An Investigation: The Misalignment of Chinese Currency

by

Baifeng Hu

(3704227)

Major Paper presented to the

Department of Economics of the University of Ottawa

In partial fulfillment of the requirements of the M.A. Degree

Supervisor: Professor Mario Seccareccia

ECO 7997

Ottawa, Ontario

August 2005

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Abstract

This paper takes a comprehensive look at the issue of the RMB revaluation. It describes major policy changes in recent decades, analyzes the problem of the formation of the RMB, and estimates misalignments of the RMB. The misalignment of the RMB is not only a simple economic problem; what's more it is related to the interests of many countries. The aim of the paper has been to explain the determinants of the exchange rate and to provide some insights about the possible undervaluation of the Chinese currency. Several previous arguments and empirical estimations are cited and criticized in this paper. The results of the empirical analysis presented in this paper clearly show that the undervaluation of the RMB is exaggerated. It is concluded that, although the United States policy of urging China to revaluate the RMB is based on its own protectionist consideration, a mild appreciation of China' currency at an appropriate time would benefit China's own interest.

Key words: RMB, Undervaluation, Balsassa-Samuelson effect, Purchasing power parity approach, Behavioral equilibrium exchange rate, Appreciation.

1. Introduction

With the rapid global economic growth, the exchange rates emerged as one of the key economic variables. According to Frankel (1999, P 3-4), there are nine major exchange regimes, ranging from the most flexible one to the strongest fixed one. The categories of exchange rates are shown in the following table:

Table 1: Taxonomy of Different Systems of Exchange Rates:

Exchange rate Systems	Flexible regimes	Free floating	The absence of regular intervention in the foreign exchange market.
		Managed float	The absence of a specific target for the exchange rate.
	Intermediate regimes	Target zone, or band	A margin of fluctuations around some central rate.
		Adjustable peg	Fixing the exchange rate, but without any open-ended commitment to resist devaluation or revaluation in the presence of a large balance of payments deficit or surplus.
		Basket peg	Fixing not to a single foreign currency but to a weighted average of other currencies.
		Crawling peg	A preannounced policy of devaluing a bit each week.
	Fixed regimes	Truly fixed peg	Fixing, committing to buy or sell however much foreign currency is necessary at a given exchange rate, with a firm and lasting intention of maintaining the policy.
		Currency board	Three defining characteristics: fixing not just by policy but by law, backing increases in the monetary base one-for-one with foreign exchange reserves, and allowing balance of payments deficits to tighten monetary policy and thereby adjust spending automatically.
		Monetary union	The adoption of a foreign currency as legal tender. This includes the special case of official dollarization.

Choosing an appropriate exchange rate is a very crucial and perplexing problem to many developing countries. And the debate over the practices of the suitable exchange rate in developing countries has been substantial. At first, some improperly implemented exchange rate policies produced great economic miracles, but they also brought the countries desperate results after several years. For instance, in the early part of the 1990s, developing countries were encouraged to adopt fixed exchange rates that were seen as providing a nominal anchor to the domestic price level that could enforce monetary policy discipline and ensure low inflation. Brazil and Argentina are good examples. Brazil adopted a fixed exchange rate as part of a nominal anchor strategy combating high inflation. In much the same way, Argentina pegged its peso to the U.S. dollar and tied the supply of money to holdings of U.S. dollar reserves. The adoption of these policies coincided with faster economic growth and significantly reduced inflation. However, this good performance crumbled in the latter part of the decade. Brazil was hit by a financial crisis in 1999 and again in 2000 and was forced to abandon its fixed exchange rate. On the other hand, Argentina was forced to abandon its currency board and moved to a floating exchange rate in 2001 (Palley, 2003, p. 62). It even made the President of Argentina de la Rua resign and led to social unrest.

The exchange rate of China has been given too much attention recently. China has operated its exchange rate regime as a *de facto* peg to the dollar since 1994. The supposed undervaluation of China's currency has been intensively argued in different

international forums. China has been accused of manipulating its currency to gain a competitive advantage. And the continued rise in the imbalance of United States – China trade, as well as complaints from U.S. manufacturing firms and workers makes economists and politicians take it more seriously than merely a general economic issue. Although the misalignment of China's exchange rate has been investigated by several well-known organizations and many researchers, there is no consensus on the extent of the undervaluation of China's currency. Various empirical results and conclusions are greatly affected by the scarcity of available data and complicated economic conditions in the case of China. This paper attempts to describe the complexity of this problem and employs a simple but direct method to calculate the misalignment of China's currency.

The rest of this paper is constructed as follows: Section 2 introduces the development of China's exchange rate regime in recent decades, provides some doubts about the undervaluation of the Chinese currency, and discusses the pressure on China to undertake the reform of its exchange rate policy. Section 3 criticizes previous studies that have attempted to calculate the misalignment. Section 4 presents the result of the analysis and offers brief concluding remarks.

2.1 The development of Chinese foreign exchange policies

Before investigating the issue of the exchange rate revaluation, let us begin with a brief history of China's foreign exchange policies. The currency of the People's Republic of China is the Renminbi (RMB), and its basic unit is the yuan. The central bank is the People's Bank of China (PBC), and the State Administration of Foreign Exchange (SAFE), which was established in 1979, under the direct control of the People's Bank of China, administers all phases of exchange rate control.

Like other communist economies, in China the exchange rate regime was subordinated to trade policy throughout the central planning period from the middle of the 1950s to the late 1970s. In 1955, China began a fixed exchange rate regime and this policy lasted for more than 17 years. In 1972, China switched to a composite peg under which the RMB was pegged to a basket of thirteen Western currencies and then in 1975 pegged it to the average rate of the U.S. dollar and the Deutsche Mark. During this period, the exchange rate was initially designed based on a rule of thumb[1] and served as tool for central planning and centralized accounting.

China's foreign exchange reform was launched in 1978 with the open-door policy. The policymakers began to realize that the exchange rate could be a means of regulating the external sectors of the economy. On the one hand, in order to increase China's foreign exchange earnings through trade promotion, the RMB should be

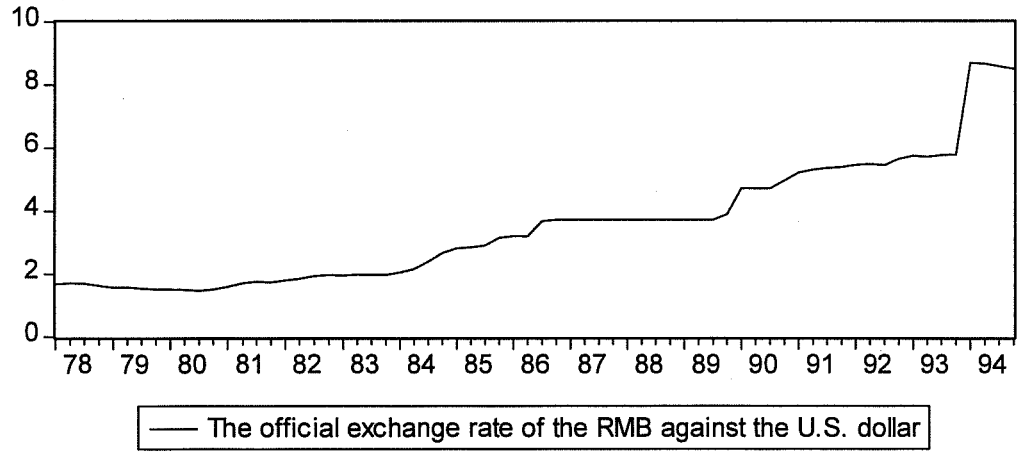
[1] The rule of thumb was "exports were supposed to generate enough foreign exchange to support imports, while imports were expected to fill in the gaps in the country's total productive capacity and boost total supplies as specified in the national economic plan" (Lin & Schramm, 2003, p. 249).

devalued. On the other hand, to increase earnings from overseas Chinese remittances and other non-trade transactions, devaluation would not be appropriate (Chou & Shih, 1997, p. 166). Hence the State Council adopted the RMB Internal Rate for Trade Settlements (IRTS) on January 1 1981. The official exchange rate was applied to non-trade-related foreign exchange transactions and the IRTS was applied to trade-related transactions. The IRTS was lower than the official rate and it was used to generate a surplus from international trade.

From 1981 to 1984, domestic prices increased steadily which necessarily made the IRTS overvalued. Since China was condemned for using the dual exchange rate system to obtain predominance in international trade by U.S. authorities, the IMF persuaded the Chinese authorities to eliminate this system, and the dual exchange rates were formally eliminated on January 1, 1985. In 1986, the authorities allowed a foreign exchange swap center to be created in the Shenzhen Special Economy Zone. Later on, other Special Economy Zones (SEZs) permitted the establishment of similar foreign exchange swap centers. The swap price was not the same as the official exchange price but was determined by buyers and sellers through negotiations. With the rapid development of the foreign exchange swap market, a new dual exchange rate system of the official exchange rate and swap market rate came into existence. Such a dual exchange rate system existed until the swap centers permanently closed in 1998. The swap market rate, which was lower than the official rate, had important welfare effects on domestic enterprises.

In the periods of the centrally planned economy, the exchange rate of the RMB was overvalued persistently for political consideration. The exchange rate even reached a peak of 1.4644 yuan per U.S. dollar in the third quarter of 1980. The overvalued exchange rate was harmful to the export sector and devaluation became inevitable. Frequent devaluations of the official exchange rate took place after 1981 in order to correct the overvaluation inherited from the central planning period. In 1985, the official exchange rate of the RMB continued to be devalued repeatedly. It was devalued from RMB 2.820 yuan per dollar in the first quarter of 1985 to RMB 3.722 yuan per dollar in the fourth quarter of 1986. In 1987, the International Monetary Fund (IMF) classified China as a managed floating exchange rate regime. The RMB was continuously devalued to RMB 5.222 yuan per dollar in the fourth quarter of 1990. And major devaluations followed in January 1994.

Figure 1: The trajectory of the RMB against the U.S. dollar from 1978 - 1994



Data source: IMF (*International Financial Statistics)*

From 1990 on, Chinese authorities worked towards putting the exchange rate regime more closely tied to its market value. The Chinese monetary authorities officially

admitted the adoption of a floating rate regime in 1991. The RMB was first allowed to be adjusted frequently based on the previous indicators. Furthermore, the Chinese monetary authorities repeatedly announced that a major goal of China's financial reform was to make the RMB a convertible currency on different occasions. In 1993, when China negotiated its entry into the General Agreement on Tariffs and Trade (GATT), the Chinese government made a formal commitment that by the year 2000 it would achieve RMB current account convertibility.

In 1994, the Chinese government officially declared that it was adopting a managed floating rate regime. Meanwhile, the People's Bank of China (PBC) proclaimed the basic standard exchange rate between the RMB and the U.S. dollar, the Hong Kong dollar, and the Japanese Yen based on the weighted average price of the swap rate. In addition, the PBC set forth that the daily movement of the exchange rate of the RMB against the U.S. dollar be limited to 0.3% on either side of the standard rate. Similarly the exchange rate of the RMB against the Hong Kong dollar and the Japanese Yen could not deviate more than 1% on the either side of the standard rate. In the case of other currencies, the deviations should not exceed 0.5% on the either side of their respective standard rates. Once the exchange rate would deviate from the band, the central bank would immediately step in, bringing the exchange rate back within the limit of the band. The RMB exchange rate remained stable from 1994. It appreciated slightly from 8.44 yuan per U.S. dollar at the first quarter of 1995 to 8.28 yuan per U.S. dollar at the third quarter of 1999, and then kept this constant nominal level until

now. In April 1999, the IMF classified China's exchange rate regime as a conventional pegged arrangement. In 1996, China accepted the obligations under the Article VIII [2]of the International Monetary Fund's Articles of Agreement. The achievement of current account convertibility was realized three years in advance of the officially announced timetable. However, China's capital account remains tightly controlled and has no timetable for liberalization.

The eruption of the Asian financial crisis in 1997 had a significant impact on China's economy. The growth rate of the consumer price index (CPI) was – 84.5% in 1998, it continued to decrease to -140.8% in 1999, and the exports only grew by 0.6% for 1998. Despite substantial currency devaluations by crisis-stricken neighbors, the Chinese authorities were committed to maintain the stability of the RMB exchange rate. The substantial foreign exchange reserves held at that time (close to 150 billion U.S. dollar), stringent restrictions on capital outflows, and relatively solid fundamentals helped the authorities successfully sustain the RMB value (Lin & Schramm 2003). China's fixed exchange rate to the dollar regime was widely praised as a key anchor for the global financial system. After the effects of the Asian financial crisis diminished, the authorities continued to loosen foreign exchange restrictions. In September 2001, the SAFE imposed some restrictions on capital account transactions during the Asian financial crisis. In November of that year, China had become one of the members of the World Trade Origination (WTO). China made a series of

[2] Article VIII is a general obligation for IMF members. The essential contents are avoidance of restrictions on current payments and avoidance of discriminatory currency practices.

commitments for the lifting of restrictions in the financial sectors, such as opening the local banking business, the securities markets, and insurance to foreign financial institutions. In October 2002, China abolished the differential treatment of foreign exchange accounts in current international transactions.

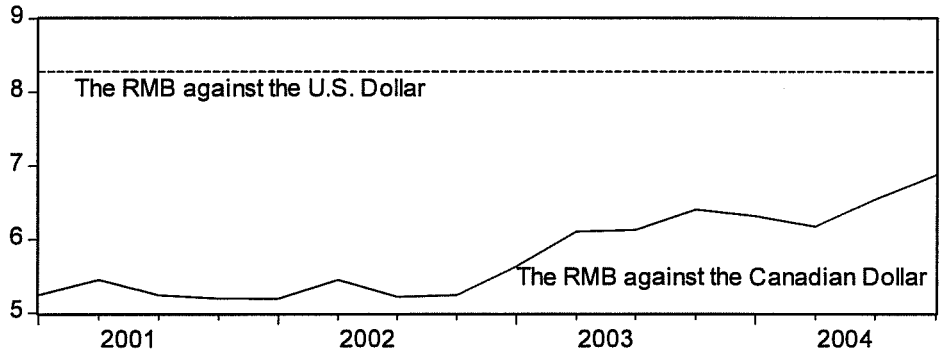
Since 1979, China's foreign exchange reform has gradually progressed. The Chinese economy has been transformed from the one that was governed by rigid central planning to one in which market forces play a significant role. Indeed, China has made great achievement in the following aspects: trade liberalization, initial exchange rate adjustments, exchange market developments, loosening of the restrictions for current international transactions, and the establishment of a capital account controlling framework. It is believed that China has undergone an economic miracle and that it will make remarkable progress in its future development.

2.2 Some doubts about undervaluation

There are some doubts as to whether the RMB has been undervalued. Firstly, since China operated its exchange rate regime as a *de facto* peg to the U.S. dollar since 1994, the depreciation of the U.S. dollar from 2002 caused the depreciation of the RMB in relation to other currencies. For example, although the exchange rate of the RMB to the U.S. dollar remained constant, the exchange rate of the Canadian dollar to the U.S. dollar appreciated from 1.594 Canadian dollar per U.S. dollar in the first quarter of 2002 to 1.204 Canadian dollar per U.S. dollar in the fourth quarter of 2004.

These changes made the exchange rate of the RMB to the Canadian dollar depreciate from 5.194 yuan per Canadian dollar in the first quarter of 2002 to 6.876 yuan per Canadian dollar. In fact, the exchange rate of the RMB against other third country's currency has depreciated, as the following figure shows:

Figure 2: The exchange rate of RMB against the U.S. Dollar and the Canadian Dollar from 2001 to 2004

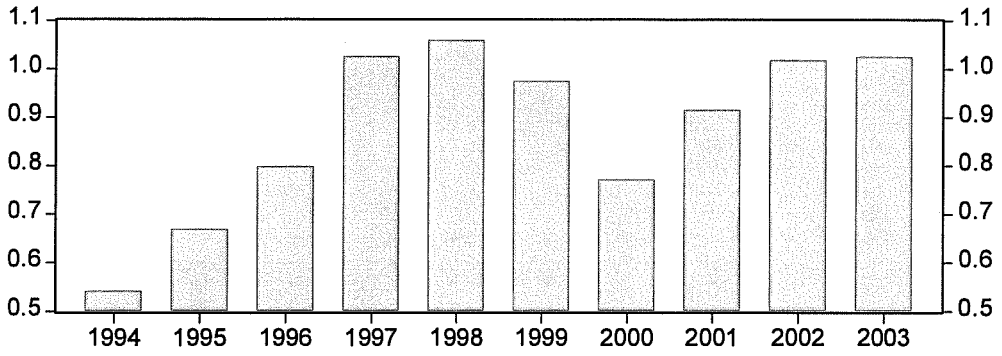


Data Source: IMF (*International Financial Statistics)*

Secondly, the central bank frequently intervened to impede the RMB appreciation. An obvious evidence is that the accumulation of the Chinese foreign exchange reserves have grown rapidly these years. They have grown from 227.605 billion U.S. dollar in the first quarter of 2002 to 609.932 billion U.S. dollar in the fourth quarter of 2004. Theoretically, if a country has run down its reserves through previous sales of foreign exchange, the motivation for purchases may simply be restoring an adequate level of reserves. There is no precise definition of "adequacy", although the World Bank benchmark over the years has been that a country should maintain reserves at least equal to 25 percent of annual imports. However, China has a level of reserve holdings far above any comparable measures, as shown in Figure 4. The ratio of China's foreign exchange holdings to annual imports increased steadily from 54.18% in 1994

to 102.45% in 2003.

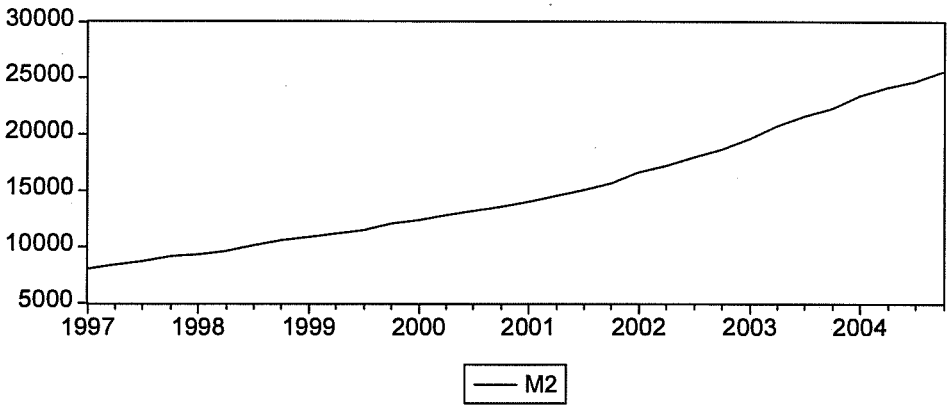
Figure 3 The ratio of foreign exchange reserves to the annual import



Data Source: IMF (*International Financial Statistics)*

Thirdly, some may argue that the depreciation of Chinese currency might result in a rapid increase in the money supply. This is because the accumulation of foreign exchange reserves might boost up the supply of high powered money. According to the orthodox quantity theory, when the country is increasing its money supply, the domestic price level will rise, and then it will produce a depreciation of the country's currency. However, in reality, this adjustment takes time and does not seem to work so well in the case of China. According to the China Statistical Yearbook 2004, the M2 increased from 10,850 billion yuan in the first quarter of 1999 to 25,654 billion yuan in the fourth quarter of 2004. The trajectory of the money supply in China from 1997 to 2004 is exhibited in the following graph:

Figure 4: Money supply in billions of the RMB



Data Source: IMF (*International Financial Statistics)*

The most important evidence is that, according to the Balassa-Samuelson effect, the currency of the catching-up countries is predicted to undergo a real appreciation. The Balsassa-Samuelson effect is based on the separation between sectors which produce tradable goods and sectors which produce non-tradable goods. A central assumption of the Balassa- Samuelson effect is that the rate of change of real wages in the traded goods sector is determined by the rate of change of labor productivity. At the same time, real wages in the non-traded goods sector are not linked to labor productivity. As wages for equal positions are expected to increase at the same pace across sectors, real wages in the non-traded goods sector are connected to tradable productivity gains. In other words, although there is an increase in relative prices in the non-tradable goods sector, the productivity in this sector has not grown at the same pace. Consequently, changes in the prices of domestic goods relative to those from abroad give rise to changes in the real exchange rate. The logarithmic functions of the relationship among wages, prices, and productivity are:

$$w_T - p_T = \theta_T \qquad 1.1$$

$$w_{NT} - p_{NT} = \theta_{NT} \qquad 1.2$$

Where p_T and p_{NT} stand for the tradable goods price index and non-tradable goods price index respectively. The w_T and w_{NT} stand for changes in nominal wages in the traded and non-traded goods sectors respectively. The θ_T and θ_{NT} stand for changes in productivity in the traded and non-traded goods sector respectively. From the above assumption, the wage should be the same between the tradable goods sector and the non-tradable goods sector. Therefore the relationship between the relative price of non-traded goods and relative productivity can be expressed as:

$$p_{NT} - p_T = \theta_T - \theta_{NT} \qquad 1.3$$

assuming purchasing power parity (PPP) is working well in China. Moreover, the real exchange rate of China is defined as:

$$Q_t = (E_t P_t^*) / P_t \qquad 1.4$$

where Q and E are the real and nominal exchange rate against the dollar respectively; P^* and P are the final demand price index in the United States and China respectively. The nominal and real exchange rates are expressed as yuan per U.S. dollar. Thus, a decrease in the nominal and real exchange rate represents the appreciation. Let us take the logarithmic derivatives of formula 1.4 with the lower-case variables representing logarithmic values:

$$q_t = e_t + p_t^* - p_t \qquad 1.5$$

The logarithmic form of final demand price can be expressed as:

$$\begin{aligned} p &= (1-\alpha)p_{NT} + \alpha p_T \\ &= p_T + (p_{NT} - p_T) - \alpha(p_{NT} - p_T) \\ &= p_T + (1-\alpha)(p_{NT} - p_T) \end{aligned} \qquad 1.6$$

where α represents the share of tradable goods in final demand.

Hereby the real exchange rate can be expressed as the total relative price for tradable goods between the two countries q_T and the difference between the two countries of relative prices for goods across the board and the tradable goods sector:

$$q = q_T + [(p^* - p_T^*) - (p - p_T)] \qquad 1.7$$

Substituting 1.6 into 1.7, we get:

$$\begin{aligned} q &= q_T + \{[p_T^* + (1-\alpha^*)(p_{NT}^* - p_T^*) - p_T^*] - [p_T + (1-\alpha)(p_{NT} - p_T) - p_T)]\} \\ &= q_T + (1-\alpha)[(p_{NT}^* - p_T^*) - (p_{NT} - p_T)] - (\alpha - \alpha^*)(p_{NT}^* - p_T^*) \end{aligned} \qquad 1.8$$

Substituting 1.3 into 1.8 and reformulating the equation, we obtain:

$$q = q_T + (1-\alpha)[(\theta_T^* - \theta_T) - (\theta_{NT}^* - \theta_{NT})] - (\alpha - \alpha^*)(\theta_T^* - \theta_{NT}^*) \qquad 1.9$$

Consequently the exchange rate between China and the United States can be expressed by equation 1.9. In general, the increase in productivity in the tradable goods sector is faster than that in non-tradable goods sector, and there is not too much difference in non-tradable goods sectors between two countries. Considering the situation of China, productivity grows rapidly in manufacturing, that is to say the increase in θ_T. From equation 1.9, the increase in θ_T will lead to a decrease in q. So the exchange rate of Chinese currency against the U.S. dollar would tend to appreciate because the productivity gains in the tradable sector are higher than those in the United States. Furthermore, a strong argument can be made for an early move toward greater exchange rate flexibility in China, irrespective of whether or not the RMB is substantially undervalued. A corollary to this argument is that what might be preferred

is a move toward flexibility rather than simply an upward revaluation of the currency to a desirable rate. As experiences of other countries have shown, rapid economic growth and a strong external position constitute relatively favorable circumstances for making such a move (Wang 2005, p. 3).

2.3 The pressure on China to reform its exchange rate regime

Undoubtedly, China achieved a great economic boom during a growth-starved time. The increasing dependence of the world economy on continued expansion of the Chinese economy was sharply underlined. China has been called a global manufacturing powerhouse. But there is more and more concern that China has gained an unfair competitive advantage by manipulating its exchange rate. The most intense claims are from the United States. Many U.S. politicians and economists believe that the RMB's true value is artificially depressed, thereby helping the Chinese economy to grow rapidly but worsening the U.S. economic depression and job loss.

According to Palley (2005, p. 9), exchange rates have important effects on the flow of goods and employment. First, exchange rates affect exports and imports. An undervalued RMB makes U.S. exports more expensive to Chinese buyers, reducing jobs in U.S. export industries. It also makes Chinese imports cheaper to U.S. consumers, displacing employment in U.S. import competing industries. Second, an undervalued RMB makes China-based production more attractive by lowering

Chinese costs measured in dollars. This encourages firms to shift production to China and to locate new investments there. Third, an overvalued dollar undermines the profitability of U.S. manufactures, which reduces manufacturing investment, cuts jobs and hinders growth of the manufacturing sector. Scott (2005) estimated that, affected by China's moving up the product ladder, the United States lost 879,280 jobs, thereby entailing approximately a 115 billion dollar deficit. Nearly 7,646 jobs are embedded in each billion dollar of account imbalances with China.

From the first supposed undervaluation of the RMB at the G7 ministerial meeting of September 2003 in Dubai, the United States imposed pressure on China to revaluate the RMB. In January 2004, the President of the United States, George W. Bush, stated in Toledo Ohio, "We expect countries like China to understand that trade imbalances mean trade is not balanced and fair. They have got to deal with their currency" (Williams, 2004). On March 25, 2004, the Treasury Secretary of the United States, John W. Snow, called for Chinese currency reform and said that a more flexible Chinese currency is a key to global economic growth. In addition, the U.S. House Representative English and his co-sponsors introduced a bill requiring an investigation into the Chinese Yuan and whether or not their rigid peg to the dollar violates any GATT or WTO regulations on June 22, 2005. And the members of the U.S. Congress unveiled legislation giving China 90 days to revalue its currency or face an across-the-board tariff on its exports to the US.

In addition to the pressure from the international community, there is also economic pressure coming from inside of China. First, maintenance of a fixed exchange rate regime can often mask the weaknesses of underlying policy and institutions and result in various sorts of imbalances. These problems can be exacerbated by an open capital account. For instance, if governments accumulate external debt in order to get around constraints to domestic financing of budget deficits, domestic firms and financial institutions may also react to the perception of limited foreign exchange risk by taking on foreign currency debt. Given the relative risk of lending to the emerging markets perceived by international investors, much of this debt tends to be short term. The presence of large amounts of short-term external debt primarily in foreign currencies is now widely recognized as a key risky factor in precipitating balance of payments crises. In addition to these general considerations, the particular circumstances with which China faces also generate some specific costs for maintaining a fixed exchange rate. The sterilization of capital inflows has been facilitated by the fact that, domestic interest rates related to the main sterilization instrument (central bank bills) have been lower than interest rates on medium and long-term foreign treasury bonds, which is where most of China's reserves are presumed to be held. Thus, the traditional net costs of sterilization are absent in this case. However, keeping such low domestic interest rates, which have recently been negative in real terms, requires domestic financial repression, which, according to Wang (2005, p. 12), can create large distortions and efficiency losses.

Second, since the undervaluation of the RMB and prediction of its revaluation has been spread, unexpected hot money has been flowing into China from 2003. In 2004, about 50 billion U.S. dollar in "hot money", or speculative short-term foreign investments, may have entered China. Much of that would have been prompted by speculation that the currency will be revaluated. That huge sum of money has produced significant macroeconomic distortions in China. In the second half of 2003, Chinese policymakers began taking many specific measures aimed at limiting upward pressure on the currency and dampening nascent signs of an overheating economy. However, none of the measures had a desired effect. In the first quarter of 2004, increases in foreign exchange reserves reached 36.8 billion U.S. dollar, averaging slightly more than 12 billion U.S. dollar gain per month or 144 billion U.S. dollar at an annualized rate. At the end of March 2004, the money supply (M2) increased by 19.4%, bank loans jumped by 20.7%, and fixed asset investment rose by 43% compared with one year before. This is consistent with the view regarding the hot-money-fueled financial figures published in 2003 (Tung & Banker, 2004, p. 332). The hot money has become recently a headache for Chinese monetary policy makers. They face a hard task in raising interest rates, because such an action would attract more speculative investments.

More seriously, if fundamental factors such as relative productivity growth create persistent pressures for real exchange appreciation, these pressures eventually force adjustment through one channel or another. Even in an economy with capital controls

and a repressed domestic financial sector, these pressures can be bottled up for a while. It is typically better to adjust through changes in the nominal exchange rate rather than through inflation. Particularly in a developing economy, such inflationary dynamics can pose serious risks as expectations of rising inflation can feed on themselves and become entrenched. Furthermore, for an independent monetary policy (with exchange rate flexibility) to be more effective, further institutional and operational improvements would be made to establish a credible monetary policy framework and improve the monetary policy transmission mechanism. However, the movement toward an independent monetary policy regime must face the challenge of maintaining China's present exchange rate regime for a long period, and the explicit and implicit costs of maintaining this regime are potentially large and likely to grow over time, especially considering the increasing globalization for China and the authorities' stated objective to gradually liberalize the capital account (Wang 2005, pp.12 - 13).

3.1 A critique of various estimates of the RMB's undervaluation

Although there is a broad view that the RMB is undervalued, there is no consensus about how much it ought to appreciate. Estimates of the extent of the RMB's undervaluation have been studied in many articles and interviews (refer to table 2). Most of the papers sustain that the RMB has been undervalued after 1997, except for Xiaopu Zhang (2002). Nevertheless, economists don't seem to have reached any consensus on the specific level of undervaluation.

For example, Bing Zhang (2003), using a single equation estimation, estimates that the RMB was undervalued by 6% to 10% till 2003. However, Chang & Shao (2004), based on the principle of purchasing power parity (PPP), estimate that the RMB was undervalued by 22.5% also until 2003. Surprisingly, using several different approaches it is in only one paper in which they estimate different results. Funcke & Rahn (2005), using the Behavioral equilibrium exchange rate model, estimate that the RMB has been undervalued by 0% to 8%, and using the Permanent equilibrium exchange rate, they estimate that the RMB has been undervalued by 12% since mid-1997. It is not clear whether the RMB is more or less undervalued now.

Table 2: Previous estimates of the RMB's equilibrium exchange rate

Analyst	Date of Publication	Method	Type of exchange rate	Percent RMB Undervalued
W. L. Chou & Y. C. Shih	October 1997	Purchasing power parity	Dollar	7.55% till 1994
		The shadow price of foreign exchange	Dollar	2.14% - 9.23% till 1994
Xiaopu Zhang	February 2002	The Equilibrium real exchange rate	REER	6% overvaluation in 1999
		Behavioral equilibrium exchange rate	REER	10% overvaluation in 1999
Ernest H. Preeg	September 2002	The rule-of-thumb estimates	Dollar	40% till 2002
Bing Zhang	August 2003	Single Equation Estimation	REER	6%-10% till 2003
Gene Hsin Chang & Qin Shao	April 2004	The model is set up based on the principle of purchasing power parity	Dollar	22.5% in 2003
Ling Jiang, Lu Han & Daivd Jiang	2004	Purchasing power parity	Dollar	10.23% till 2000
Fan Zhang & Zuohong Pan	2004	The hypothetical long run nominal exchange rate without intervention	Dollar	15 – 22% in 2003
Jiawen Yang	2004	The Big Mac index	Dollar	49% till 2002
Virginie Coudert & Cécile Couharde	January 2005	Fundamental equilibrium exchange rate	REER	23% till 2003
			Dollar	44% till 2003
		Regression in level, sample of 93 emerging and developing countries	Dollar	41% till 2003
		Behavioral equilibrium exchange rate	Dollar	18% till 2002
Michael Funcke & Jörg Rahn	2005	Behavioral equilibrium exchange rate	REER	0%-8% after mid-1997
		Permanent equilibrium exchange rate	Dollar	12% after mid-1997

The most serious problem in investigating the undervaluation of the China's currency is insufficient data. Even some general data, such as the quarterly data for Gross domestic product before 1999, the Consumer price index before 1985, the Whole sale price, the government debt, and so on, are absent. Therefore, it makes research on China more complicated.

Most of the papers have mentioned this problem and used various indirect methods to solve it. For instances, Chou & Shih (1997, p. 168) found that a quarterly series for the overall CPI is not available. They used the urban CPI from the first quarter of 1993 to the first quarter of 1994 instead of the overall CPI. And figures for other quarters were derived by estimating the equation $PC\_UR = a + bPC + \varepsilon$, where PC_UR is the change in the urban CPI, PC is the change in the overall CPI, and ε is the error term, using annual data from 1987 to 1993. Substituting quarterly data for PC into the estimated equation, the estimated values of quarterly changes in urban CPIs are obtained.

Similarly, Funke & Rahn (2005, p. 475) wrote, "Chinese data for consumer price index are available on a quarterly basis beginning in 1987 from the IFS database. Annual data from the CEIC database are used to extend the time series back to 1985. The same data source publish annual PPI values for China, which we transform from low frequency (annual data) to high frequency (quarterly data) using an optimal interpolation procedure." In their test, although only three main variables are used in

their models, the data for two of them are generated in this way. They admitted that (2005, p. 475), "interpolated data are no substitute for actual data, since the higher resolution is fictitious." It is believed that frequently using the artificial data in the empirical test must mislead the outcome. Xiaopu Zhang (2002, p. 17) found that the quarterly data of China's terms of trade are not available. She used the trade surplus as a proxy instead of terms of trade. By definition, the terms of trade is the ratio of the domestic export unit value to the import unit value relative to the equivalent effective foreign ratio.

Using inaccurate data to substitute this variable may produce incorrect and unpractical result. Xiaopu Zhang (2002) is the only one who asserted that the Chinese exchange rate was overvalued in 1999. Zhichao Zhang (2000, pp. 85-86) used some unrelated variables to make up for deficient data. He employed the index of government consumption to capture the effect of fiscal policy in manipulating exchange rate. He also used the index of gross fixed capital formation to determine the domestic supply capacity and estimate the technological progress. Moreover, the growth rate of China's exports was used to reflect the effect of terms of trade. However, the author had to rely on an excessive number of variables in order to obtain any meaningful empirical support. Reliance on unreliable data makes the empirical results untrustworthy.

In additional to the problem of lacking reliable data, some of the empirical methods

have limitations. Chou & Shih (1997), Chang & Shao (2004), Ling Jiang, Lu Han & Daivd Jiang (2004) all setup empirical models based on the theory of purchasing power parity (PPP) to calculate the misalignment of the RMB. The theory assumes the law of one price (LOP) and implies that changes in exchange rates are related to changes in relative prices among countries. Normally, it is assumed, the PPP holds in the long run. However, in the short run, exchange rates can deviate significantly from PPP.

One of the reasons is that trade barriers can inhibit the free flow of goods between countries. First, high transportation costs make it possible that prices of the same product in different countries could diverge. Second, competitive versus non-competitive markets could cause international price differences for the same product. Third, misapplication of the price of non-tradable goods as the price index to calculate the misalignment of exchange rates produces incorrect results. For example, Jiawen Yang (2004) estimated that the RMB was undervalued by 49% in 2002 by employing the Big Mac index. Based on the theory of purchasing power parity, the Big Mac index compares the price of a McDonald's Big Mac in China to the United States. Since a Big Mac in China was 49% cheaper than in the United States, the index concludes that the RMB was undervalued by that much till 2002. But PPP only applies to tradable goods, and a Big Mac is not tradable. In fact, Morrison & Labonte (2005, p. 13) found that 94% of the value of a Big Mac comes not from the hamburger itself, but from the services associated with the hamburger. These include the wages

of employees serving the Big Mac and the rent of the restaurant in which it is eaten, both of which are determined by local factors. Since the hamburger itself is the only tradable portion of the Big Mac, only a small fraction of the Big Mac's value should be determined by PPP. Fourth, the PPP approach is highly sensitive to the selection of the base year. For instance, if the benchmark year was 1995, the RMB would have been undervalued by 2.6% in 1999. If the benchmark year was 2000, the RMB would have been undervalued by 3.9% in 2003.

Preeg (2002, pp. 4 - 7) employs several rule-of-thumb methods to estimate that the RMB is undervalued by 40% till 2002. He puts forward the following ideas: firstly, the increase in Chinese foreign exchange reserves equals 100% of the Chinese trade surplus minus net foreign direct investment flows in the first six months of 2002; secondly, a 1% decline in the dollar gives rise to a 10 billion U.S. dollar decline in the trade deficit in the US; finally, the dollar ought to decline by 40% to eliminate the trade deficit since the U.S. trade deficit was about 400 billion U.S. dollar in 2002. Because the Chinese trade surplus plus net FDI (Foreign Direct Investment) flows amount to 100% of the increase in foreign exchange reserves, he concludes that, if the central bank no longer increases its foreign exchange reserves by letting the RMB float, the surplus less FDI would be zero and the RMB would appreciate by 40% based on the U.S. ratio.

There are some criticisms of the Preeg estimate. Preeg's transferring of the rule of

thumb from dollar terms to percentage of the total trade deficit is not justified. His conversion suggests that if the U.S. trade deficit were 1 dollar, a 40% decline in the dollar would lower the deficit by 1 dollar. In the same way, if the trade deficit were 1 trillion dollar, a 40% decline in the dollar would lower the deficit by 1 trillion dollar. Obviously, this would be highly unlikely, since the absolute value of the deficit would matter. Moreover, Preeg applies his estimate based on U.S. data to the Chinese trade surplus without any convincing evidence. Since the United States and China are very different economic systems, especially in terms of trading patterns, trade balances, and exchange rate regimes, there is no reason to believe that the estimate would be the same for both countries. He also uses overall and bilateral trade balances interchangeably. It is difficult to accept that a 40% decline in the dollar would have the same effect on a 400 billion U.S. dollar overall trade deficit as a 40% decline in the RMB would have on a 60 billion dollar bilateral Chinese trade surplus minus FDI (Morrison & Labonte, 2005, p. 12).

Coudert & Couharde (2005) took a FEER approach to estimate the equilibrium exchange rate. The FEER is defined as the equilibrium level of the exchange rate when economies are at their potential growth and have reached their current account balance targets. They suggest that the misalignments are largely due to great imbalances on the external accounts but also to the high level of misalignment arising from responses to imbalances. Thus, large movements in the exchange rate are needed to reach an equilibrium rate so as to correct a large external imbalance. And the

deviation of the real effective exchange rate from its equilibrium value can be offered by calculating the deviation of the current account from its equilibrium value.

The above estimation procedure would then allow researchers to define the appreciation that would be required for China to reach an "equilibrium" in the current account balance. There is much debate over the definition of an "equilibrium" current account balance, and no consensus about what equilibrium would be based on theories or evidence. Although some economists argue that current account balance should always be close to zero in equilibrium, this contradicts the fact that countries with different saving and investment rates may tend to borrow from or lend to one another for a long time. Moreover, Coudert & Couharde (2005) employed an assumption of equilibrium less favorable to China than simply the current account balance. Actually they regard balance as only in official and portfolio borrowing. But they still allow foreign direct investment (FDI) inflows, which implies that their estimation of China's whole "equilibrium" current account position is indeed a deficit.

What is more is that it is particularly difficult to determine the equilibrium current account balance in China due to the current presence of capital control. If China were to exert capital controls after the currency reform, current account balance may be a reasonable assumption. But if capital controls were eliminated, as is the case with a floating exchange rate, the economic situation would change completely – "equilibrium" could now include persistent borrowing from or lending to the rest of the world by private Chinese citizens, which would lead to a corresponding persistent

trade deficit or surplus respectively. If private citizens lend as much to the United States in equilibrium as the Chinese central bank is currently lending, then the equilibrium market exchange rate would be equivalent to the current fixed rate, and the trade deficit would remain unchanged. If private capital outflows exceeded the current increase in foreign reserves, the RMB would depreciate. Since China is a country with both a high national saving rate and a high investment rate, it remains unclear whether China would be a net borrower or lender if its currency floats and capital controls are abandoned.

3.2 The theoretical framework

It seems that there are no ideal methods to decide how much the RMB is undervalued. But at least it is possible to find a more reasonable and less faulty approach. In this paper, the behavioral equilibrium exchange rate (BEER) is introduced to analysis the misalignment of the Chinese currency. The BEER entails the use of an estimated reduced-form equation that interprets the behavior of the real effective exchange rate over the sample period. It is thought that the equilibrium exchange rate is determined by fundamental economic factors. Equilibrium exchange rates act as an attractor for the actual exchange rate, pulling the actual exchange rate toward it. The reduced form expression of the BEER is represented as follows:

$$q_t = \alpha_0 + \alpha_1 Z_t + \varepsilon_t \qquad 2.1$$

Where:

q_t is the real exchange rate;

Z_t is a vector of economic fundamentals that affect the real exchange rate q_t over the medium or long run;

ε_t includes both short-term influences and random disturbance terms. It is the deviation of the actual value of the real exchange rate from the current equilibrium rate, $\overline{q}$, the latter being the level of the exchange rate given by the current values of economic fundamentals:

$$\overline{q}_t = \alpha_0 + \alpha_1 Z_t \qquad 2.2$$

Using this framework, it is natural to define the current misalignment as the difference between the actual exchange rate, e, and the behavioral real exchange rate determined by the current values of the overall economic fundamentals:

$$MIS_t = e_t - \overline{q}_t \qquad 2.3$$

The choices of economic fundamentals are different among previous studies. However, as the preceding section criticizes, some selected variables in previous paper are meaningless. Considering the availability of data and the results of repeated tentative tests on various variables, the model of BEER in this paper is constructed on the basis of the following fundamentals:

$$\overline{q}_t = f(\overset{+}{PROD}_t, \overset{+}{NFA}_t) \qquad 2.4$$

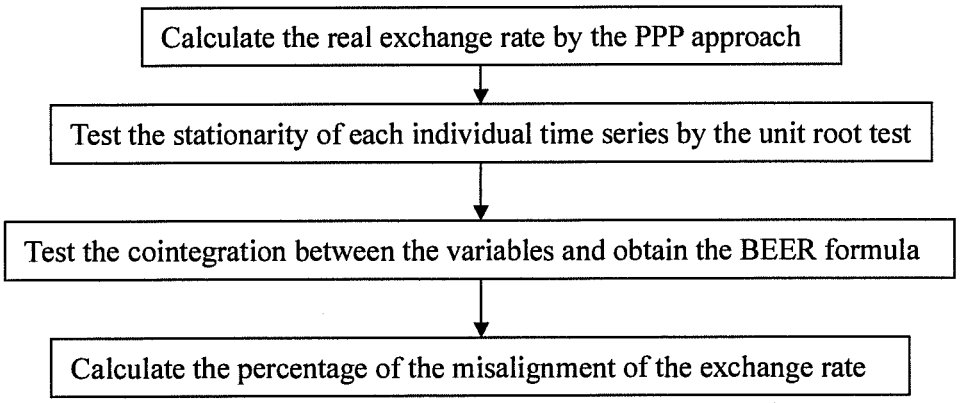
Here the real exchange rate, q_t, is calculated by the purchasing power parity approach. $PROD_t$ is productivity and it is defined as the ratio of gross domestic product to the labor force. According to the Balassa-Samuelson effect discussed previously, the improvement in productivity will appreciate the exchange rate (refer to pp. 13 – 15). NFA_t is the ratio of the change of net foreign assets. The net foreign assets are

defined as total foreign assets (less official gold holding) minus total liabilities to foreigners (Clark & MacDonald, 1998, p. 19). Explained by Funke and Rahn (2005, p. 470), the real exchange rate can be affected by the net foreign asset position via several channels. For example, a worsening of the net foreign asset position would entail raising interest payments of net debtor countries on their debt but lowering incomes from interest payments for creditor countries. This deficit engendered by changing interest rate must be financed by an improvement in the trade balance, which requires a depreciation of the currency. Meanwhile, higher debt leads to a rise in the risk premium. But a higher yield can only be guaranteed at some point if the domestic currency depreciates.

3.3 The estimation process

The estimation of misalignment in this paper consists of four steps:

Table 4: The flow chart of the estimation



Besides China, two East Asian countries (Japan and Thailand) and two developed countries (Australia and Denmark) are randomly selected for the test. Considering the

limited access to the data, the sample period is from the 1986 to 2003. Except for the data on whole sale price for the United States which comes from the *IMF* (*International Financial Statistics)*, data for other variables are all collected from *the World Bank* (*World Development Indicators 2005)*.

3.31 CHINA

The first process is the PPP approach. According to the theory of purchasing power parity, the real exchange rate represents the relative price between a domestic basket of tradable goods and a foreign basket of tradable goods. Refer to Kakkar & Ogaki (1999, pp. 193-196), the real exchange rate is defined as:

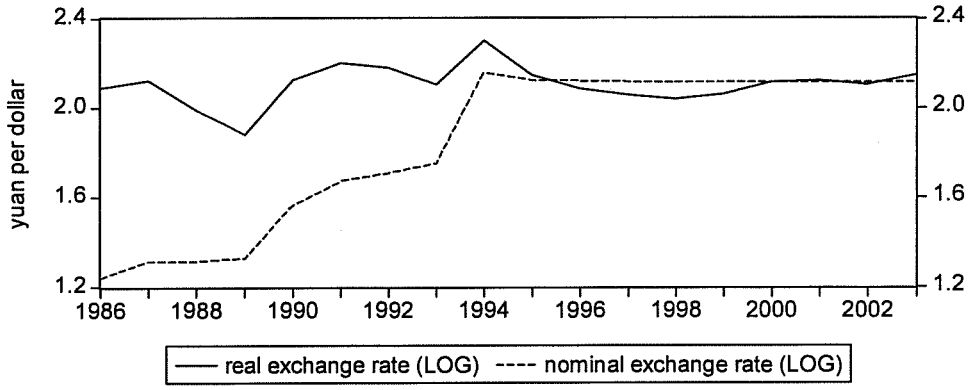
$$Q_t \equiv E_t WPI_t^{US} / CPI_t \qquad 3.1$$

Where Q_t is the real exchange rate, E_t is the nominal exchange rate in terms of domestic currency per unit of foreign currency, WPI_t^{US} is the wholesale price index in the United States and is used as a proxy for the foreign price of tradable goods, and the CPI_t is the domestic consumer price index and is used as a proxy for the domestic price of non-tradable goods. Equation 3.1 can be transformed to logarithmic form:

$$q_t = e_t + wpi_t^{US} - cpi_t \qquad 3.2$$

The lower case letters denotes logarithms. By the purchasing power parity approach, the real exchange rate of China is exhibited in the following graph:

Figure 5: The nominal exchange rate and real exchange rate of the RMB against the U.S. dollar



Data Source: IMF (*International Financial Statistics)*

From the PPP approach, there is not much deviation of the real exchange rate from the nominal exchange rate. But as verified previously, the PPP approach is highly sensitive to the selection of the base year. There is a need to take the BEER approach to estimate the equilibrium exchange rate which is not affected by the selection of the benchmark time.

Second, we proceed with the Unit root test[3]. It is necessary to test the stationarity of each time series before the estimation. Considering advantages of testing limited observations, the Phillips-Perron (PP) test is used in this paper instead of conventional augmented Dickey Fuller (ADF) test. The PP method estimates the non-augmented DF test equation, and modifies the t-ratio of the α coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test is based on the statistic:

[3] Refer to Eviews 5.0 Help: The unit root test introduction.

$$\hat{t}_\alpha = t_\alpha \left(\frac{\gamma_o}{f_o}\right)^{\frac{1}{2}} - \frac{T(f_o - \gamma_o)(se(\hat{\alpha}))}{2f_o^{\frac{1}{2}}s} \qquad 3.3$$

where $\hat{\alpha}$ is the estimate, and t_α the t-ratio of α, $se(\hat{\alpha})$ is the coefficient standard error, and s is the standard error of the test regression. In addition, γ_o is a consistent estimate of the error variance in 3.3 (calculated as $(T-k)s^2/T$, where k is the number of regressors). The remaining term, f_o is an estimator of the residual spectrum at frequency zero. The result of unit root test is reported in table 5:

Table 5: Unit Root Tests-- China RMB

Variable	Test Statistic	Critical Value at 5%
Real exchange rate (q)	-2.720325	-3.052169
Productivity (PROD)	-2.027354	-3.052169
Net foreign asset position (NFA)	-2.566593	-3.052169

In all three cases the null hypothesis of a unit root cannot be rejected.

Next, cointegration is investigated using the Johansen approach and the degree of integration of the system is determined in the process. The purpose of the cointegration test is to determine whether a group of non-stationary series is cointegrated or not. Johansen cointegration test which is based on a vector auto-regression (VAR) model is implemented:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + Bx_t + \varepsilon_t \qquad 3.4$$

where y_t is a k-vector of non-stationary I(1) variables, x_t is a d-vector of deterministic variables, and ε_t is a vector of innovations. This VAR can be rewritten as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \qquad 3.5$$

where:

$$\Pi = \sum_{i=1}^{p} A_i - I \ , \qquad \Gamma_i = -\sum_{j=i+1}^{p} A_j \qquad 3.6$$

There are two methods to determine the number of cointegrating vectors r. The first one is the trace test. The null hypothesis is that there are at most r cointegrating vectors, while the alternative hypothesis is that there are less than r cointegrating vectors. The trace statistic for the null hypothesis of r cointegrating relations is computed as:

$$LR_{tr}(r \mid k) = -T \sum_{i=r+1}^{n} \log(1 - \lambda_i) \qquad 3.7$$

where λ_i is the characteristic root of matrix Π (for I =1 , 2 ...), and T is the number of observations. The alternative method to determine r is the maximum eigenvalue statistic. In this test, the null hypothesis is that there exist at least r cointegrating vectors, against the alternative hypothesis that there are $r+1$ cointegrating vectors. This test statistic is computed as:

$$LR_{\max}(r \mid r+1) = -T \log(1 - \lambda_{r+1}) = LR_{tr}(r \mid k) - LR_{tr}(r+1 \mid k) \qquad 3.8$$

for r = 0, 1, ..., k-1. The critical values of both statistics are provided by Osterwald-Lenum (1992). The result of the cointegration test is reported in table 6:

Table 6: Cointegration test – China RMB

Trace Test			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value
None	0.954927	72.16921	34.91
At most 1	0.556736	18.57761	19.96
At most 2	0.449821	9.060186	9.24

Trace test indicates 1 cointegrating equations at 5% level

Max-eigenvalue test			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value
None	0.954927	49.59160	22.00
At most 1	0.556736	13.01742	15.67
At most 2	0.449821	9.560186	9.24

Max-eigenvalue test indicates 1 cointegration equations at the 5% level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)			
LQ	NFA	PROD	C
1.000000	-0.208395	-0.101781	-1.171247
	(0.01295)	(0.00980)	(0.07068)

Log likelihood: 80.16123 Std. error in parentheses

Table 6 presents the normalized cointgration vector, as well as the corresponding adjustment coefficients. The implied behavioral equilibrium real exchange rate can be represented in Equation 4.1:

$$BEER = 1.171247 + 0.208395NFA + 0.101781PROD \qquad 4.1$$

In Equation 4.1, BEER is the behavioral equilibrium exchange rate in logarithmic form. As theory indicates, the productivity and net foreign asset position has a positive and significant impact on the real exchange rate.

After the BEER equation is obtained, the misalignment of the Chinese RMB can be computed as – [(Nominal exchange rate – BEER) /BEER] × 100. The output is

exhibited in the following table:

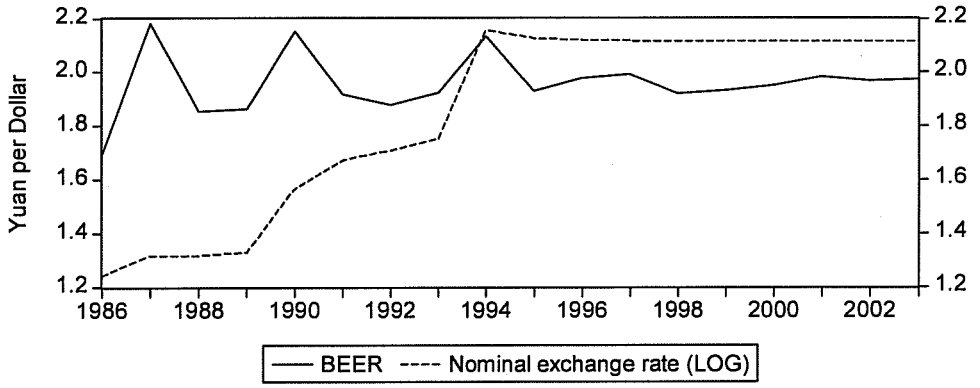
Table 7: The misalignment of Chinese RMB

Year	% Deviations from the BEER Rate
1986	26.97%
1987	39.69%
1988	29.13%
1989	28.88%
1990	27.26%
1991	12.74%
1992	9.05%
1993	8.90%
1994	-0.98%
1995	-9.97%
1996	-7.20%
1997	-6.16%
1998	-10.16%
1999	-9.45%
2000	-8.47%
2001	-6.62%
2002	-7.46%
2003	-7.14%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

The results show that the RMB experienced overvaluation before 1994. The exchange rate was even overvalued nearly by 40% in 1987. From the beginning of the peg regime, the exchange rate of RMB has remained undervalued. It is very interesting to find that the floating range of the RMB against the U.S dollar started to shrink, especially after the Asian financial crisis in late 1997. The behavioral equilibrium exchange rate became more stable after 1994, especially after 1997. As it is shown in Figure 6:

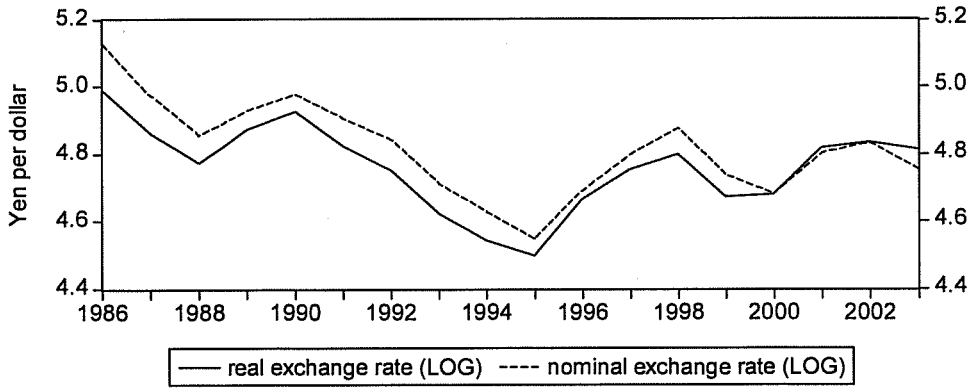
Figure 6: The BEER and Nominal exchange rate of the RMB against the U.S. dollar



3.32 JAPAN

The currency of Japan is the Yen. Japan had maintained a fixed exchange rate of 360.00 Yen per U.S. Dollar until August 1971. In 1973, a floating exchange rate system was introduced in Japan. The Bank of Japan only intervened in the currency market when the Yen fluctuated in a disorderly fashion. The exchange rate regime has not changed much in Japan.

Figure 7: The PPP approach of the Yen against the U.S. dollar



By stationarity test and then cointegration test, the BEER model for the Japanese Yen

against the U.S. dollar is obtained (refer to the appendix for detailed outputs of tests):

$$BEER=-10.20644+0.053824NFA+1.338283PROD \quad 4.2$$

The misalignment of the Japanese Yen against the U.S. dollar is computed in table 8:

Table 8: The misalignment of Japanese Yen

Year	% Deviations from the BEER Rate
1986	-15.90%
1987	-12.35%
1988	-7.87%
1989	-8.12%
1990	-7.78%
1991	-6.21%
1992	-5.02%
1993	-8.22%
1994	0.21%
1995	2.60%
1996	-0.17%
1997	-1.65%
1998	-4.51%
1999	-1.35%
2000	0.80%
2001	-1.64%
2002	-2.46%
2003	-0.07%

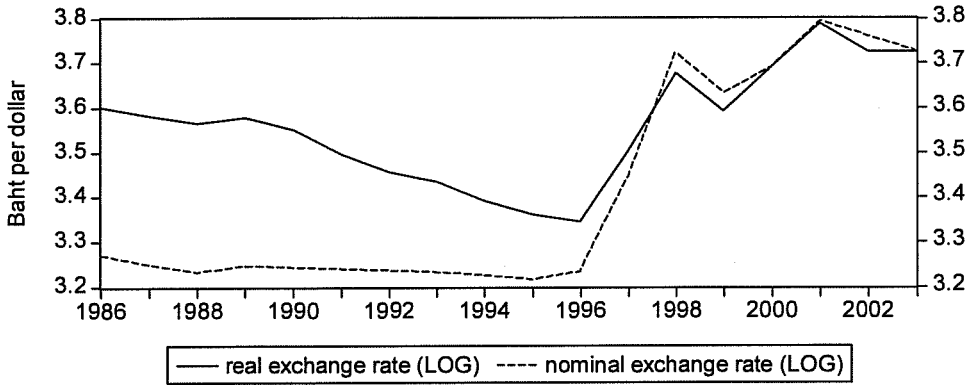
*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

3.33 THAILAND:

The currency of Thailand is the Baht. The exchange rate regime of Thailand has changed from the one that was pegged to the U.S. Dollar to one of pegging to a weighted basket currency of Thailand's major trading partners since March 1978. From 1987 to 1997, the Exchange Equalization Fund (EEF) defended that Baht value against the U.S. Dollar by using monetary and financial measures in accordance with the pegged exchange rate regime. From July 1997, the exchange rate of Baht has been

largely determined by market forces and was allowed to float independently.

Figure 8: The PPP approach



From the stationarity test and then cointegration test, the BEER model for the Baht against the U.S. dollar is obtained (refer to the appendix for detailed outputs of tests):

$$BEER=-2.167207+0.007453NFA+0.683371PROD \qquad 4.3$$

The misalignment of Baht can be computed as – [(Nominal exchange rate – BEER) /BEER]×100. The misalignment of the Baht against the U.S. dollar is computed in table 9:

Table 9: The misalignment of Baht

Year	% Deviations from the BEER Rate
1986	-10.85%
1987	-8.49%
1988	-5.50%
1989	-3.91%
1990	-2.02%
1991	-0.54%
1992	0.73%
1993	2.18%
1994	3.40%
1995	-23.59%
1996	6.19%
1997	-0.52%
1998	-9.19%
1999	-7.82%
2000	-8.78%
2001	-11.65%
2002	-9.64%
2003	-7.40%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

3.34 AUSTRALIA:

The currency of Australia is the Australian dollar. Australia removed all foreign exchange controls since 1983. From that time, the Australian dollar was allowed to freely float. By implementing the same estimation procedures, the BEER of the Australian dollar can be computed in accordance with the following formula (refer to the appendix for detailed outputs of tests):

$$BEER=-4.398738+0.485112NFA+0.477028PROD \qquad 4.4$$

3.35 DENMARK:

The currency of Denmark is the Danish krone. Denmark has run a fixed exchange rate

policy for more than twenty years. A fixed exchange rate policy is difficult to maintain because of its susceptibility to speculative attacks. It is especially tough to combat speculation being built up in anticipation of a devaluation of a currency. Denmark has experienced a number of currency crises since the early 1980s. However, the fixed exchange rate policy has remained intact. By implementing the same estimations, the BEER of Danish krone can be computed on the basis of the following formula (refer to the appendix for detailed outputs of tests):

$$BEER = -3.562215 + 0.073472NFA + 0.522610PROD \qquad 4.5$$

4. Analysis of Results

The coefficients of the variables in each test in some sense support the assumptions, not only for Asian countries, but also for countries under different exchange rate regimes or in different parts of the world. It may be argued that a well-founded measure of the equilibrium value of currencies may be obtained from a small set of fundamental variables and that this can be used to evaluate the misalignment of the currencies.

In the case of China, the exchange rate has been substantially overvalued before 1994 (refer to figure 6 and table 7). After 1994, the RMB began to be pegged to the U.S. dollar, and the BEER estimate remained fairly stable and more closely connected to the nominal exchange rate. It is at that time that the RMB started to be undervalued. According to the results of East Asian countries, it seems that China, Japan and Thailand have systematically undervalued their currency. The Chinese government intervenes and acquires dollar securities to prevent appreciation. Other East Asian governments have also intervened to prevent their currencies from appreciating, thereby reflecting the fact that currency undervaluation is a Pacific Rim phenomenon (Palley, 2005, pp. 10- 11). On the other hand, it is found that the RMB is not substantially undervalued. The RMB was undervalued by only 7% till 2003. Even during the most undervalued period of 1998, the misalignment of the RMB was no more than 10%. This corresponds well with the declaration of the IMF on November 20, 2003, which said that there was no clear evidence that China's yuan was

substantially undervalued.

5. Conclusion

From the above results, the so-called undervaluation of the RMB is to some degree exaggerated and does not warrant the kind of attention it has been given. But why has the United States been so strongly urging China to reform its currency regime? There are several explanations. China is considered as the largest contributor to the U.S. current account deficit. Many U.S. economists and politicians believe that a Chinese exchange rate adjustment can influence significantly in restoring the U.S. current account. Palley (2005) thought that China's failure to adjust is also causing an exchange rate "logjam" effect as other East Asian countries refuse to revalue for fear of losing competitiveness vis-à-vis China. This makes it difficult to improve the deficit of the U.S. current account. In addition, the RMB pegged to the dollar means that China's currency is depreciating against the euro as the dollar weakens against these currencies. This threatens to weaken the manufacturing industry in the European economies even more. As commented by one European Central Bank (ECB) official recently: "It may be our problem, but it is their currency". (Liang, 2003)

Would a marked increase in the exchange value of the Chinese RMB relative to the U.S. dollar significantly increase manufacturing activity and jobs in the United States? It may be just some people's wishful thinking. Coudert & Couharde (2005, p. 33) suggested that a revaluation of the RMB would have only a small effect on the U.S. external deficit.

Funcke & Rahn (2005, pp. 485 - 486) proved that the immediate effect of the

appreciated RMB would be to inhibit the pressure of Chinese competition on Western jobs but this effect would arise in the short run. Since the Chinese labor market is exceptionally flexible, wages in China are priced by international demand for Chinese products. If China's competitiveness is under pressure, firms would respond by shifting labor-intensive production inland, where employment costs are cheaper. Ultimately, the exchange rate will not account for the competitiveness of an economy with such labour market flexibility and high factor mobility.

Also, commented by Hu (2003, pp. 4 - 5), an important reason for China's ballooning trade surplus is that it is the predictable outcome of outsourcing and trade chaining that has taken place in Asia. It is testified that goods which used to be made in Japan, Taiwan and Korea, and exported to the U.S. , are now instead made in China - in most cases by the same Asian and Western multinational companies – and exported from China to the same U.S. market. Instead of showing up in the bilateral trade balance between U.S. and other Asian economies, it is recorded in the bilateral trade balance between the U.S. and China. Consequently, a trade surplus grows for China with respect to the U.S., whereas it runs a large deficit on a combined basis with Japan, Korea, and other Asian countries. What is more, on June 23, 2005, the chairman of the U.S. Federal Reserve Board, Alan Greenspan, argued that no credible evidence supports that the appreciation of the RMB will help significantly to increase manufacturing activity and jobs in the United States. He appealed "for our part, it is essential that we not put that outcome, or our future, at risk with a step back into

protectionism."

Should China evaluate upward its currency? It is suggested that some mild RMB revaluation at an appropriate time is highly necessary. First, it should be a mild revaluation. There was a lesson in 1985, when Japan signed the "Plaza Agreement" by allowing that the yen against U.S. dollars to rise from its original fixed lowest point 360:1 to 240:1. The sharp yen revaluation hit badly and directly Japanese foreign trade, throwing Japan's economy, which depended heavily on foreign resources, into a "Yen revaluation depression" during the 1990s. Second, it should be at an appropriate time to avoid speculative attacks. A revaluation of the RMB would increase the net welfare gain for the Chinese people and stimulate domestic demand. It would convert China from an export-led growth economy to a domestic demand-led growth economy. And a currency appreciation would effectively remove the need for additional tightening and give the central bank renewed control over the domestic money supply. Furthermore, it should be realized that continuation of the RMB peg would not only cost them too much politically in the international arena, but also cost them dearly in terms of building up dangerous internal imbalances. Therefore, a mild revaluation of the RMB and appropriate adjustment of exchange rate policy would benefit the interest of China.

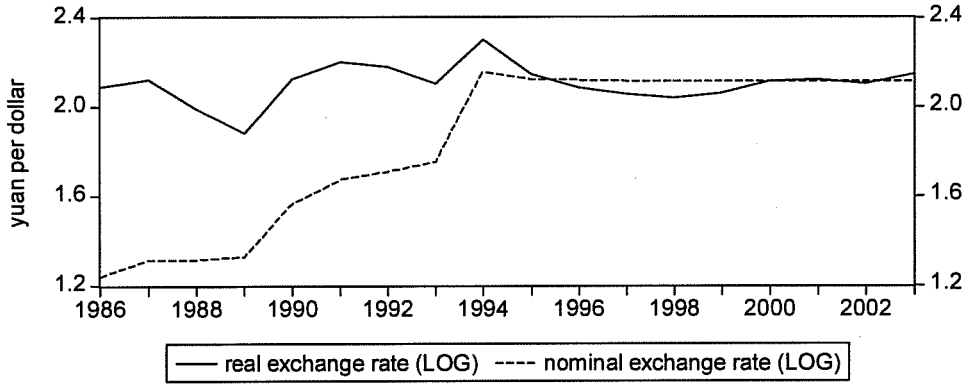
A week after the first draft of this paper was submitted, on July 21, 2005, news came out that China allowed its currency, the RMB, to appreciate by a modest 2 percent.

Meanwhile, the RMB will no longer be pegged to the U.S. dollar but adjusted with reference to a basket of currencies. This decision substantiates conclusions of this paper.

APPENDIX

CHINA:

1.1 The PPP approach: the real exchange rate and nominal exchange rate of the RMB against the U.S. dollar



1.2 The Unit Root Test:

Variable	Test Statistic	Critical Value at 5%
Real exchange rate (q)	-2.720325	-3.052169
Productivity (PROD)	-2.027354	-3.052169
Net foreign asset position (NFA)	-2.566593	-3.052169

1.3 The Cointegration test

Trace Test			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value
None	0.954927	72.16921	34.91
At most 1	0.556736	18.57761	19.96
At most 2	0.449821	9.060186	9.24

Trace test indicates 1 cointegrating equations at 5% level

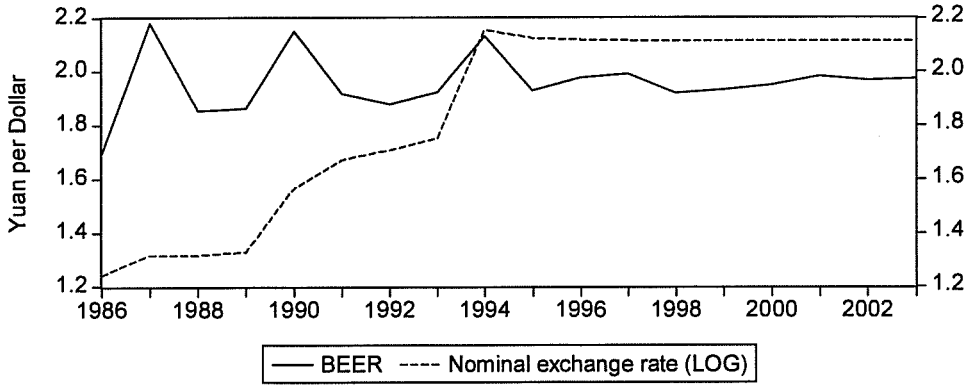
Max-eigenvalue test			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value
None	0.954927	49.59160	22.00
At most 1	0.556736	13.01742	15.67
At most 2	0.449821	9.560186	9.24

Max-eigenvalue test indicates 1 cointegration equations at the 5% level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)			
LQ	NFA	PROD	C
1.000000	-0.208395	-0.101781	-1.171247
	(0.01295)	(0.00980)	(0.07068)

Log likelihood: 80.16123 Std. error in parentheses

1.4 The BEER and the nominal exchange rate of the RMB against the U.S. dollar:



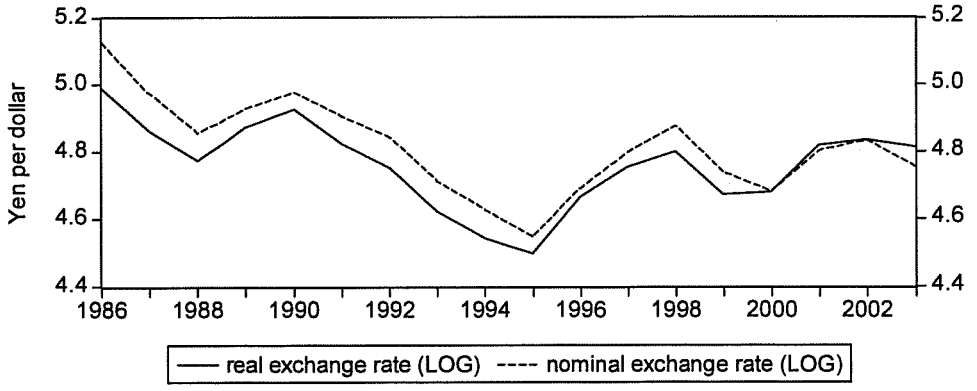
1.5 The misalignment of the RMB:

Year	% Deviations from the BEER Rate
1986	26.97%
1987	39.69%
1988	29.13%
1989	28.88%
1990	27.26%
1991	12.74%
1992	9.05%
1993	8.90%
1994	-0.98%
1995	-9.97%
1996	-7.20%
1997	-6.16%
1998	-10.16%
1999	-9.45%
2000	-8.47%
2001	-6.62%
2002	-7.46%
2003	-7.14%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

JAPAN:

2.1 The PPP approach: the real exchange rate and nominal exchange rate of the Yen against the U.S. dollar



2.2 The Unit Root Test:

Variable	Test Statistic	Critical Value at 5%
Real exchange rate (q)	-2.221468	-3.052169
Productivity (PROD)	-2.761187	-3.052169
Net foreign asset position (NFA)	-3.009726	-3.052169

2.3 The Cointegration test

Trace Test			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value
None	0.820264	49.96531	34.91
At most 1	0.670687	22.50505	19.96
At most 2	0.256078	4.733111	9.24

Trace test indicates 2 cointegrating equations at 5% level

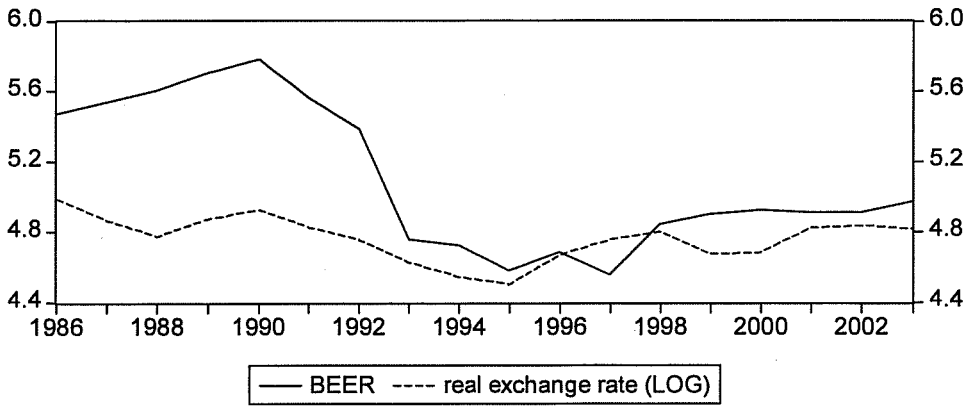
Max-eigenvalue test			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value
None	0.820264	27.46023	22.00
At most 1	0.670687	17.77194	15.67
At most 2	0.256078	4.733111	9.24

Max-eigenvalue test indicates 2 cointegration equations at the 5% level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)			
LQ	NFA	PROD	C
1.000000	-0.053824	-1.338283	10.20644
	(0.02384)	(0.44746)	(4.97697)

Log likelihood: 43.82916 Std. error in parentheses

2.4 The BEER and the nominal exchange rate of the Yen against the U.S. dollar:



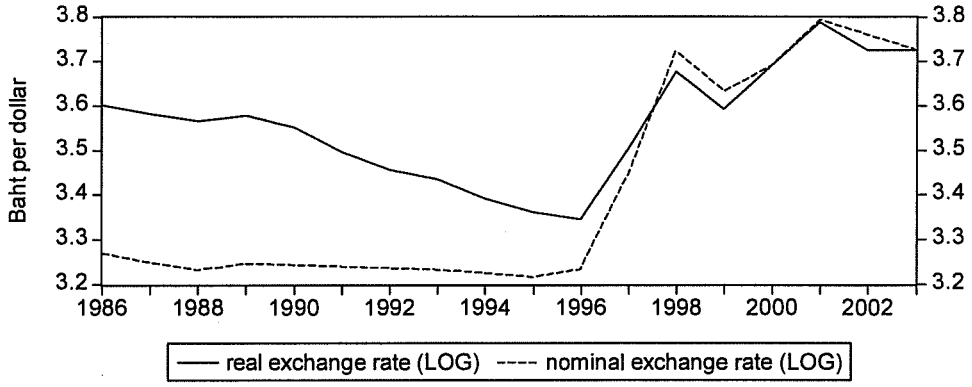
2.5 The misalignment of Japanese Yen:

Year	% Deviations from the BEER Rate
1986	-15.90%
1987	-12.35%
1988	-7.87%
1989	-8.12%
1990	-7.78%
1991	-6.21%
1992	-5.02%
1993	-8.22%
1994	0.21%
1995	2.60%
1996	-0.17%
1997	-1.65%
1998	-4.51%
1999	-1.35%
2000	0.80%
2001	-1.64%
2002	-2.46%
2003	-0.07%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

THAILAND:

3.1 The PPP approach: the real exchange rate and nominal exchange rate of the Baht against the U.S. dollar



3.2 The Unit Root Test:

Variable	Test Statistic	Critical Value at 5%
Real exchange rate (q)	-0.851679	-3.052169
Productivity (PROD)	-2.498485	-3.052169
Net foreign asset position (NFA)	-2.015833	-3.052169

3.3 The Cointegration test

Trace Test			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value
None	0.807844	41.52428	34.91
At most 1	0.528796	15.13307	19.96
At most 2	0.175809	3.093656	9.24

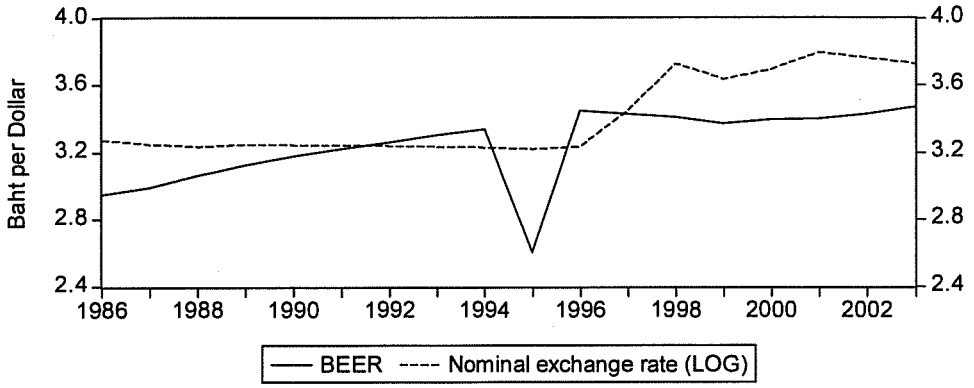
Trace test indicates 1 cointegrating equations at 5% level

Max-eigenvalue test			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value
None	0.807844	26.39120	22.00
At most 1	0.528796	12.03942	15.67
At most 2	0.175809	3.093656	9.24

Max-eigenvalue test indicates 1 cointegration equations at the 5% level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)			
LQ	NFA	PROD	C
1.000000	-0.007453	-0.683371	2.167207
	(0.00169)	(0.17145)	(1.38485)
Log likelihood: -11.52619			Std. error in parentheses

3.4 The BEER and the nominal exchange rate of the Baht against the U.S. dollar:



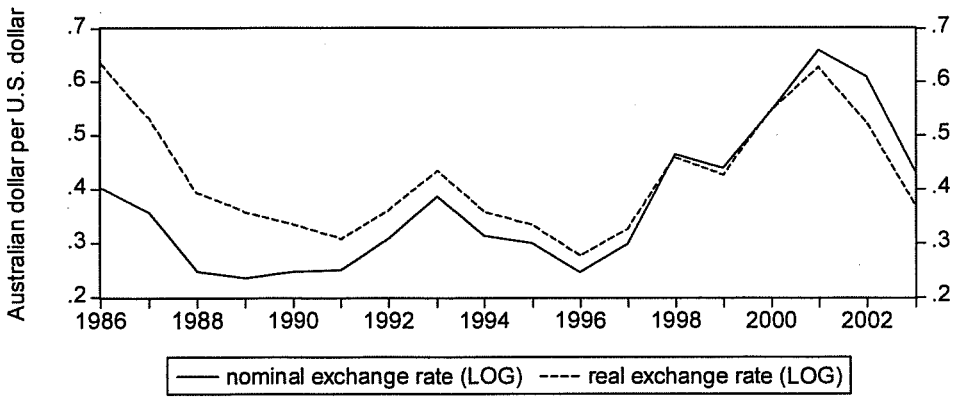
3.5 The misalignment of the Baht:

Year	% Deviations from the BEER Rate
1986	-10.85%
1987	-8.49%
1988	-5.50%
1989	-3.91%
1990	-2.02%
1991	-0.54%
1992	0.73%
1993	2.18%
1994	3.40%
1995	-23.59%
1996	6.19%
1997	-0.52%
1998	-9.19%
1999	-7.82%
2000	-8.78%
2001	-11.65%
2002	-9.64%
2003	-7.40%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

AUSTRALIA:

4.1 The PPP approach: the real exchange rate and nominal exchange rate of the Australian dollar against the U.S. dollar



4.2 The Unit Root Test:

Variable	Test Statistic	Critical Value at 5%
Real exchange rate (q)	-2.460552	-3.052169
Productivity (PROD)	0.696363	-3.052169
Net foreign asset position (NFA)	-2.608537	-3.052169

4.3 The Cointegration test

Trace Test			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value
None	0.802840	38.12463	34.91
At most 1	0.416974	12.14480	19.96
At most 2	0.197101	3.512419	9.24

Trace test indicates 1 cointegrating equations at 5% level

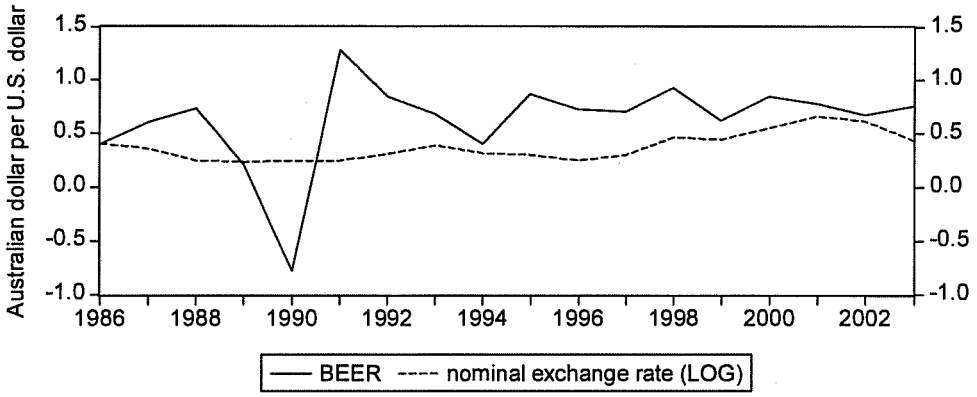
Max-eigenvalue test			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value
None	0.802840	25.97983	22.00
At most 1	0.416974	8.632384	15.67
At most 2	0.197101	3.512419	9.24

Max-eigenvalue test indicates 1 cointegration equations at the 5% level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)			
LQ	NFA	PROD	C
1.000000	-0.485112	-0.477028	4.398738
	(0.07853)	(0.34433)	(3.60051)

Log likelihood: 56.36107 Std. error in parentheses

4.4 The BEER and the nominal exchange rate of the Australian dollar against the U.S. dollar:



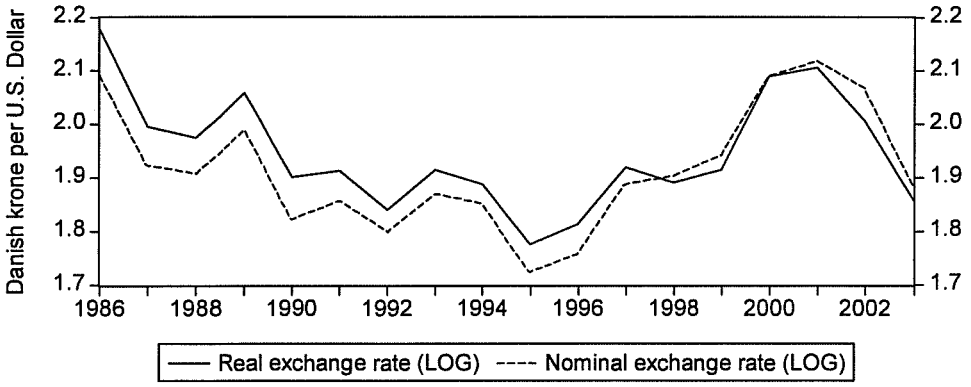
4.5 The misalignment of the Australian dollar:

Year	% Deviations from the BEER Rate
1986	0.65%
1987	40.86%
1988	66.20%
1989	-14.35%
1990	131.74%
1991	80.42%
1992	63.48%
1993	43.26%
1994	22.67%
1995	65.45%
1996	66.28%
1997	57.60%
1998	49.68%
1999	29.08%
2000	35.56%
2001	14.91%
2002	9.23%
2003	42.57%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

DENMARK:

5.1 The PPP approach: the real exchange rate and nominal exchange rate of the Danish krone against the U.S. dollar



5.2 The Unit Root Test:

Variable	Test Statistic	Critical Value at 5%
Real exchange rate (q)	-2.905419	-3.052169
Productivity (PROD)	-2.196022	-3.052169
Net foreign asset position (NFA)	0.893367	-3.052169

5.3 The Cointegration test

Trace Test			
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value
None	0.780140	42.12663	34.91
At most 1	0.579634	17.89039	19.96
At most 2	0.222382	4.024317	9.24

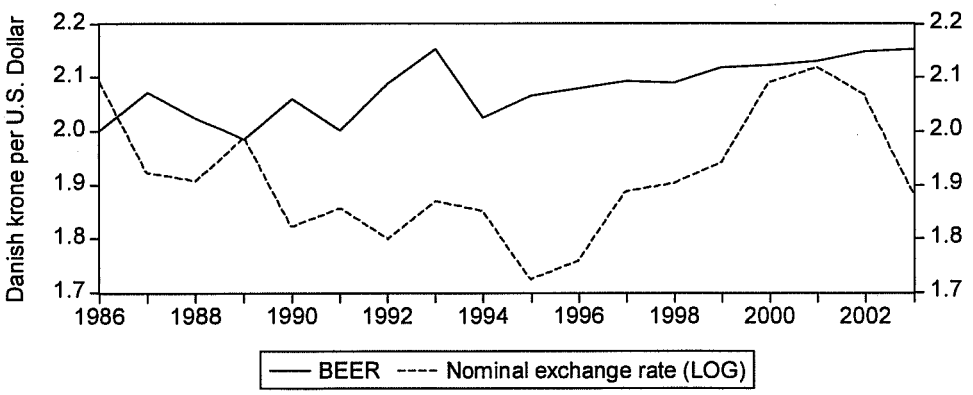
Trace test indicates 1 cointegrating equations at 5% level

Max-eigenvalue test			
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value
None	0.780140	24.23623	22.00
At most 1	0.579634	13.86608	15.67
At most 2	0.222382	4.023317	9.24

Max-eigenvalue test indicates 1 cointegration equations at the 5% level

Normalized Cointegrating Coefficients: 1 Cointegrating Equation(s)			
LQ	NFA	PROD	C
1.000000	-0.522610	-0.073472	3.562215
	(0.20890)	(0.03974)	(2.24199)
Log likelihood: 66.38628			Std. error in parentheses

1.4 The BEER and the nominal exchange rate of the Danish krone against the U.S. dollar:



1.5 The misalignment of the Danish krone:

Year	% Deviations from the BEER Rate
1986	-4.44%
1987	7.20%
1988	5.83%
1989	-0.19%
1990	11.53%
1991	7.30%
1992	13.90%
1993	13.18%
1994	8.68%
1995	16.58%
1996	15.49%
1997	9.78%
1998	9.00%
1999	8.28%
2000	1.53%
2001	0.55%
2002	3.81%
2003	12.42%

*A positive sign refers to an overvaluation of the currency and a negative sign refers to an undervaluation.

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