing financial subsidies. As a result, the internal settlement price was abandoned from 1985 (Goldstein, 2004).

The ratio of retailed foreign exchange was demanded from 1988 to assist foreign trade reform, promote contract system and gradually cancel financial subsidies. Foreign exchange swap centers were set up all over the country. The release of exchange rate in foreign swap market resulted in the coexistence of official exchange rate and market exchange rate of foreign exchange swap (Liu, Zhang, & Yang, 2003).

From 1985 to 1990, exchange rate of RMB against USD was adjusted substantially several times. However, from April 9, 1991, a measure of gradual adjustment in official exchange rate replaced the one-time measure of a large margin adjustment in official exchange rate to avoid the adverse influence of substantial decrease in official exchange rate on production of enterprises. During the period, the market exchange rate (swap exchange rate) fluctuated with the supply and demand status of foreign exchange in the market, which provided an important reference for the adjustment direction of official exchange rate. In this period, the real RMB exchange rate was the mean of swap exchange rate and official exchange rate calculated on a weighted basis according to ratio of retained foreign exchange. The official exchange rate and swap exchange rate was different from each other except the period from the end of 1990 to the middle of 1992. However, in light of the increasing ratio of retained foreign exchange, the real RMB exchange rate moved towards the swap exchange rate in the later stage. Some scholars also suggested that the two-track exchange rate system was a transitional choice for China during its economic transition: the official exchange rate was guided through swap
exchange rate, and the influence of market power on RMB exchange rate was strengthened by gradually increasing the ratio of retained foreign exchange reserve. Market economy period: after the Fourth Plenary Session of the 14th Central Committee, the official exchange rate of the RMB was merged with exchange rate of foreign swap market on January 1, 1994 to complete the objective of promoting RMB towards a convertible currency by reforming the foreign exchange administrative system, establishing a managed floating exchange rate system based on market supply and demand, and setting up a unified and standard foreign exchange market. Since then, the banking exchange system was implemented; the unified interbank foreign exchange market was set up; the single exchange rate based on supply and demand of the market was realized. The unification of exchange rate was subject to the swap exchange rate, resulting in a depreciation of nearly 50% in RMB official exchange rate. However, as the ratio of retained foreign exchange in the end of 1993 reached about 0.8, the influence of the depreciation on the overall economy was not significant (Williamson, 1985).

3.3 Market economy period (1994-2000)

From 1994, a mandatory foreign exchange settlement system was implemented in China. It stated that the foreign currency earnings in most domestic enterprises should be sold to authorized bank for dealing in foreign exchange, and the People’s Bank of China implemented proportion and range management on foreign exchange balance for settlement and turnover in authorized bank for dealing in foreign exchange. In this system, the foreign exchange balance for settlement and turnover held by banks should be subject to certain proportion and range. The banks with foreign exchange exceeding the limitation should sell them through interbank foreign exchange market, and otherwise purchased foreign exchange from interbank foreign exchange market (Jonathan, 2006).

In April, 1994, China Foreign Exchange Trading Center was founded in Shanghai, which was an important step in the RMB exchange rate’s move towards market orientation. However, various factors including single transaction currency, tangible market transaction, monopoly of People’s bank and state-owned banks, excessive limitation on member admission blocked the further development of Chinese foreign exchange market (Shen, 2001). The Chinese
foreign exchange market was featured by its role as an important place for the People’s Bank of China’s open market operation, through which it participated in the transactions of foreign exchange market to influence RMB exchange rate (Hendry & Juselius, 2000) (Williamson, 1985).

After the unification of exchange rates in 1994, the nominal exchange rate of the RMB appreciated constantly until decreasing from 8.7RMB/USD to 8.3RMB/USD in Jan, 1995. Then the exchange rate stayed in the interval around 8.27RMB/USD till now with only small fluctuations. As the exchange rate of RMB (against USD) was nearly constant during the several years, the IMF classified the RMB exchange rate system from managed floating exchange rate system to pegged exchange rate system against single currency. On Dec 1, 1996, China agreed to Clause 8 of IMF, and realized the convertibility of RMB in current account. All legitimate current account foreign exchange with actual transaction demand could be paid to foreign countries, which was an important step for RMB to realize freely convertibility. With respect to capital account, China introduced some admittance systems including QFII, but still performed strict control on capital account as a whole (Goldstein, 2008) (Datenbank, 2001).

During this period, RMB exchange rate, after the unification, encountered acute tests on operational mechanism, foreign trade, foreign investment and influence to foreign macroeconomics. In July, 1997, due to the financial crisis in Southeast Asia created from rapid depreciation of the THB, currencies in various Southeast Asian countries depreciated one by one in domino fashion. Furthermore, countries in East Asia, including Japan and Korea, also experienced consistent currency depreciation by contagion. However, the RMB exchange rate stayed stable over time. China announced many times that RMB would not depreciate. As a result of this, from the unification of exchange rate in 1994 to the end of 2001, the exchange rate of RMB against USD appreciated by 44%. According to the data and measure offered by IMF, in view of the trade weighted factor, RMB totally appreciated by over 25% in the same term.

On November 17, 2001, China formally entered into the World Trade Organization (WTO). As a result, the Chinese economy would be opened to the world completely, which was helpful for the improvement of managed floating exchange rate system. Therefore, RMB would gradually move towards freely convertibility in the future with a mature environment (Engle & Granger, 1987).
4 Current status of RMB exchange rate (Since 2001)

Since reform of the RMB exchange rate system in July 2005, the RMB exchange rate generation mechanism was reformed steadily towards the direction of market orientation according to the "independent, controllable and gradual" principles. The exchange rate of RMB against USD appreciated totally by about 23%. However, in recent years, China and America has collided on the issue of whether the RMB exchange rate should appreciate. The UK, EU, UNCTAD, and IMF have also participated in the controversy. On June 19, 2010, People’s Bank of China announced its’ intention to promote the reform of RMB exchange rate generation mechanism and strengthen the elasticity of RMB by restarting the exchange rate reform suspended for two years. As a result, the appreciation of RMB exchange rate again became the focus of the world.

In the 21st century, a brand new issue, the constant RMB appreciation pressure, has presented itself to the Chinese economy. The RMB exchange rate issue exceeds that of a simple economic scope, but is a political problem pertaining to national strategy between China and the developed world, notably between China and America. Based on the review of the history RMB appreciation pressure, three main stages are found:

4.1 The first stage: (2001-2005)

The formation stage of RMB appreciation pressure (2001 to July, 2005). The RMB appreciation pressure in this period mainly came from foreign countries, emerging as early as 2001. On Sep, 2001, Nihon Keizai Shimbun published an article named “Hope for the Appreciation of RMB Exchange- Rising China Threat Theory”, and announced the demand for RMB appreciation. From 2003 to 3005, the disequilibrium of the global economy began to draw attention from the world. Arguments of trade balance between China and America was hotly debated. US Treasury Secretary, John Snow, President of FED, Alan Greenspan, and President George Bush all made public statements indicating hope for the appreciation of the RMB and the implementation of flexible exchange rate policy; furthermore, America voiced,
with various countries, its concern for RMB appreciation at the G7 and the annual meeting of IMF; in 2005, the U.S. Senate passed a proposal to threaten China into allowing RMB appreciation. Meanwhile, most researches in international academic circles also suggested that the RMB exchange rate was undervalued. In domestic aspect, due to international payments surplus and old foreign exchange administrative system, Chinese foreign exchange reserve increased rapidly, compressing the space of monetary policy in People’s bank of China, resulting in signs of excess liquidity and overheating economy. During this period, the Chinese government signaled many times that China would promote the reform of RMB exchange rate according to its national conditions, and would never yield to any foreign pressure. Simultaneously, China promoted various reform measures of foreign exchange control to ease RMB appreciation pressure (Yu, 2001).

4.2 The second stage: (2005-2008)

RMB appreciated gradually (July, 2005- 2008). On July 21, 2005, People’s Bank of China announced the implementation of a managed floating exchange rate regime based on market supply and demand with reference to a basket of currencies. As such, the RMB began to appreciate. Taking for example the exchange rate of RMB against USD, the appreciation range was 2.5% in the first year after the reform of exchange rate system. The RMB appreciated more quickly by 5.7% and 11.7% respectively in the second and third year. Up to July, 2008, the exchange rate of RMB against USD appreciated by 18% in total. The gradual appreciation strategy strengthened the expectation on RMB appreciation, which was related to a series of problems in macroeconomics in this period. After the reform of exchange rate system, Chinese trade surplus increased by a large scale. In 2004, the trade surplus was only 32.09 billion USD. In 2005, the trade surplus soared to 102 billion USD, and soared to 300 billion USD in 2008, increasing by 8.2 times compared with that in 2004. The main reason was that the expectation on RMB appreciation drove large amounts of hot money into China, reflected in the soaring of trade surplus. The expectation of RMB appreciation also led to accelerated increase of Chinese foreign exchange reserves. By the end of 2006, Chinese foreign exchange reserves reached 853.672 billion USD, ranking first in the world and surpassing Japan for the first time. In April, 2009, foreign exchange reserves exceeded 2000
billion RMB. Due to unilateral expectation on appreciation, the folk impounding reservoir of foreign exchange essentially disappeared. The great growth in trade surplus and foreign exchange reserves in turn aggravated the expectation of RMB appreciation. The inflow of hot money led to bubbles of different scale in the Chinese stock market and real estate market, resulting in unabated increases in asset price. As a result, from July, 2007, China encountered significant inflationary pressures. In 2008, the national CPI exceeded 7% for 6 successive months. Due to the coexistence of internal depreciation and external appreciation in RMB, People’ Bank of China encountered unprecedented difficulty in the application of monetary policy. In the second half year of 2008, the American subprime crisis led to a global financial crisis, resulting in depreciation in exchange rate of RMB against USD. As the crisis extended from financial field to the real economy, the global economy glided down, and global trade declined. Faced with downward risks, the Chinese economy had less appreciation pressure for RMB exchange rate. The exchange rate of RMB against USD fluctuated in the limited interval between 6.81 and 6.85 (Zhang, 2000) (Dornbusch, 1976) (Mahadeva & Robinson, 2004).

4.3 The third stage: (2009 to now)

The period with temporary stable RMB exchange rate (2009 to now). Since 2009, the global economy went through deepened crisis, economic rebound, and economic recovery. Due to influence of external impact, the total volume of foreign trades decreased greatly for 10 months in 2009, resulting in corresponding decrease in trade surplus. According to market standard, the RMB exchange rate should depreciate. However, due to the overall consideration on economic recovery, China applied stable strategy by pegging the exchange rate of RMB against USD at 6.83. It was proved by facts that the policy was good for China to face the challenge of financial crisis and good for the economic recovery of Asia and the world. Along with the global economic recovery, China further solidified the foundation for a better economy. The economic operation tended to be stable, and the foreign trade tended to reach a balance. From 2009, the ratio of Chinese current account surplus to GDP decreased significantly, and international balance of payments tended to reach the equilibrium. There was no basis for the large fluctuations and changes of RMB. With this background, China
announced the restart of reforms on the exchange rate system, aiming to promote the basic international balance of payments in China, maintain the basic stability of RMB in reasonable equilibrium level, and preserve the stability of macroeconomics and financial markets. After the restart of reforms, the RMB appreciated by a small margin. However, the bilateral exchange rate experienced more volatility as well. As seen from the overall steady market performance, the RMB exchange rate nearly reached the equilibrium level (Barro & Sala-i-Martin, 1995) (Zhang, 2000).
5 Mathematical model for exchange rate research

5.1 Balassa-Samuelson effect

At the beginning of 1960s, the Balassa-Samuelson effect was brought forwards in the discussion on disequilibrium of international balance of payment and USD crisis in America, which revealed that the purchasing power parity theory had systematic deviation as an explanatory theory for equilibrium exchange rate (Balassa, 1964) (Samuelson, 1964). The Balassa-Samuelson effect has proposed a theoretical speculation on the relationship between labor productivity growth and actual exchange rate fluctuation during the economic development process of a country, which has gradually become the basic analyzing framework to study the relationship between economic growth and exchange rate trend of domestic currency (Krugman & Obstfeld, 2005).

5.1.1 Introduction of Balassa-Samuelson effect

When the relative growth rate of labor productivity in tradable products department and nontrade products department is faster than that of foreign countries, the actual exchange rate of domestic currency will appreciate compared with foreign currencies (Samuelson, 1964). According to this theory, when a country persists in the developing economy, the actual exchange rate of domestic currency will face an appreciation trend in the long term (Tica & Druzin, 2006). It is suggested in this theory that when a country is in the economic development stage, the growth of labor productivity in tradable manufacturing department increases faster (Linder, 1961). With increasing export, the demand of tradable products department on labor force will increase (Balassa, 1964). As the economy is in the status of full employment, the increasing demand on labor force will lead to the increase of salary in tradable products department (Heston, Nuxoll, & Summers, 1994). As a result, the labor force in nontrade department transfers to tradable department, and the salary in nontrade department will increase as well (Linder, 1961). The increasing salary level can only be only absorbed through price inflation. Therefore, the overall price level in a country rises, resulting in
appreciation of actual exchange rate under the fixed exchange rate system. This appreciation is caused by the structural factor, the increase of labor productivity. Thus, it belongs to long term and durable appreciation, which is different from short term appreciation of actual exchange rate caused by other impacts (Balassa, 1964) (Samuelson, 1964) (Krugman & Obstfeld, 2005).

Before the occurrence of Balassa-Samuelson effect, the pegged exchange rate system of Bretton Woods System was widely used in the world, under which the bank normal exchange rate was assumed invariant, and then the real appreciation of exchange rate would be realized through relative growth of common price. However, if the normal exchange rate can be adjusted, in addition with underemployment, the salary growth may be lower than the growth of labor productivity (Krugman & Obstfeld, 2005). At this time, the unit labor cost in tradable products department will lead to price fall of tradable products and stronger international competitive power, resulting in current account surplus. The appreciation of actual exchange rate will be realized through appreciation of normal exchange rate; or if the normal exchange rate is invariant in short term, the disequilibrium of international balance of payment in this country will lead to variation on amount of reserve assets. However, this variation will not continue without limit, but be reflected in the appreciation of normal exchange rate. According to the extended deduction of Balassa-Samuelson effect, in current international economic environment, appreciation of actual exchange rate has more complex channels (Linder, 1961). The appreciation of normal exchange rate is determined by the decrease of unit labor cost in tradable department. The appreciation of actual exchange rate can be determined by variations or certain combinations of two factors such as common price level and nominal exchange rate (Krugman & Obstfeld, 2005) (Bhagwati, 1984).

5.1.2 Balassa-Samuelson effect and RMB appreciation exchange rate

According to Balassa-Samuelson effect, the rapid development of the Chinese economy will inevitably lead to the appreciation of the RMB exchange rate. With China pursuing economic development, changes in various factors, including labor productivity, salary, employment,
movement of labor force competition, degree of trade liberalization (Bhagwati, 1984), will allow for a greater likelihood of the occurrence of the Balassa-Samuelson effect, which is important to know for the long term trend of RMB exchange rate (Cihak & Holub, 2001). According to the deduction of Balassa-Samuelson effect, if the relative salary growth in tradable department is lower than relative growth of labor productivity, which means that unit labor cost is reduced, the appreciation of actual exchange rate in domestic currency will be realized through the appreciation of nominal exchange rate (Kravis & Lipsey, 1953) (Marston, 1987). With clear policy orientation, this conclusion has pointed out that the appreciation pressure of RMB nominal exchange rate is from Balassa-Samuelson effect, which is the inevitable result of increasing labor productivity (Marston, 1987). Chinese economists have systematically studied the variations of unit labor cost in Chinese manufacturing industry since 1978 (Rogoff, 1996). During the period of reforming and opening up, unit labor cost in Chinese tradable department first rose and then descended with the boundary of 1995 (Chen, 2011). Compared with the average value of 13 countries of OECD, the indicator fell off by about 30% to 40% from 1995 to 2006. In the latter state, the unit labor cost in Chinese tradable department decreased mainly because the labor productivity in this department increased quickly along with the great growth in actual salary of laborers. Therefore, he suggested that the appreciation pressure of RMB actual exchange rate was caused by the rapid development of labor productivity in Chinese tradable department, and the constant reduction of unit labor cost in the same term pointed out that the appreciation of actual exchange rate should be realized through the appreciation of nominal exchange rate (Chen, 2011) (Bergin, Reuven, & Taylor, 2004).

There are many disputes in academic circles about whether the Balassa-Samuelson effect has taken place in China now. Extended time period is a necessary condition to judge the variation trend of equilibrium exchange rate, for the disturbance of short term factor on the long term trend can be avoided (Bourdet & Falck, 2006) (Chen, 2011). Or else, the judgment on variation trend of actual exchange rate may be distorted. In real life, the situation that actual exchange rate is lower than equilibrium exchange rate may be caused by various factors, resulting in increasing appreciation pressure on actual exchange rate. Especially since the economic development of China is still in the early stage, the Balassa-Samuelson effect may not perform due function due to differences in various aspects including system, management method, degree of market orientation, economic structure, technological absorption capacity,
and employment status. Besides, in the current world, the developmental speed of the virtual economy is much faster than the real economy, and international capital flow is much faster than trade flow, so the maneuverability of equilibrium exchange rate may be reduced. Therefore, it is not fully persuasive to judge the RMB appreciation nominal exchange rate in current stage through this theory and its extended deduction (Bhagwati, 1984) (Tica & Druzic, 2006).

However, we should be aware that the internal relationship between the economic growth and actual exchange rate trend of domestic currency should be investigated through Balassa-Samuelson effect in a clear and concise analytical framework, for the role of a basis factor influencing the long term actual equilibrium exchange rate during the economic development process has been revealed in this effect (Bourdet & Falck, 2006). Meanwhile, a basic model has been provided in Balassa-Samuelson effect to understand the evolution rule of RMB actual exchange rate in economic development progress. It can be predicted that, the labor productivity in Chinese manufacturing section is still far behind that of the developed countries, so the labor productivity will maintain its fast growth speed as seen from the economic growth status and technological progress in China, which will promote the RMB appreciation actual exchange rate in the long term. However, due to the great uncertainty in the variation trend of unit labor cost, the appreciation trend of actual exchange rate may be realized through the combination of two factors including nominal exchange rate and common price level (Chen, 2011) (Cihak & Holub, 2001) (Bergin, Reuven, & Taylor, 2004).

5.2 Benchmark to analyze the RMB actual exchange rate

As to USD exchange rate, the trade-weighted USD index may be used commonly. However, as to RMB, the main focus is on the exchange rate of USD to RMB, which may be due to the fact that the RMB was pegged to the USD at most times during the previous decades (Chen & Shi, 1998).

However, China has many trade partners besides America. The RMB effective exchange rate depends on the weighted average of a basket of currencies relative to trade partner countries. The trend of RMB/USD exchange rate may be very different from the trend of RMB effective
exchange rate. For example, from mid 2005 to mid 2008, the RMB/USD exchange rate increased by 21%, but the effective exchange rate increased by only 11% (Fig.1). Since mid 2008, the RMB has been pegged to the USD, but the RMB effective exchange rate has experienced great fluctuations (Wang & Hu, 2010).

![Exchange of RMB to U.S. Dollar](Image)

Fig.1 RMB against the U.S. dollar exchange rate and nominal effective exchange rate (Wang & Hu, 2010)

Besides, the value of a currency to other currency is in fact a relative purchasing power. Therefore, the relative price of domestic products and services to foreign products and services is also very important. For example, if price growth in China is faster than that in its trade partners (such as America), the RMB actual exchange rate will appreciate though the
nominal exchange rate is invariant, for foreign currency (such as USD) can purchase fewer Chinese products than before (Hefeker & Nabor, 2002) (Baig, 2001).

Therefore, the economists pay attention to real effective exchange rate, which refers to exchange rate adjusted according to relative price (CPI) and measured by trade-weighted basket of currencies. (Dobson, 2001) The monthly data calculated and released by IMF and BIS is RMB real effective exchange rate. The nominal effective exchange rate is released in monthly report of <Observe Chinese Economy through Data> by the analyst of UBS (Wang & Hu, 2010). In the mean time, the annual real effective exchange rates of China relative to 20 trade partners from 1980 to 2009 have been estimated for analysis (Baig, 2001). I have applied the estimated real effective exchange rate from UBS and have adjusted the nominal exchange rates for multiple exchange rates existed in some previous years (the real effective exchange rate calculated by IMF was not adjusted for this). Furthermore, UBS’s backtracking time is longer than that of the BIS. UBS estimated values are similar to that of BIS since 1994 (BIS began tracking the statistics from 1994), though the data of the latter is based on over 50 trade partners of China (Wang & Hu, 2010).
In the long term, there are mainly three methods to evaluate exchange rate level: the traditional purchasing power parity model is regarded as the frame of reference for exchange rate adjustment in the first method. In this method, the actual exchange rate of a certain year is assumed as equilibrium, and then the influence of inflation rate for future years is deducted from this exchange rate. Then this exchange rate is compared with actual exchange rate of evaluation period. The disadvantage of this method is that equilibrium exchange rate of every year is assumed to be the same during the comparison period. However, according to the fact, the equilibrium exchange rate is a dynamic indicator, which will change along with the
changing basic economic factors. In the second method, the exchange rate is adjusted by regarding black market exchange rate as the equilibrium exchange rate. However, up to now, the relationship between the black market exchange rate and the equilibrium exchange rate cannot be proved. In addition, the information available from the black market is also limited. In the third method, the exchange rate that satisfies the internal equilibrium and external equilibrium of macroeconomics is regarded as the equilibrium exchange rate to determine and adjust actual exchange rate level in the economy. This method has been a mature method to evaluate exchange rate (Wang & Hu, 2010) (Williamson, 1985).

The theory of equilibrium exchange rate was firstly put forwards by English economist, T·E·Gregory, in 1934. In 1954, economist Nurkes, of Stanford University, defined the equilibrium exchange rate based on basic international balance of payment (Williamson, 1985). In 1963, Swan an expert of exchange rate at the IMF, further developed the thought of Nurkes, and put forwards the analyzing method of macroeconomic equilibrium for exchange rate, and defined the equilibrium exchange rate as the potential production capacity to realize current account internally, and exchange rate level to realize equilibrium in current account and capital account externally. The substantive characteristics of equilibrium exchange rate are reflected by various definitions from various aspects, which mean that the equilibrium exchange rate is the exchange rate to realize max economic benefits by maintaining equilibrium in international balance of payment without sacrificing the domestic economy. As the determination of equilibrium exchange rate involves domestic demands and foreign demands, so too the concept of exchange rate based on this has been accepted by various scholars (Wang & Hu, 2010) (Williamson, 1985) (Wang, 2004).

5.3.1 Intuitive Estimation

The simplest way to judge whether the RMB is underestimated may be observing rapid accumulation of foreign exchange reserve in China. Currently, the foreign exchange reserve in China has reached 2500 billion USD (Fig.3). If the People’s Bank of China had not purchased so much foreign currencies, the RMB exchange rate should be much higher. Meanwhile, People’s Bank of China usually hedges most inflow of foreign currencies to avoid
inflation generated from excessively loose mobility into China (Fig. 4). In other words, the hedging intervention in foreign exchange market reduces the RMB appreciation actual exchange rate (Wang & Hu, 2010) (Krugman & Obstfeld, 2003).

Fig. 3 Rapid accumulation of foreign exchange reserves in China (Wang & Hu, 2010)
Fig. 4 Monthly increase the amount of foreign exchange reserves and Hedging (Wang & Hu, 2010)

Of course, it does not necessarily mean that the exchange rate is free from the intervention of the People’s Bank of China is the equilibrium exchange rate of RMB. Emerging market entities often are influenced by great amount of unsteady capital flow. For China, the expectation for RMB appreciation and prosperous capital market are often regarded as the reason to attract the inflow of speculative capital. However, the outflow of speculative capital may impose descending pressure on RMB. However, the increase of foreign reserve in China mainly comes from trade surplus and net foreign direct investment of previous years. The inflow of unknown capital (usually hot money in China) is small (Fig. 5). In fact, the proportion of current account surplus in GDP increased dramatically from average 2% to 3%
during 1990 to 2004 to over 11% of 2007, and subsequently decreased to 6% in 2009 (Fig. 6) (Wang & Hu, 2010) (Krugman & Obstfeld, 2003).

The massive current account surplus is another reason that most people believe that the RMB is undervalued. In the opinion of mainstream economists, developing countries such as China should often have current account surplus, since they usually become importing country of capital due to faster economic growth and higher capital return. Some developing countries even maintain constant current account surplus. In contrast, America has experienced extensive current account deficit for the past decades. The suitable level of current account balance for a country should depend on several other basic factors, which will be discussed in the ERER section of this paper (Wang & Hu, 2010) (Krugman & Obstfeld, 2003).
5.3.2 Purchasing power parity and improved purchasing power parity method

The purchasing power parity may be the most famous exchange rate indicator. As the exchange rate measures the purchasing power of domestic currency relative to that of trade
partners, so the exchange rate leading to equal purchasing power is often regarded as equilibrium exchange rate. In other words, purchasing power parity refers to the amount of RMB that can purchase products and services in China equal to products and services purchased by 1 USD in America (Krugman & Obstfeld, 2003).

The most famous example of purchasing power parity is the Big Mac indicator released by <The Economist>. Based on purchasing power parity, the purchasing power parity exchange rate applied by World Bank to compare GDP (Sum of all commodities and services) of all countries and areas in the world is more complex. According to the latest calculation result from the World Bank, the purchasing power parity exchange rate is about 3.8, and the market exchange rate of USD/RMB is 6.8. This has led some to assert that the RMB is undervalued by over 40% according to the purchasing power parity (Krugman & Obstfeld, 2003) (Hefeker & Nabor, 2002).

According to the same standard, it seems that currencies of all developing countries are significantly undervalued. Figure 7 illustrates the market exchange rate of currencies in countries and areas with population over 1 million and their exchange rate to purchasing power parity ratio. Generally, when a country is poorer, it had smaller ratio of its market exchange rate to purchasing power parity. However, when a country’s per capital income is closer to that of America, the ratio is closer to 1 (Wang & Hu, 2010) (Krugman & Obstfeld, 2003). This is because that the prices of nontrade products (services) in poor countries are much lower than rich countries, which can only increase gradually along with the economic development and increasing productivity. The phenomenon was explained theoretically by Balassa and Samuelson in 1960s (Balassa, 1964) (Samuelson, 1964).
It has been pointed out by Balassa (1964) the increase of productivity in a country during the development process mainly focuses on the tradable products department (Balassa, 1964). Compared with trade partners, the productivity of tradable products grows faster than that of nontrade products, so the prices of nontrade products in this country increase compared with tradable products, resulting in appreciation of actual exchange rate in this country. Therefore, economists always compare the trend of absolute purchasing power parity with the trend of Balassa-Samuelson base line, which means the trend for variations of actual exchange rate in all countries and the trend for variation of actual income (or productivity) (Samuelson, 1964). Any deviation herein refers to the over and undervaluation of currency values (Wang & Hu, 2010).

Based on this extended purchasing power parity, Frankel(2005) estimated that the exchange rate of RMB to USD is undervalued by about 45% (Frankel, 2005). However, the previous price data to measure purchasing power parity in China and some other countries and areas is incorrect. According to more comprehensive adjusted data in international comparison project
released by the World Bank, the exchange rate of RMB to USD is undervalued by about 15% (based on the calculation of Arvind Subramanian) (Datenbank, 2011).

5.3.3 FEER (Fundamental Equilibrium Exchange Rates)

Put forwards by Williamson in 1983, the concept of FEER refers to actual exchange rate that is in line with medium-term macroeconomics to maintain a sustainable trade position with other countries in the world when the domestic activities are normal (Williamson, 1985). According to the definition of FEER, firstly, it’s an actual exchange rate, and a medium-term exchange rate. The capital flow in medium-term, or the structural capital flow, is important to the estimation of FEER. In this respect, FEER is closer to flow equilibrium instead of stock flow equilibrium in the long term. Secondly, domestic activities are considered normal when the economy has natural unemployment rate, neutral currency policy and inflation expectation rate at 0. Thirdly, FEER refers to the actual exchange rate in medium-term that can keep a sustainable international balance of payments through the current account surplus or capital and financial account surplus (Williamson, 1994).

The most important thing for the implementation of macroeconomic equilibrium exchange rate should be calculating the exchange rate suitable for the internal and external equilibrium of the macro economy. Williamson has made a definition on internal equilibrium similar to the common definition, which pointed out that the potential productivity of economy is realized under internal equilibrium, or suggested that the output level of the economy is in line with full employment, and a slow and stable inflation rate. In the definition of external equilibrium, Williamson has put forwards a new opinion on traditional overall balance. The common external equilibrium refers to overall international balance of payments, which means the quantity balance or no difference in international balance of payments. However, Williamson has pointed out that it is not insufficient to define the external equilibrium of a country with overall international balance of payments, for different interest levels will lead to different scales of capital inflow even when international balance of payments reach an overall equilibrium. If a country blindly pursues equilibrium in international balance of payments, the fluctuations in current account will come out, resulting in fluctuations in exchange rate. Therefore, Williamson has defined the external equilibrium with current account target-which means that a country will reach external equilibrium when it maintains a
sustainable current account target in line with economic development. This theory of external equilibrium has rejected this possibility that the country will reach the external equilibrium when it applied high-interest policy to make up great current account with surplus of capital account. It is suggested by Williamson that this kind of currency policy would lead to loss of credit in a country during the long term, resulting in impact to equilibrium exchange rate. Meanwhile, he pointed out that it is infeasible to maintain current account surplus in the long term. A target account surplus suitable for the economic development of a country should be found to achieve long term external equilibrium (Williamson, 1994) (Williamson, 1985) (Bayoumi, 1994).

The identical equation of current account and capital account is used to reflect external equilibrium in the system of national accounts (Williamson, 1994):

\[ \text{CA} = -KA \]

It is generally believer that the factors influencing current accounts mainly include domestic aggregate output (or aggregate demand) \( Y_d \), foreign aggregate output (or aggregate demand) \( Y_f \), and real effective exchange rate \( q \). The medium-term capital account equilibrium can be concluded through judgment according to relevant economic factors. Therefore, the equation (2) can be transferred to the equation reflecting the equilibrium relationship between current account and capital account (Williamson, 1994):

\[ \text{CA} = \text{CA}(q, Y_d, Y_f) \]

\[ q = f(KA, Y_d, Y_f) \]

For a clear introduction, the current account is expressed by linear function of above determinants under the situation of full employment, as shown in the following equation (Williamson, 1994):

\[ \text{CA} = b_0 + b_1q + b_2Y_d + b_3Y_f = KA \]

In the equation (5), q is the exchange rate suitable for the macroeconomic equilibrium, which is named fundamental equilibrium exchange rate by Williamson in 1983(Fundamental Equilibrium Exchange Rate, FEER for short). With the q, the current account balance equals to normal and sustainable capital account balance. The determinants for current account in
equation (3) should apply values under full employment. The \( q \) in FEER based on the solution of (3) is (Williamson, 1994):

\[
\text{FEER} = \left( -KA - b_0 - b_2 y_d - b_3 y_f \right) / b_1
\]

According to the above equation, FEER is an exchange rate in line with the medium term macro economy, which means that the FEER can be calculated based on external sustainable capital flow under the premise that various parameters in current account model are given, especially the sensitiveness of current account flow to real effective exchange rate is given. It should be noted that FEER is only a method to calculate equilibrium exchange rate, but not an exchange rate determination theory. As the embedded hypothesis in the calculation of FEER is that the real occurrence value \( q \) of real effective exchange rate will gradually converge to FEER, so the exchange rate determination theory in FEER method is the determination theory for current account of exchange rate (Williamson, 1994) (Bayoumi, 1994).

During the specific implementation of FEER, the estimation and judgment should be performed on relevant parameters, including the potential domestic yield, potential yield of main partner countries, \( (y_d \text{ and } y_f) \) and capital account equilibrium \((KA)\). Both the concept and calculation method of potential yield are very clear. However, the concept and calculation method of capital account equilibrium are still worthy of study. Combining the judgment on sustainability and consistency, Williamson (1994) once deduced the current account targets of 14 countries and areas in 1996 based on factors influencing the savings behaviors including investment demand determined by debt cycle and age structure of population \((-KA)\). When Bayoumi (1994) calculated the equilibrium exchange rate of main industrial countries in 1970, he assumed the status of equilibrium current accounts was that the current account surplus accounted for 1% of GDP (Bayoumi, 1994). This ratio came from the current accounts budget target released by America during the discussion of the Smith Agreement on suitable price parity of exchange rate in various industrial countries. The above two methods had significant subjectivity. In 1996, Faruqee put forwards a transparent and feasible method to calculate the equilibrium current account to be largely free of subjective judgment (Cline & Williamson, 2007) (Clark & MacDonald, 1998).

The method of FEER has got rid of short term periodical condition and temporary factor, and has focused on basic economic element. Therefore, the equilibrium exchange rate will be more credible. However, the basic economic elements here refer to economic conditions and
economic variables that may play a role in the medium-term. In reality, theses equilibrium economic condition may be ideal result that can never be realized. In this way, FEER has measured the standardized exchange rate. In fact, Williamson has described FEER as the equilibrium exchange rate in line with ideal economic condition. As a standardized exchange rate, FEER is in line with the approach, for it has only reflected the corrected target of exchange rate in good combination of economic conditions. Of course, the exchange rate can be calculated in the combination of economic conditions different from the above. For example, the exchange rate can be calculated based on possible economic conditions in interested period (Driver & Westaway, 2004) (Clark & MacDonald, 1998).

5.3.4 BEER (Behavior Equilibrium Exchange Rate)

Based on the above introduction, it can be seen that FEER is focused on basic economic element, and removed short term periodical condition and temporary factor. The core section of this method is that the internal and external equilibrium is calculated firstly, and then the corresponding equilibrium exchange rate is calculated. As an ideal method in theory, it involves many actual issues including uncertain parameters and time delay. The greatest disadvantage is that only an estimated value can be put forward for the evaluation of exchange rate, and the reason for disequilibrium cannot found. In order to solve the disadvantage of FEER, Edwards (1998) estimated the relationship between real exchange rate and basic economic factor directly through the co-integration process analyzing method of econometrics, and reached a equilibrium value in economic approximate, which was named behavior equilibrium exchange rate (BEER for short) (Edwards, 1998).

The method of BEER has directly investigated important factors influencing real exchange rate behaviors to set up econometric model of single equation between real exchange rate and its influencing factors, and estimate and evaluate the behavior determinant of real exchange rate during sample period. The method was firstly brought out by scholars such as Clark (1994) and Baffes (1994), and then summarized by Clark and MacDonald (1998). The approach often includes: a single equation econometrical model, between real exchange rate and its influencing factors, is created from the common equilibrium model of real exchange
rate or FEER model. Then the medium and long term factors influencing the real exchange rate are treated through co-integration technology to achieve the determinant model of equilibrium exchange rate. (Bai & Perron, 1998) As a result, the equilibrium exchange rate can be estimated to judge whether the current exchange rate is improper. This method has been widely used in theoretical circles and practice circles. Theoretical circles have applied this method to estimate RMB equilibrium exchange rate. As the method of BEER stresses empirical meaning, so the selection of basic economic variables is the most important section in application of BEER to estimate equilibrium exchange rate and its disequilibrium degree.

In the past ten years, various theories about the selection of basic economic variables have been put forward, (Montiel, 1999) which form the basis of the BEER method. Clark and MacDonald (1999) suggested that according to research objective, basic economic elements including terms of trade, financial policies, relative technological progress, openness degree, monetary policies, foreign exchange reserve, and capital flow control are enough to form a collection of basic economic variables influencing real effective exchange rate. The following factors have been considered in the selection of basic economic variables collection influencing RMB equilibrium real effective exchange rate: firstly, the suggested variables in theoretical model mainly follow the suggestions of previous domestic and foreign literatures; secondly, the specific national status and availability of data in China have been considered. Based on the above factors, basic economic variables, including relative technological progress, terms of trade, openness degree, financial policies, monetary policies, and capital flow control have been selected in this paper. The real effective exchange rate and the mechanism of these main basic economic variables on real effective exchange rate are as follows (Clark & MacDonald, 2000) (MacDonald & Dias, 2007):

REER: Real effective exchange rate is a weighted average exchange rate, which not only includes relative variability of all bilateral nominal exchange rates, but also rejects the influence of inflation on value disturbance in currency. As a result, REER can reflect the external value and relative purchasing power of domestic currency. Indirect quotation is applied here (the same with methods applied by IMF), which refers to that of the foreign currency value of the RMB. The increase of REER indicates RMB appreciation and vice versa. Relative technological progress (TNT) is an indirect indicator measuring the difference between domestic productivity growth and foreign productivity growth. In empirical study, a more direct indicator, the relative ratio of actual GDP against total laboring population, is
used more often to measure the difference between domestic productivity and foreign productivity. The direct indicator attempts to describe the growth trend of productivity. On the other hand, indirect indicator attempts to describe the growth difference between productivity of tradable products department and productivity of non-trade products department. The Balassa-Samuelson effect can be reflected as a result. The samples used in this paper are monthly data. However, there is no monthly labor population in Chinese statistics. Therefore, the indirect indicator, relative price of tradable products and non-trade products will be used in this paper to reflect technological progress (Funke & Rahn, 2005) (Clark & MacDonald, 1998).

Theoretically, the indicator should be calculated based on price indexes of tradable products and non-trade products. However, in actual practice, the two price indexes are not available. According to methods in common literatures, the PPI or WPI is used to describe the price changes of tradable products, and CPI is used to describe price changes of non-trade products. As a result, the relative technological progress is reflected by the ratio of price changes in non-trade products against price changes of tradable products. The increase of the indicator means the price of non-trade products increases relative to tradable products, resulting in increase in real effective exchange rate. Terms of trade (TOT): Applied by various literatures studying the equilibrium exchange rate based on basic economic elements, TOT is defined as the ratio of export price against import price, or the volume of export to volume of import, which is used to describe the competitive power of tradable products from a country in the world market. It is suggested by most literatures, without explanation, that the improvement in TOT of a country will lead to the appreciation of domestic currency and vice versa. However, scholars, including Shi Jianzhun, (2005) have pointed out that the improvement of TOT has two effects. Therefore, the interaction between TOT and equilibrium real effective exchange rate is undetermined, which should be subjected to the actual situation (Milesi-Ferretti & Lane, 2006).

Openness degree (OPEN): Since the BEER model established by Clark and MacDonald (1999) is aimed at developed countries with high openness degree, and that China is a developing country in the opening process, openness degree should be included in the RMB equilibrium exchange rate model. Commonly, countries with low openness degree have smaller foreign reserves. In order to import key equipments and advanced technology, these countries have to limit domestic import demand on foreign common commodities by overvaluing domestic
currency and performing strict trade control. However, after trade liberalization, along with increasing openness degree, these countries depreciated domestic currency to a lower level in order to promote export and accumulate foreign exchange. Therefore, increasing openness degree leads to worsened current account balance. For an equilibrium status, real effective exchange rate should depreciate to promote export and maintain external equilibrium. The openness degree has a negative relationship with equilibrium real effective exchange rate. Financial policy (GOVEXP) was mainly measured by ratio of government expenditure in GDP. (Bai & Perron, 2003) According to Hu Zaiyong, the influence of governmental expenditure not only depends on budget, but also on the composition of tradable products and non-trade products in governmental consumption. If the tradable products account for great ratio in governmental consumption, the governmental expenditure will increase. Therefore, the current account may worsen, resulting in the depreciation of equilibrium real effective exchange rate. Conversely, the equilibrium real effective exchange rate may appreciate if the opposite were to occur. As a result, influence of the governmental expenditure on equilibrium is also undetermined, which should be subjected to the actual situation. Monetary policy (MG): as seen from the monetary model of exchange rate, the money aggregate is an important factor to determine equilibrium real effective exchange rate. The expansion of M2 will lead to increase in inflation rate, resulting in worsened current account balance. Therefore, the real effective exchange rate should depreciate to maintain sustainability of external equilibrium. Capital flow control (NFA): The indicator is mainly measured by ratio of net foreign assets in GDP indirectly. Net foreign assets are net amount of foreign assets and foreign debts, mainly including foreign exchange reserves and gold. Based on the investigation to openness status of capital account in developing countries, the capital flow control will be an important determinant of real effective exchange rate. Under loosened capital control, net foreign assets will increase followed by foreign income, resulting in better current account balance. The equilibrium RMB exchange rate should then appreciate to maintain the sustainability of external equilibrium (Clark & MacDonald, 1998) (Clark & MacDonald, 2000) (Schnatz, 2007).

According to the above introduction and practice of common literature, TNT, TOT, OPEN, GOVENXP, MG and NAF are selected as basic economic variables, and the theoretical model of RMB equilibrium real effective exchange rate is as follows (Schnatz, 2007):

\[
\text{BEER}=\mathcal{F}\{\text{TNT} (+), \text{TOT} (?), \text{OPEN} (-), \text{GOVEXP} (?), \text{MG} (-), \text{NAF} (+) \}
\]
The sign in the right brackets of every explanatory variable on the right of the formula has reflected the sign of first derivative for each variable, which means the fluctuation direction of RMB equilibrium exchange rate when basic economic element increases. The question mark means the interaction between equilibrium and this economic variable is uncertain. The dominant effect should be determined according to coefficient.


For example, Xiang H.J & Pan X.Q (2010) suggested that the RMB was overvalued after April, 2007. Hu C.T (2009) suggested RMB was overvalued by 13.4%. Peng, G.F & Cai, Y (2010) suggested RMB was overvalued by 8.69%. Liu, Y.G (2009) suggested RMB was overvalued by 8% (Funke & Rahn, 2005) (Wang, 2004).

5.3.5 ERER (Equilibrium Real Exchange Rates)

In 1989, Chilean economist, Sebastian Edwards (Edwards, 1994) put forward the equilibrium rate of exchange theory for developing country, also known as the ERER model. This theory has fully considered the most obvious features in the macroeconomics of developing countries, including common implementation of exchange control, existence of trade barriers and parallel exchange rate, and low economic openness. According to ERER theory, Edwards carried out empirical research on exchange rates of developing countries including Brazil, Columbia, India, Philippines, Malaysia, Thailand, and South Africa. However, due to the development level of econometrics at that time, the ERER theory was not ideal in empirical research. More important, some assumptions of Edwards seriously deviated from reality. For example, in Edwards’ model, the changes of international reserves directly equaled to current account balance due to the assumption without capital flow. In contrast, Elbadawi (1994)
subsequently proposed a more reasonable amended ERER model (Elbadawi, 1994). The paper
drew from the model in the empirical research on RMB equilibrium rate, and made more
reasonable selections of explanatory variables in the model based on China’s current realities.
As a result, the RMB equilibrium exchange rate can be measured more accurately to find and
correct deviation between RMB real effective exchange rate and equilibrium exchange rate
(Elbadawi, 1994) (Hinkle & Montiel, 1999).

5.3.5.1 Methods and Estimation

ERER method of simplified equation performed direct estimation by regarding equilibrium
real exchange rate as function of medium-term fundamental plane. The difference between
estimated equilibrium exchange rate (fitted value) and real exchange rate is the deviation of
currency value. The ERER model of simplified equation has many variants, most of which
include indicator of relative productivity to reflect the Balassa-Samuelson effect (IMF, 2003)
(Wang, 2004). The CGER subordinate to IMF has adjusted this model and performed
estimation for several years. Sometimes, this method is named as extended relative
purchasing power parity model. In recent research by the IMF (Lee, 2008), the real exchange
rate model built up based on fundamental plane has included difference of productivity, net
foreign assets, terms of trade, and openness degree of trade. These fundamentals has
influenced medium-term real exchange rate. The NFA is taken into consideration because
debtor nations should repay their debts by trade surplus generated from lower exchange rate,
and creditor nations can suffer high real exchange rate. Commonly, the closed trade system is
related to overestimated exchange rate. The improvement of TOT will increase real
exchange rate through real income or wealth effect. An empirical research on a group of
developed economies and large emerging economies was completed. However, IMF has not
published the deviation between real exchange rate and estimated exchange rate in various
countries. UBS analysts have set up a similar model by using Chinese data from 1987 to
2009. In the UBS model, the real effective exchange rate was regarded as the function of
relative productivity growth, NFA, openness degree of trade system and relative terms of
trade (Wang & Hu, 2010). As it was hard to calculate the Chinese and foreign productivity
growths, they were replaced by price ratio of tradable products and non-trade products. PPI
represented price of tradable products. CPI and GDP Deflator represented overall price,
among which most were non-trade products. The result of the regression analysis can be
found in table 1. TNT was the productivity of tradable products relative to productivity of non-trade products. TOT was relative terms of trade. Open was the indicator measuring the openness degree of the trade system. The result in column (1) was calculated through least square method. The dynamic regression results in column (2) were calculated by summing the result of least squares with advanced and lagged items after the first-order difference on explanatory variables. Column (3) was amendment from column (2), where advanced item and lagged item not statistically significant were deleted. The number under the coefficient was absolute t value (Wang & Hu, 2010) (Hinkle & Montiel, 1999).

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant term</td>
<td>-8,57</td>
<td>-7,98</td>
<td>-8,63</td>
</tr>
<tr>
<td></td>
<td>(3,02)</td>
<td>(3,96)</td>
<td>(5,37)</td>
</tr>
<tr>
<td>TNT</td>
<td>1,74</td>
<td>1,76</td>
<td>1,79</td>
</tr>
<tr>
<td></td>
<td>(5,32)</td>
<td>(8,65)</td>
<td>(10,06)</td>
</tr>
<tr>
<td>NFA</td>
<td>1,09</td>
<td>1,79</td>
<td>1,77</td>
</tr>
<tr>
<td></td>
<td>(3,96)</td>
<td>(5,05)</td>
<td>(5,88)</td>
</tr>
<tr>
<td>TOT</td>
<td>1,15</td>
<td>1,03</td>
<td>1,13</td>
</tr>
<tr>
<td></td>
<td>(3,22)</td>
<td>(4,08)</td>
<td>(6,17)</td>
</tr>
<tr>
<td>OPEN</td>
<td>-0,09</td>
<td>-0,95</td>
<td>-0,85</td>
</tr>
<tr>
<td></td>
<td>(0,16)</td>
<td>(1,81)</td>
<td>(2,03)</td>
</tr>
<tr>
<td>Sample number</td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>R’s square after</td>
<td>0,70</td>
<td>0,95</td>
<td>0,96</td>
</tr>
</tbody>
</table>
adjust

<table>
<thead>
<tr>
<th>Standard deviation of regression equation</th>
<th>0.07</th>
<th>0.03</th>
<th>0.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>F’s statistic</td>
<td>14.0</td>
<td>38.0</td>
<td>58.9</td>
</tr>
</tbody>
</table>

Tab. 1 The determining factor of the real effective exchange rate within a balanced (Wang & Hu, 2010).

All signs of coefficient were in line with the expectation of standard economic theory. The estimated value in dynamic least square (column (2) and column (3)) reflected that the equation had better overall fitted value (measured by F Value), and NFA and OPEN had larger coefficient. According to estimated coefficient, when TNT or the ratio of NFA/GDP increased by 1%, real exchange rate would increase by about 1.8%. On the other hand, when the OPEN increased by 1%, real exchange rate would depreciate by 0.9% (Wang & Hu, 2010).

The trend of real exchange rate and that of estimated equilibrium exchange rate were compared. The results are found in Figure 8 (coefficients in column (3) are applied). While estimated results should not be stressed, it should be noted that:

- deviation often appeared in real exchange rate and estimated medium-term exchange rate during over 20 years;
- the real exchange rates in previous years were increasingly lower than estimated medium-term exchange rate, and the difference between the two was about 18% in 2009. The second conclusion was especially surprising, for real exchange rate increased by 18% after 2005, but the range of undervaluation for the RMB exchange rate increased in the estimated results.
5.3.5.2 Moving objective and explanation

What promoted the rapid increase of equilibrium exchange rate in the past few years? According to the UBS model, more than a half of (55%) growth came from the NFA in China, and 1/4 of growth came from the difference of relative productivity. Other growth was due to the decrease in ratio of trade in GDP. It would be suggested by some people that the decrease of openness degree was temporary in certain degree, so the growth of equilibrium exchange rate may be exaggerated. However, the increase of estimated equilibrium was mainly due to the increase of net foreign assets and stronger relative productivity (Wang & Hu, 2010).

Of course, it was problematic to regard the fitted value estimated in this simplified equation as equilibrium exchange rate (Bai & Perron, 2003). A common criticism was that the equilibrium real exchange rate method assumed that real exchange rate met the fundamentals from the angle of the long term average, which meant real exchange rate was in a state equilibrium. Another explanation was that the period of over 20 years was long enough to reflect the
influence from fundamentals. Besides, only the long-term coefficient in dynamic least square estimation was used, which allowed the result to steadily deviate from average value (Wang & Hu, 2010).

The advantage of equilibrium real exchange rate model was that it may better indicate that the reasonable value was changing along with time, and along with the changes of the economic fundamental plane. This is reasonable visually: when a country was catching up with other countries, the productivity in manufacturing industry of this country was particularly fast compared with other countries and areas in the world, so the real exchange rate should reflect this factor of fundamental plane (Balassa-Samuelson Effect); with the accumulation of net foreign assets, due to the income from these assets, this country may accept smaller trade surplus (or greater trade deficit), so the real exchange rate appreciated when other conditions remained constant (Coudert & Couharde, 2005). As the reasonable value of exchange rate was a moving objective, so the range of underestimation on RMB at the point may lose meaning in the short time. Meanwhile, we should not regard the current exchange rate as reasonable just because the range of appreciation was 15% five years ago, while the real exchange rate increased by 15%, many factors may have changed in this period (Wang & Hu, 2010).

In this situation, how fast will the changes of our estimated equilibrium exchange rate be? In other words, in order to catch up with the changing steps of factors promoting the increase in current account surplus, how much should RMB appreciate from now?

The answer to this problem is very complex. In our assumption: from now on, the openness degree of trade system and terms of trade had no change; the ratio of net foreign assets to GDP tended to be steady (it was assumed that current account surplus maintained steady, and nominal GDP grew 12% to 13% per year) (Datenbank, Datastream); and the relative productivity in China grew at the average speed of past five years (Datenbank, 2011). The above estimation would suggest that the equilibrium real exchange rate would increase slightly (increase 1.5% per year) in the next few years. In the past few years, the constant growth of current account surplus promoted the increase in ratio of net foreign assets to GDP, so the estimated equilibrium exchange rate was increased. Of course, if the relative productivity in China was much faster, or the price of bulk stock decreased significantly, the equilibrium real exchange rate would increase, and vice versa (Zhang, 2001).
The point for the complexity of the answer was that the results from equilibrium real exchange rate were very sensitive to the selection of estimation methods and variables (Lütkepohl, 2007). It was reflected in Table 1 that the coefficient was changing with the regressive methods. Besides, if the CPI/PPI was replaced with relative GDP Deflation/PPI, the coefficient of relative productivity would fall to about 1.5, and the coefficient of OPEN would increase to about -2.5. Table 2 reflected the changes in range of underestimation for the RMB generated from the changes of selection in independent variables. Certainly, this further supported my opinion that the "point" evaluation for undervaluation of the RMB should not be overstressed (Wang & Hu, 2010).

<table>
<thead>
<tr>
<th>The undervalue range of the estimated real effective exchange rate for RMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic standard (Column 3 in Tab. 1)</td>
</tr>
<tr>
<td>The CPI/PPI was replaced with relative GDP Deflation/PPI</td>
</tr>
<tr>
<td>Processing trade was eliminated from OPEN variable</td>
</tr>
<tr>
<td>TOT variable was eliminated</td>
</tr>
</tbody>
</table>

Tab. 2 The results from equilibrium real exchange rate with different independent variable (Wang & Hu, 2010).

A more important complex situation may be Chinese policy, which has blocked the adjustment of real exchange rate in the past. According to the report of UBS, the policy, stressing the development of tradable departments, led to the torsion of relative price in elements (such as land, capital, energy and resource) (Wang, 2004). For example, the prices of land and energy were reduced for the development of manufacturing industry, which aggravated the degree of undervaluation in exchange rate. As a result, the investment on tradable department increased and capacity expansion accelerated. Due to excessive
production capacity in manufacturing industry and compressed price in service industry, the inflation was maintained in lower level, which reduced the real exchange rate (Wang & Hu, 2010).

In the future, the changes of relative element price in China, including the increasing land price and industrial electrovalence will lead to increase in real effective exchange rate. This kind of adjustment will help to reduce the speed of capacity expansion in tradable departments and reduce the structural current account surplus (Wang & Hu, 2010).

5.3.6 Macro Economic Equilibrium Analyzing Method

5.3.6.1 Method

Another method to evaluate the level real exchange rate is the macroeconomic equilibrium method, which was firstly put forward by John Williamson in PIIE. The CGER of IMF applied the method widely in the evaluating the improper exchange rate in developed economies, and improved upon it (Williamson, 1985).

Different from the common view that developing country should have current account deficit as the importing country of capital, the macro equilibrium method have taken the medium-term determinants of savings and investment into account, and then evaluated the balanced or standard current account equilibrium. Later, the normal standard (the influences from domestic and foreign periodical factors and pervious exchange rate fluctuations were adjusted) would be compared with real current account equilibrium. The difference between the two data would be used to deduce and evaluate the range of misvaluation of the exchange rate (Wang & Hu, 2010).

Jonathan Anderson of SBC once applied one of the methods, basic balance of payments, to evaluate the currency value of the RMB (Jonathan, 2006). According to basic balance of payments, we should measure how to adjust the exchange rate to make the sum of current account balance and net foreign direct investment equal to 0. According to this method, RMB exchange rate was underestimated by 20% in 2006 (Wang & Hu, 2010).
For many years, IMF has applied the macroeconomic balance method in developed economies. However, the most famous method in China may be PIIE. In their latest estimation, Cline and Williamson suggested that the real effective exchange rate of RMB was underestimated by 21% in March, 2009 (Cline & Williamson, 2009). The estimation was based on the assumption that the ratio of Chinese basic current account surplus to GDP was 6.4% higher than standard level, which they believed was about 4% of GDP.

5.3.6.2 Calculation

We should firstly calculate the "standard" Chinese current account surplus. In 2008, the IMF (Lee, 2008) performed research on 54 developed and developing economies, including China, and found the important factors determining the medium-term sustainable current account equilibrium included financial situation, population structure (dependency ratio and population growth), net foreign assets and economic growth in a country. According to the research of the IMF, Asian developing countries should maintain a current account surplus at 1.3% of GDP on average. However, there was no single report focusing on the estimation of China. According to a recent work thesis of the IMF (Medina, 2010), Chinese current account surplus based on CGER coefficient was 2.9% of GDP (Datenbank, 2011) (Wang & Hu, 2010). Due to Chinese population characteristic and other fundamentals, the standard level of China should be higher than the average level of 1.3% (the standard applied by Williamson was 4% of GDP). For example, in China, the most powerful determinant- the dependency ratio of laboring age population decreased greatly in the previous 30 years. The dependency ratio in China was greatly lower than that in other countries, which should be an important reason that the savings ratio and current account surplus is higher than adjacent countries. In this report, we selected 2.9% of GDP as the standard of Chinese current account surplus (follow the calculation of Medina report in 2010) (Medina, 2010), and summarized different estimation results based on different standards in Figure 9 (Wang & Hu, 2010).
In the next step, we should find the real (adjusted by periodical factors) current account balance, and compared it with the above standard. After reached the peak value at about 11% of GDP in 2007, the current account surplus fell to about 5.8%. Many argued that the degree of undervaluation of the RMB was greatly reduced or even eliminated due to the great fall (Wang & Hu, 2010).

However, the decrease in Chinese current account surplus may well be periodical. Due to influence of the global financial crisis, domestic demand of China’s main trade partners had shrank sharply. However, Chinese domestic demand remained strong due to large scale economic stimulation. We attempted to deduce the real current account surplus based on output gap of China and its partners and demand elasticity of Chinese import and export in 2009. Based on the above assumption, the ratio of current account surplus to GDP was 2.1%
higher than the public data after the periodical factors of 2009 were adjusted (Wang & Hu, 2010).

In terms of export, according to the UBS analyst’s estimation, the gap of weighted average output for partners of China was -4.5%. In the UBS model assumption, the elasticity of export against partners’ demand was 2.5. The adjustment based on the above assumption of export caused the ratio of export in GDP to increase by 3.1% after periodical factors were adjusted.

In terms of import, the UBS model suggested that the gap of domestic output was about 0, so there was no need to adjust it. However, the adjustment of import price for bulk stock accounted for about 1% of GDP (Wang & Hu, 2010).

The difference between the real current account surplus (about 8% of GDP) in this model estimation and the standard value was about 5% of GDP.

In the end, how much is the range of adjustment in RMB real exchange rate while the ratio of current account surplus to GDP falls by 5%? This of course depends on the elasticity of important and exports against exchange rate (Wang & Hu, 2010).

Many attempted to work out the trade equation for China. Of which, two recent reports have caught people’s sights, for they both considered most Chinese trades to be export and estimated coefficient of elasticity for processing export and non-processing export. Aziz and Lee (IMF, 2007) have found that the elasticity of total export against exchange rate was -1.5, among which the elasticity of processing export was -0.5, and non-processing export was -2.2. Shagil Ahmed of FED found similar elasticity relationship in his recent thesis, -1.9 for non-processing export and -1.5 for processing export. In terms of import, we assumed that the elasticity of processing import was similar to processing export. The elasticity of non-processing import against exchange rate was 1 (Ahmed, 2009) (Lee, 2008).

Of course, the elasticity of import and export was relative to real effective exchange rate, instead of bilateral exchange rate of RMB/USD. If the currencies in other Asian countries appreciated together with RMB, and/or inflation in China was lower than its partner countries, the effect from RMB appreciation against USD by 10% would be far less than the effect from the appreciation of real effective exchange rate by 10% (Wang & Hu, 2010).

According to my calculation, based on trade level of 2009, the real effective exchange rate of RMB was underestimated by 17% to 18% no matter whether the export elasticity of Aziz and Li or export elasticity of Ahmed was applied.
5.3.6.3 Summary of underestimation measurement.

The range of underestimation in our measurement mainly relied on balance of current account and trade elasticity. Table 3 summarized different measurement results. Obviously, only based on assumption on different current account surplus standards, the results of underestimations may vary from 13% to 30%. According to recent report of IMF (Medina, 2010), the standard level of current account surplus in China may be as high as 6% of GDP. If this standard was applied and compared with unadjusted real current account surplus in 2009, the conclusion that RMB was not undervalued may be made.

Even when we applied the same macro evaluation method, the estimation result with great difference is also corresponding to the different opinions on the RMB issue. Our best estimation was that the RMB may well be undervalued by 17% in 2009. However, due to existence of other very different estimations, politicians (and economists) have good reason to select economic considerations in line with their opinions.

5.3.7 Conclusion and forecast

According to the above analysis, the currency value of RMB is underestimated in various methods. However, the degrees of underestimation vary from different methods and different parameters/variables. In addition, the range is not as great as reported by the financial media. Furthermore, the reasonable level of RMB is a moving objective changing with time, depending on the changes of economic fundamental plane. In past few years, the reasonable level has risen with the times.

Furthermore, the mainstream methods to estimate exchange rate and corresponding adjustment range more or less assumed that the exchange rate was the only policy tool to solve external disequilibrium, though the disequilibrium is not totally caused by improper exchange rate. However, the exchange rate adjustment is not always the best or the most suitable policy. In the situation that domestic economical fundamentals are facing serious distortions (for example, excessive low resource price; enterprises enjoying low interest rate and receiving loans easily), it will be more useful and efficient to eliminate these distortions
than to offset them through exchange rate adjustment (Hendry & Juselius, 2000) (Williamson, 1985) (Wang & Hu, 2010).

For example, for China, appreciation of exchange rate will lead to equal impact on all tradable products industries, including private textiles and shoemaking enterprises as well as state-owned aluminum manufacturers and steel manufactures. However, according to the report by UBS (Jonathon, 2008), the increase of trade surplus in China of recent years mainly came from improvement of trade equilibrium in metal industry. However, factors such as increased electrovalence, charge for pollution, increased industrial land and/or, increased rate, may have greater influence on the metal industry than private exporters of soft goods. This adjustment will increase the price of domestic heavy industrial products compared with import foreign products, and reduce the current account surplus. Meanwhile, through the elimination of torsion factors, this adjustment is helpful in dividing some future investment in heavy industry and reducing the future excessive production capacity and increase of structural trade surplus (Wang & Hu, 2010).

Nevertheless, the improper exchange rate is the most important reason for external disequilibrium of China. The adjustment of nominal exchange rate is also important for external disequilibrium. RMB appreciation will make the production of non-trade products more attractive than tradable products, and then help to transfer growth form. For example, the heavy industry will have smaller impulse to expand production capacity while the profit of heavy industrial products is decreased (Wang & Hu, 2010). With the appreciation of exchange rate, the export goods will be more expensive than export goods in adjacent countries, and import goods will be cheaper than domestic goods, which is helpful to reduce current account surplus (Jonathon, 2008).

In the past, policy constitutors attempted to maintain low inflation and fixed exchange rate through various administrative control measures (Ahmed, 2009). They achieved some successes, but increased the risk in the economy, including the accumulated risk on the balance sheet of People’s bank of China. For the long term, the method is not sustainable. The torsion of policies would be reflected in other means (Jaggi, 1996). The consequences may be structural excess production capacity of various industries, long term suppressed development in service industry, and stronger resistances on Chinese export expansion from international society. These adverse consequences may block the long term sustainable development of the Chinese economy (Wang & Hu, 2010).
It is possible in principle to insist on the fixed normal exchange rate of RMB against USD and leave all to adjustment of domestic price. However, this means that all appreciation of real exchange rate comes from increase of domestic price, which is inflation. The great inflation in the medium-term is obviously not selected by residents or policy constitutors. Therefore, the adjustment of nominal exchange rate is attractive (Hefeker & Nabor, 2002).

Then how much will the RMB appreciate in the coming years?

In future years, real exchange rate will increase by 5% to 10% through the combined means of normal exchange rate appreciation and domestic relative price adjustment (increase of domestic inflation rate). Although we focus on real effective exchange rate, we also suggested that the bilateral exchange rate of RMB/USD should be paid most attention to, for policy constitutor may restrain the fluctuation of this exchange rate due to the consideration for exporters. We expect that the exchange rate of RMB/USD to reach 6.0 by the end of 2011 (Wang & Hu, 2010). In my opinion, the adjustment of current account disequilibrium may benefit from the appreciation of exchange rate, the reduction of other torsion factors and increase in import. I expect that the current account surplus will be stabilized at 4% to 5% of GDP in future years (Wang & Hu, 2010).
6 Internationalization of RMB

Before the discussion about the influence of fluctuation in RMB exchange rate on the world economy, an issue that has received more attention is the internationalization of RMB. At present, along with increasing international economic status for China, increasing ratio of international trade and deepening participation in world economy, the internationalization of the RMB has been a focus in academic circles. The financial crisis from America has not only led to substantial losses in many countries, but also to appeals for the reform of the current international monetary financial system, which offers a very rare historical opportunity for China to realize the internationalization of RMB (Liu, Zhang, & Yang, 2003).

Though there is no conclusion on whether the RMB should be internationalized or how to realize such internationalization, but it can be seen from past behaviors of the decision-making board of China that internationalization of the RMB has been an important objective of the Chinese government: including strengthening regional cooperation, striving for greater voting rights at the IMF, and signing currency swap agreement with various countries (Anderson, 2005). The trend for internationalization of RMB has been increasingly more obvious with faster actions. Therefore, the internationalization of RMB is an undeniable trend (Bottelier, 2009).

The Jamaica system applied after the collapse of Bretton Woods system since 1970s was in fact a loose international monetary system or even just a system in name only. The Jamaica system implemented a managed floating rate system with diverse international reserve assets, diverse exchange rate arrangement, and various regulatory mechanisms for international balance of payments. In the Jamaica system, though USD is not the only international currency in the world, it is also the most important price currency, currency of settlement, and reserve currency in the world. Now, over 2/3 of import and export trades are priced and settled in USD (Anderson, 2005). USD is the supreme measure of and intervene currency in the foreign exchange transaction of international finance market. 50% of transactions in the global exchange transaction market regard the USD as opponent currency. 80% of global derived financial products regard the USD as transaction currency. 45% of global bills are priced and traded in USD. Bulk stocks in the world including petroleum, gas, iron ore, and
foods are all priced and traded in USD. 64% of global currency reserves are in USD. Currently, monetary exchange rates in 68 countries are directly or indirectly tied to the USD (Liu, Zhang, & Yang, 2003).

Under the monetary system of USD standard, developed countries, especially America, are at the center and other countries belong to the peripheral. Commodities and resources from peripheral countries flow into central countries, notably America, resulting in huge trade surplus and foreign exchange reserves. Meanwhile, these countries invest their massive foreign exchange reserves in financial assets including American treasure bills, so USD flow back to America (Liu, Zhang, & Yang, 2003). This situation inevitably leads to serious disequilibrium in global trade. America has huge trade deficit, while on the other hand, countries such as China accumulate large trade surplus. Current international monetary system will not only lead to disequilibrium in global trade, but also have drawbacks, including an unstable exchange rate system and incomplete crisis salvation system (Datenbank, 2011).

Due to the international financial crisis, the inner contradictions and conflicts accumulated from the generation of current international monetary system have been more significant, and the world economic situation have changed greatly. The emerging countries represented by BRIC have rapid development, accounting for greater share in global economic aggregate and making increasing contribution to global economic growth. The whole emerging markets have accounted for 60% of total world economic growth, which is far more than the developed countries. Fundamentally, the international monetary system is supported by national economies and their respective financial strength (Datenbank, 2011). Therefore, the development of emerging market national economies will promote the adjustment of international monetary system in the end, to reflect the international economic situation with greater changes. This means that the economic development of emerging market countries will promote their currencies to occupy a space in future international monetary system. Along with the development of the world economy, the international monetary system will change fundamentally (Ahmed, 2009). The development of the international monetary system and world economy has walked from the process of basic adaptation to the process inadaptation, which inevitably lead to crisis. It has been proved by history that the collapse of an old system would breed a new system (Frankel, 2005).
In April, 2009, Zhou Xiaochuan, the President for People’s Bank of China, suggested that an international reserve currency beyond sovereignty should be created to avoid the internal deficit that regarded credit currency of sovereignty as reserve currency (Bottelier, 2009). He believed that the special drawing rights (SDR) had the feature and potential to be reserve currency beyond sovereignty. The existence of SDR offered a hope for the reform of the international monetary system. Therefore, we should specially consider its role. In Nov, 2008, the President of France, Nicholas Sarkozy, repeatedly stressed that it was very necessary to reform the current international monetary system dominated by the USD, which reflected EU hopes to promote the status of the EU in the international monetary system through reform. In the middle of June, 2009, leaders of BRIC appealed in the joint statement after the first official meeting that a steady, predictable, and more diverse international monetary system should be set up (Crook, 2010). Later, People’s Bank of China expressed again that it would make efforts to reform the international monetary system and promoted the international reserve currency to improve along with the direction of steady currency value, orderly supply and adjustable quantum. Again, it appealed to create an international reserve currency beyond sovereignty. In the end of March, 2011, the international seminar of 20 countries held in Nanjing of China and advocated by Mr. Sarkozy focused on the reform issue of international monetary system. In this seminar, Finance Ministers and bankers of central banks from various countries discussed various topics including current situation and deficit in the international monetary system, countermeasure for risk capital, global finance safety network and special drawing rights. This seminar was regarded as the new beginning that France and China would work together to promote a new order for international currencies (Crook, 2010).

Before the spring meeting of IMF and WB in 2011, Kahn, who took the post of president of IMF, also talked of the reform of international monetary system, including: how to strengthen the coordination of economic policies among various countries in the world and reduce fluctuations; how to treat capital flow and fluctuation in exchange rate; how to improve the global liquidity supply mechanism in emergency period. He also proposed many times that emerging countries should play a leading role in IMF and WB. Kahn suggested that, in the post-crisis period, the global economic recovery was weak and unbalanced with great uncertainty. The whole world should build up a new ways of thinking to face economic and social challenges. He appealed that macroeconomic policies should focus on financial stabilization, and stressed setting up more equitable globalization (IMF, 2011).
In April, 2011, the leaders of BRIC made clear again in the <Sanya Declaration> after meeting for the third time: “China has known that the international financial crisis has reflected the deficit and shortage of current international monetary system and international financial system. China agrees to reform and improve international monetary system, and agrees to set up steady, reliable, basic and vast international reserve monetary system. China welcomes the discussion about the role of special drawing rights in current international monetary system, including constitution of a basket of currencies for special drawing rights (Daily, 2011).”

6.1 The positive influence from internationalization of RMB

Internationalization of the RMB improves right to speak and promotes enterprises to improve overall performance. After which, with the constantly exporting RMB, China will not only get huge import of real resources in return, but also extend the channels for Chinese enterprises to make use of fund along with the increasing international currency status for the RMB. As a result, enterprises can promote oversea development by reducing the cost of capital raising, capital transaction, and increasing the efficiency of investment and financing. At that time, Chinese enterprises will compete and Chinese brands will be recognizable globally. Enterprises will be less worried about oversea financing since the RMB would become the common currency of settlement, the import and export enterprises will reduce risks of asset losses caused by fluctuations in exchange rate. China is a large global trader, and the largest manufacturing country in the world. Many export commodities have little additional value with low price. Most import products have high values. Therefore, slight fluctuation in exchange rate will lead to a fatal blow on many foreign trade enterprises in China. If the RMB becomes a direct currency of settlement in trade between China and various countries, Chinese enterprises will remove that fear (Anderson, 2005) (Bottelier, 2009).

The international status of China can be improved. Monetary internationalization represent that a country has developed comprehensive economic power at a certain degree. The main international currencies in the world, such as USD, Euro, and JPY, became international currencies for America, EU and Japan with corresponding strong economic strength and high
international credit status (Dobson, 2001). After the internationalization of the RMB, China would have the right to issue and adjust world currency, greater influence on world economic activities, and more right to speak. Those countries and areas using RMB will become dependent on the Chinese economy in certain degrees. Meanwhile, the economic status and economic policies in China may have certain influence on these countries and areas. Furthermore, with a space in international monetary system, the RMB can change the controlled status of China, and reduce the adverse influence of international monetary system on China. Besides, China will have more influence and right to speak in the world economic activities, resulting in improvement in Chinese international status (Crook, 2010).

The disequilibrium inside and outside the country can be solved. The internationalization of RMB will be the key to solve the disequilibrium both inside and outside of China: firstly, the internationalization of RMB will greatly improve the effectiveness of monetary policy, and promote relevant policies to focus more on internal equilibrium. It has been increasingly difficult to implement effective control on capital accounts. Meanwhile, monetary policy has been busy in hedging the funds outstanding for foreign exchange. According to experiences in the world, compared with difficulty due to the loss of independency of monetary policy, the great economies should prefer releasing the space of monetary policy and increasing effect of policy through currency internationalization, which will fundamentally promote the dynamic implementation of equilibrium inside and outside of China. Secondly, as seen from the increment aspect, the internationalization of the RMB can avoid the paradox of developing an export-oriented economy and occupying huge foreign exchange reserve. Thirdly, as seen from the stock aspect, the internationalization of RMB will reduce the demand of China on foreign exchange reserve, which will greatly promote the solvency and safety factor in the international balance of payments. Finally, the internationalization of RMB will hedge the shrink risk of foreign exchange reserve. The process of currency internationalization is often along with the appreciation of currency. The RMB appreciation will, on the one hand, lead to depreciation of the USD, resulting in shrink pressure on current foreign exchange reserve, and on the other hand, will lead to increase in oversea attraction of RMB and unit international seignorage (Bottelier, 2009).

At present, the RMB cannot contend against international currencies including USD and Euro. However, it will become an international currency similar to them in the end. For the Chinese capital market, on the one hand, stock market will benefit from the long term bull market
caused by increase in asset prices, and from the opportunity for investors caused by two-way extension of capital market. It is better for investors to hold assets benefiting from appreciation, including banks and lands with strategic view, than depositing their money in the banks. Moreover, after the implementation of value regression and full circulation in Chinese stock, the benefits from dividends and rationed shares will become mainstream profitable mode by replacing excessive speculation. This mode is a process of internationalization and belongs to real scope of investment since it is connected with the world (Bottelier, 2009).

Currency is one of the basic element and basic carrier in capital market. The currency’s internationalization can effectively promote the movement of international capital, and then promote the international transition and development of capital market. Simultaneously, it can promote the cross-border circulation of monetary capital, and improve the fund operation efficiency of stock market in this economy, which is helpful for promoting the activeness and prosperous degree of stock market. On the other hand, as RMB internationalization eliminates the demarcation line of international capital amount economies, so it easily leads to fluctuation in capital market. According to data analysis on three international currencies including USD, Pound, and JPY, the degree of currency internationalization has a positive influence on the scale and degree of stock markets in the economy, which plays a role in its promotion. Therefore, the internationalization of RMB will play an important role in promoting the development of stock markets in the Chinese mainland as well. With infinite wish, the internationalization of RMB is beyond expectation. It is reported in recent news that the international board of A-stock coming out soon will be priced in RMB, which is good news for its internationalization. This means that the A-stock market will be open to the world. It is also obvious that the government want to achieve internationalization of RMB through the openness of capital market. There will be enough funds in A-stock market for they will flow into China from the whole world. In fact, the market is never short of fund. Take the arts market for example and a painting can be auctioned at several million Yuan. Is the market short of fund? No, it is short of earning effect (Crook, 2010).
6.2 The barrier and adverse influence for the internationalization of RMB:

China should pay the bill for financial crisis for there is no foundation for internationalization of RMB. There is no need for China to perform currency internationalization by promoting RMB to be the world currency in the coming 20 to 30 years or even before the end of this century. This is because China has no capital for currency internationalization, no steady basic currency form and no international credit. The establishment of the reliable currency and credit will not be accomplished in an action (Chen & Shi, 1998). China should make clear that the basis for Chinese economic development is still not steady, and Chinese economic quality is still bad. The economic development in China depends on excessive waste of resources, labors and environmental degradation. Even with the rapid development of another half a century, China cannot achieve the status of the American economy in the world. When China wants to challenge the international status and benefits of America, America will not watch the Chinese development with apathy. Instead, America will inevitably restrain the economic development of China through financial battles (Liu, Zhang, & Yang, 2003).

There are no talents of currency internationalization in China. As there are very few people in China familiar with the international financial system including exchange rate and interest rate operation, so the monetary system opened up by China must be operated by international speculators. As a result, the RMB will be the tools for these international speculators to enjoy achievement of reforming and opening up, but the common people in China have to pay the bill for the malpractice of reform (Liu, Zhang, & Yang, 2003).

There is no credit system for currency internationalization in China. Although the RMB has a tiny space in the transactions of Southeast Asian areas, China should make it clear that the credit system in China is just at the beginning, with the domestic credit environment and poor investments, resulting in various cheating behaviors. Many dare not invest in the Chinese economy. China should pay the bill for the issues in development of other countries, once the RMB becomes a world currency. In the meantime, the common people in China have to pay for the financial crisis (Liu, Zhang, & Yang, 2003).
What is the danger for China when the RMB becomes an international currency that is stored freely by all units and persons in the world without support of enough strength? It is known by most bankers and financial scholars that the monetary speculation that cannot stop will tunnel from the bottom of Chinese economy as pluvial erosion on sand (Chang, 2007). Faced with the great impacts from Asian financial crisis and international crisis, the only secret to the Chinese economy maintaining a rapid development trend is its the financial control. If the RMB is successfully internationalized in the future 10 to 20 years, and becomes the main international reserve currency, then everyone can hold large quantities of RMB without limitation. However, if the international financial environment still has no material reform, how can China deal with the next financial tsunami? In front of joint attach of international predators, when the amount of RMB flowing to the world is beyond the domestic scale, how can China deal with the block (Liu, Zhang, & Yang, 2003)?

Although the reform of international monetary system is imperative, but the great reform of the international monetary system based on the USD standard system will still be a long term, gradual and slow process. Since this financial crisis, America has suffered great impacts on its economy, but these impacts are controllable. America is still an incontrovertible great economy in the world, with economic competitive power ranking the first in the world. Therefore, the status of USD could not be shaken in the short term. Besides, the operation of international monetary system still had huge inertia, for most countries did not wish the uncertainty caused by serious changes in this system. In fact, most countries agree to maintain the steady status and exchange rate of USD for it fits their benefits to regard USD as an important international reserve currency. Therefore, the reform of international monetary system will still be a long term task. According to recent period, further improvement should be made on current international monetary system. For example, the monitoring on macro economy in main reserve currency countries should be strengthened, and the shares and the rights to speak of emerging market countries and developing countries at the IMF should be increased (Yu, 2003).
7 Analysis on influence of the RMB appreciation on world economy

Since the beginning of 2003, the issue whether RMB should appreciate has been the hot topic in the international community. Furthermore, the simple economic issue became a political issue. America and Japan became the main powers promoting public opinions for RMB appreciation. The Minister of Finance in Japan, Masajuro Shiokawa put forward documents similar to Plaza Accord of 1985 for JPY in the Finance Ministers Conference of Seven Countries in Feb, 2003, and demanded RMB appreciation, which was the first call for it. Snow, Finance Minister of America, also appealed for RMB appreciation in his speech. The Coalition for a Sound USD of America also suggested promoting the RMB appreciation by passing Clause 301. Meanwhile, due to the constant fall of the USD, some countries in Europe and East Asia began to worry about the impact from export commodities of China, so they also appealed for the RMB appreciation. European Commission took the lead in raising the preferential duties of export commodities that China enjoyed in GSP from Oct, 2003, increasing from 3.5% to 5%. On July 16, 2003, in the speech of Greenspan, the chairman of FED, attracted the attention of people all over the world to the RMB being under pressure to appreciate from the world. As a result, RMB encountered unprecedented appreciation pressure (Yu, 2003).

However, various domestic and foreign research institutions and famous scholars have put forwards different opinions including: Professor Robert Mundell, the father of the Euro, who won Nobel Economics Prize; Professor Ronald McCann at Stanford University of America; Steve Roche, chief economist at Morgan Stanley of America; Doctor Xie Guozhong, managing director of Morgan Stanley Asia and economist of APAC; Doctor Hu Zuli, chief economist of Goldman Sachs (Asia); Rogoff, chief economist of IMF. All of whom opposed the RMB appreciation. In Sep, 2003, the president of IMF, Host Kohler announced to the press circles that the IMF was opposed to exerting pressure on China on the issue of RMB exchange rate (Crook, 2010).
7.1 The impact of RMB appreciation on The Chinese economy

When the world appeals for RMB appreciation, China is afraid of the impact of RMB appreciation on the Chinese economy. There are mainly three reasons for this fear: firstly, after the appreciation, Chinese export surplus will decrease, or even change into deficit. As a result, the economic growth speed will decrease, resulting in corresponding adverse influence on growth of employment. Secondly, an expectation for appreciation will generate after the appreciation, and the expectation for appreciation will lead to the inflow of speculative capital, impacting financial stabilization (such as generation of capital foam). Thirdly, the RMB appreciation will lead to worsen currency deflation. The above three arguments are reasonable, but they are not sufficient reasons for opposing limited appreciation (Yu, 2003).

There are four comments about the first reason. firstly, the export processing industries are dominant industries in Chinese foreign trade. The main feature of export processing industries is high content of import. The price decrease in supplied materials, purchased materials and intermediate products calculated by domestic currency would offset the price decrease in export products. Secondly, due to their own features, the common Chinese export commodities have very low price elasticity in general. In foreign markets, the limited variations of Chinese export commodities will not lead to great changes in consumers’ demands on Chinese commodities. Furthermore, the variations of Chinese import depend more on non-price factor, or even acts in opposition to the price rule (For example, importing great amount of petroleum at the highest price). In fact, both the experiences in Asian financial crisis period (although currencies of other Asian countries depreciated greatly against RMB, the ratio of Chinese export amount in main target export countries had no obvious changes) and results calculated by relevant departments through different methods (including Research Group of World Economy and Politics) have suggested that: In the situation that RMB appreciates slightly, the trade status of China will not be influenced greatly (McKinnon & Ohno, 1997). Thirdly, the economists opposing the appreciation (including Professor Mackinnon) have the common argument: the trade surplus is mainly because that the savings ratio is higher than investment rate in one country, but not because that the prices of tradable products are lower. It can be concluded from this logic that even...
when RMB appreciates, Chinese trade balance would have no changes (Isard, 1995). Fourthly, the trade deficit is not always a bad thing for economic growth. The key issue is economic efficiency. If the trade deficit is caused by high investment driven by high efficiency, the trade deficit is a good thing instead of a bad thing so long as it is under control. Firstly, the adverse influence of decreased trade surplus on the short term economic growth will be offset by positive influence of increased investment demand. Secondly and more importantly, as the increase of investment rate based on trade deficit will lead to increasing economic growth potential, so too the future employment status will be improved. The prosperous American economy in the later stages of 1990s is an excellent example illustration of this aspect (Yu, 2003).

The comment for the second reason: according to common estimations of foreign investors, RMB is undervalued by 20% to 30%, so any declaration made by China that RMB would never appreciate is not creditable except that the international balance of payment is reserved. Investors would not change their expectation in RMB appreciation. On the other hand, the slight RMB appreciation would not greatly strengthen the existed expectation in appreciation. Anyway, even when there is strong expectation of RMB appreciation, Chinese currency authority also has many options to restrain the inflow of speculative capital (Yu, 2001). For example: (1) capital control should be further strengthened, and foreign exchange, foreign exchange futures and foreign exchange options transaction irrelevant to current account must be prohibited; (2) the domestic interest rate should be reduced to decrease the attraction of RMB capital; (4) RMB appreciates greatly in one time to eliminate the investors’ expectation of appreciation. Although it is difficult to restrain the capital inflow by strengthening capital control, it is also feasible. Capital control is the final line of defense to maintain financial stabilization in China, which could not be abandoned before the basic completion of reform focusing on improving property relations. Exchange control authorities in China should have a set of methods to increase the risk and transaction cost of speculators, and promote them to shrink back from difficulties. In the current situation, it seemed not possible that the implementation of capital control in China had unconquerable technical difficulties. Reduction of interest was one of the options, but the whole macro economic status should be considered during the application of interest rate. The tool of interest rate should not be used for restraining inflow of short term capita. Currently, the guidance for strengthening capital control is strict entrance and loose exit. This principle seems to have some problems (in
countries including Malaysia, the principle of strict entrance and loose exist is implemented. The strict entrance is inevitably correct, while the loose exit will be helpful to reduce the appreciation pressure, but will be convenient for black money (different from hot money) from state-owned assets to flow out of the country (this situation may not be serious in Malaysia). Moreover, the hot money for arbitrage inflowing to China will flow out through loose exit, which will be well-known to the world. Due to the current overheated economy, it is impossible to reduce interest rate. As substantial RMB appreciation in one time will lead to great impact on the economy, so this measure is also difficult to carry out. Moreover, in common situations, the main objective for a country to implement capital control is maintaining steady exchange rate. Why can’t we restrain the inflow of speculative capital through capital control? Nevertheless, these opinions lack of theoretical and practical evidence: compared with insisting on fixed RMB exchange rate, the slight RMB appreciation will greatly strengthen the expectation of appreciation and lead to huge inflow of short-term risk capital, which cannot be avoided. Conversely, to release appreciation pressure gradually through slight RMB appreciation should be a feasible method (Yu, 2003).

The third reason against RMB appreciation is also open to question. Through the decrease of trade surplus or decrease of growth speed, the RMB appreciation may really have a downward pressure on price level or increase rate of price due to the decrease of aggregate demand or decrease of growth speed. However, empirical research could not offer definite evidence for the theory that RMB appreciation would lead to the decrease of price and decrease in increase rate of price. When Mackinnon suggested that the JPY appreciation caused the currency deflation in Japan, he mainly put forward two rationales: firstly, due to the JPY appreciation, the price level in Japan was much higher than purchasing power parity, so the enterprises reduced their investment greatly in unprofitable situation. Secondly, under the condition of fixed American interest rate, the expectation for JPY appreciation led to the decrease of Japanese interest rate. As a result, Japan fell into a liquidity trap, resulting in invalidation of monetary policy. It was not difficult to find that China was very different from Japan. The currency deflation caused by appreciation would not happen in China (Yu, 2003).

Many economists who opposed the RMB appreciation preferred to explain the damage of JPY appreciation on Japanese economy by quoting the experience of Japan. It should be noted that the explanation of Japanese experience was not correct enough in various aspects. Even the famous economist, Professor McKinnon, who also formed a school of his own in the
explanation of Japanese experience, failed to win general acceptance from Japanese and international economic circles. People often regarded the JPY appreciation after Plaza Accord in Sep, 1985 as the reason for economic foam and later currency deflation in Japan (McKinnon, 1991). However, the Finance Ministers Conference of Seven Countries (Louvre Accord) in Feb, 1987 was often forgotten by the public. The Louvre Accord aimed to restrain the rapid fall of USD after Plaza Accord. Moreover, it aimed to restrain the JPY and Mark appreciation. Japan reduced the bank discount rate to 2.5% (German refused to reduce interest rate) (Zhang, 2000). From the aspect of macroeconomics, the main and direct reason for the creating of the foam economy in Japan was the expansionary monetary policy applied by Japan for JPY depreciation (economic recovery), instead of JPY appreciation. The JPY appreciation in the early stage of 1990s was related to the evaporation of the Japanese foam economy and its sequences. For example, in 1995, due to serious worsen non-performing loans in Japanese financial institutions, Japanese institutions had to recall numerous funds back from foreign countries to charge off non-performing loans and satisfy the requirement of capital adequacy ratio, resulting in JPY appreciation. In one word, the relationship between fluctuations in exchange rate and economic status of a country was very complex. The conclusion should be made based on strict consideration (Yu, 2003).

The reality in front of China is: huge appreciation pressure, People’s Bank of China has to constantly purchase American treasure bills and other USD assets to maintain the invariant RMB exchange rate. Meanwhile, in order to prevent the fast growth of money supply, People’s Bank of China has to hedge the rapidly increasing basic currency. According to many literatures, hedging is an operation with high cost. When People’s Bank of China increases the investment on oversea assets, it also decreases domestic assets on hand (treasure bill and other debts) (Coudert & Couharde, 2005). However, the return of the former is lower than the return of the latter. How much does People’s Bank of China gain obtain by purchasing American treasure bills at tens of billions of USD? How may losses doest People’s Bank of China suffer from by selling equal domestic assets? Outsiders can only guess the amount, but cannot tell the truth. The losses may be undertaken by the public finance in the end (Yu, 2003).

7.2 The influence of RMB Appreciation on world economy
In the era that China has close economic and trade relationship with various countries in the world, the limited RMB appreciation in certain range is good for the further development of the Chinese economy and world economic recovery.

7.2.1 The influence of RMB appreciation on trade status and economic status of America and Japan

Some scholars in Japan have made great efforts to appeal for RMB appreciation. The appropriate RMB appreciation may promote the depreciation of JPY. As a result, the trade status in Japan may be improved, and the export may be enlarged to drive the economic recovery of Japan. However, we should also note that Japan is the largest trade partner of China, but Japan does not have huge trade deficit with China. Meanwhile, Chinese products do not threaten Japanese trade status. Due to profound reasons, the long term economic depression is result from combined actions by various factors including lagged industrial structure transformation, slow growth of labor productivity, currency deflation and severe non-performing bank loans. Therefore, the problem cannot be solved simply by export. Besides, with high cost and low competitiveness in the Japanese manufacturing industry, RMB appreciation will not change the hollowing-out phenomenon of the Japanese manufacturing industry’s transfer to oversee areas (Hefeker & Nabor, 2002). As the labor cost is very expensive in Japan, it’s not a suitable place for the continued development of the traditional manufacturing industry with mature technology where labor cost plays a decisive role. If the RMB appreciates, the product cost in China will increase due to the fluctuation in exchange rate, and these industries will continue to transfer towards other developing countries such as Vietnam, Indonesia, and Thailand, which is very helpful to drive the economies in Southeast Asia and promote economic recovery in the region from the last economic crisis. Meanwhile, the weak economy of America is due to the adjustment after evaporation of foam in high-tech industries, instead of worsen trade status. However, if the RMB appreciates, the comparative advantage of America in labor intensive industries such as shoes, clothes and other textile will be promoted inevitably. If the RMB maintain the status of being undervalued, the partners of China may encounter currency deflation (Yu, 2003).
However, in our further analysis, RMB appreciation would have adverse influence on economic growth in America and Japan. As most products exported by China are necessities of life, high in quality and inexpensive in prices. In the economic depression period, they may satisfy basic demand of residents and improve living standard, resulting in more consumption. The prices of exported products would be raised when the RMB appreciates, so the benefit level of foreign consumers would decrease (Chang, 2007). In this way, the expenditure should be reduced further, resulting in suppression of demand and impact on consumption, which is not good for the economic growth and recovery in countries including America and Japan. In July, 2011, according to latest report of IMF: if the RMB appreciates by 20%, the American economy would increase by 0.05% to 0.07%, the economy of the Eurozone would increase no more than 0.12%. The current account in America will lead to increase in GDP by 0.02% to 0.08%. The current account of the Eurozone will lead to increase in GDP by 0.05% to 0.1% (Datenbank, 2011).

7.2.2 The influence of RMB appreciation on Asian trade and economy

It is well-known that China has a unique status in the international supply chain for it is becoming the largest parts market of high-tech products produced by Korea, Singapore and Japan. Furthermore, these parts will be exported to America and Europe with the tag of made in China. Stephen Roach suggested that the broken linkage between RMB and USD would lead to the damage in supply chain required by global new-type production mode. As a result, serious adverse influences would be brought about to Japanese enterprises, American enterprises and European enterprises while they took the lead to purchase in China. The Chinese economy, with rapid development, has absorbed numerous automobile parts, computer chips, and machinery equipments from the whole world. In addition, the appropriate RMB appreciation would stimulate the import trade of China, and then stimulate the export demand of global machines and raw materials. Furthermore, the growth of world economy would be stimulated to accelerate the solution of economic crisis (Coudert & Couharde, 2005).
In recent years, the exports of Asian countries have generally been closely related to the Chinese economy. The imports of China from East Asian areas (including Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan, and Thailand) increased from 6.2% in 1980 to 40.9% in 2001 (Datenbank, 2011). The trade surplus of these countries against China has been the source power of its economic growth. China has played an important role of economic stabilizer in the increasingly integrating East Asian areas. During the period of USD devaluation, the currencies of various countries in Asia have maintained relative stabilization, resulting in steady foreign trade. The limited RMB appreciation not only will not influence the economies of the surrounding countries, but also maintain the stabilization of Asian currencies and promote the growth of Asian economies. The appropriate RMB appreciation exchange rate and the growth of the Chinese economy are opportunities for Asian countries instead of threats. Asian countries will benefit from mutual efforts and the huge Chinese market by cooperating closely with China and making (Liu, Zhang, & Yang, 2003).
## 8 List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BEER</td>
<td>Behavior Equilibrium Exchange Rate</td>
</tr>
<tr>
<td>BIS</td>
<td>Bank for International Settlements</td>
</tr>
<tr>
<td>BRIC</td>
<td>Brazil, Russia, India, China</td>
</tr>
<tr>
<td>CGER</td>
<td>Consultative Group on Exchange Rate Issues</td>
</tr>
<tr>
<td>CPI</td>
<td>Consumer Price Index</td>
</tr>
<tr>
<td>ERER</td>
<td>Equilibrium Real Exchange Rates</td>
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<tr>
<td>FED</td>
<td>Federal Reserve System</td>
</tr>
<tr>
<td>FEER</td>
<td>Fundamental Equilibrium Exchange Rates</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>IMF</td>
<td>International Monetary Fund</td>
</tr>
<tr>
<td>JPY</td>
<td>Japanese Yen</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>PIIE</td>
<td>Peterson Institute of Economics</td>
</tr>
<tr>
<td>REER</td>
<td>Real effective exchange rate</td>
</tr>
<tr>
<td>RMB</td>
<td>RenMinBi（Chinese Yuan）</td>
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<tr>
<td>SDR</td>
<td>Special drawing rights</td>
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<tr>
<td>UBS</td>
<td>United Bank of Switzerland</td>
</tr>
<tr>
<td>USD</td>
<td>U.S Dollar</td>
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9 Bibliography


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Abstract

Since 21 Century, a consortium of countries, mainly led by the United States of America (America), has criticized the People’s Republic of China (China) for its RMB exchange rate policy, which it claims is controlled by the Chinese government to restrain import and encourage export. This paper will explore whether the real RMB exchange rate against a basket of currencies is underestimated and to what degree. Econometric models, including FEER, BEER and ERER, have been applied in this paper to realize that goal.

The first chapter is the introduction; the second chapter will discuss the theories of purchasing power parity, international indebtedness, and interest rate parity; the generation and development of the RMB exchange rate will be described in the third chapter along with the current status of the RMB exchange rate; important models and financial theories including Balassa-Samuelson effect, FEER, ERER, and BEER are applied to explore the degree of RMB undervaluation in the fifth chapter; the internationalization of RMB as well as the influence of fluctuations in RMB exchange rate on the Chinese Economy is discussed in the sixth chapter and seventh chapter.
Zusammenfassung


In der dritte Kapitel wird die Entwicklung des chinesischen Wechselkurssystems beschrieben. Im vierten Kapitel wird auf den aktuellen Stand der Chinesische RMB dar gestellt.

Für die Frage, dass inwieweit wird Renminbi unterbewertet, müssen einige wichtigste Modelle und Finanztheorien beschreiben werden. Der Balassa-Samuelson Effekt, Fundamental Equilibrium Exchange Rates (FEER), Equilibrium Real Exchange Rate (ERER), Behavioral Equilibrium Exchange Rate (BEER) werden in Kapitel 5 diskutiert.

In Kapitel 6 und Kapitel 7 sollen das Internationales Problem der RMB und das Einfluss der Änderung des Wechselkurses der RMB vermittelt werden.
Lebenslauf

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Sprachkenntnisse:

Chinesisch: Muttersprache

Englisch: Fließend

Deutsch: Fließend