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A Triangular Analysis of Exchange Rate Determination and Adjustments
- The case of RMB, the US dollar and the euro

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A Triangular Analysis of Exchange Rate Determination and Adjustments[1]

- The case of RMB, the US dollar and the euro

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Abstract

Exchange rate determination is of phenomenal importance in international economic relations and should be scrutinized with diverse perspectives and from various points of view. While RMB is pegged to the US dollar, the exchange rate between RMB and the euro is not fixed, due to that the exchange rate between the euro and the US dollar is not fixed. Since RMB is not a small currency, its pegging to the US dollar would have a profound effect on the floating exchange rate between the US dollar and the euro, forcing the exchange rate between the US dollar and the euro to depart from a "fair" market determined rate if the exchange rate between the US dollar and RMB is not set right.

The above scenario provides us with a means to assess the fairness of exchanges rates resulting from pegs. Our analysis suggests that when RMB is overvalued relative to the US dollar, the euro would tend to be overvalued relative to the US dollar too, and vice versa. This in turn leads to a channel for examining whether RMB is undervalued or overvalued against the US dollar, an argument all stemming from the effective peg of RMB to the US dollar. It is to scrutinize the exchange rate of the US dollar vis-à-vis the euro to establish ultimately whether RMB is undervalued or overvalued vis-à-vis the US dollar. That is, an overvalued euro currency vis-à-vis the US dollar would imply a kind of overvaluation of RMB vis-à-vis the US dollar; or put it another way, an undervalued euro currency vis-à-vis the US dollar would justify that RMB is undervalued vis-à-vis the US dollar.

As a corollary derived from the above analysis, if the objective of the monetary authorities is to float RMB at the right exchange rate and at the right time, a triangular rotation approach to anchoring currencies can be appropriate. A peg of RMB to a basket of currencies is unfeasible, inconvenient and moreover, unable to avoid being criticized for pegging at an artificially low value as its peg to the US dollar. While it has been increasingly acknowledged that competitive advantages in international trade in the long run can rarely benefit from distorted exchange rates, a notion of currency undervaluation remains cumbersome.

Key words: exchange rate, RMB, US dollar, euro

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1.   Introduction

Balance of payments issues have always been matters of concern ever since international trade took place between nations. The exchange rate, together with its determination and adjustments, has always been one of the major factors that are perceived to have an effect on the improvement or deterioration in trade balance or the current account of the balance of payments. In this paper, we pay attention primarily to the determination of exchange rates and, specifically, to the determination of the right level of the exchange rate between RMB and the US dollar under the present arrangements and existing circumstances. Our starting point is an emphasis on the plain fact that RMB is a big currency, which rarely fit into any prevailing models that treat the currency under consideration in such a way that the currency and the associated economy do not influence the rest of world but are influenced by the rest of the world. Specifically, we bring the euro into play, developing a triangular analytical framework encompassing three currencies of comparable size, RMB, the US dollar and the euro. One of the arms of the triangle, the one between RMB and the US dollar, is rigid if not fixed, and the other two arms are flexible to change, mimicking the exchange rate arrangements between them. Moreover, interactions amongst them can be contemplated and assessed. The issue of whether RMB is undervalued or overvalued vis-à-vis the US dollar can then be established ultimately via scrutinizing the exchange rate of the US dollar vis-à-vis the euro. The paper then evolves to a corollary derived from the above analysis, a triangular rotation approach to anchoring currencies. We believe that there are more factors if not more important factors, other than exchange rate matters, playing a role in the improvement or deterioration in the balance of payments current account or trade balance. These include foreign direct investment (FDI) and other components on the financial account of the balance of payments, reserve currencies and consumption, among others, which are also scrutinized in the paper.

The rest of the paper is organized as follows. The next section presents and outlines the framework for the triangular analysis of exchange rate determination. Section 3 scrutinizes the exchange rate between the US dollar and RMB with the triangular

analytical framework developed earlier to assess whether RMB is undervalued or overvalued against the US dollar. Section 4 analyzes relevant factors that may influence trade balance and inspects certain background information and figures of bilateral trade and FDI on the financial account. Review of the pertinent approaches to balance of payments issues in the literature is also blended in this part. A triangular rotation approach to exchange rate arrangement is proposed and illustrated in Section 5, based on the analysis and discussion in the previous sections. Finally, Section 6 summarizes the study.

2.   Triangular Analysis of Exchange Rate Determination

The setting of our model is as follows. The exchange rate of RMB vis-à-vis the US dollar is 1\$:α¥; the exchange rate of the euro vis-à-vis the US dollar is 1€β\$; and the exchange rate of RMB vis-à-vis the euro is therefore 1€:γ¥ (γ = αβ). In other words, one US dollar can be converted to α RMB yuan, one euro to β US dollar and one euro to γ yuan. The analytical framework and the relationships are illustrated by Figure 1, with three vertexes of ¥, \$ and € and three arms ofα, β and γ linking the three vertexes.
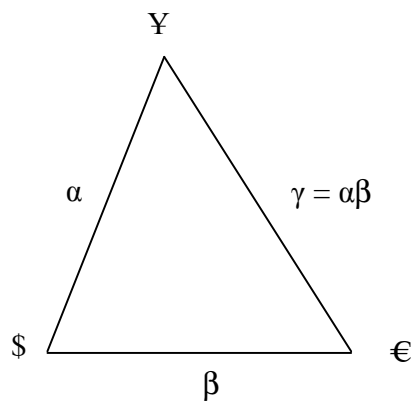
Figure 1. Triangular presentation of exchange rates and relationships

between €, \$ and¥

The exchange rate between RMB and the US dollar is pegged around α. The exchange rate between the euro and the US dollar is not fixed; β is variable, not a constant. Variation in α is much smaller than that in β. The exchange rate between RMB and the euro is therefore not fixed either. Since RMB is not a small currency, its pegging to the US dollar would have a profound effect on the floating exchange rate between the dollar and the euro, forcing the dollar euro exchange rate to depart from a "fair" market determined exchange rate. If the dollar depreciates against the euro, i.e., β increases, RMB would also depreciate against the euro. It can be demonstrated as follows:

> *Case 1*
>
> For example, α=8, β=1, γ=αβ=8 before the depreciation; i.e., 1\$=8¥, 1\$=1€,
> 1€=8¥. If \$ depreciates against € to 1€=1.2\$, then 1€~~γ¥~~=αβ¥=9.6¥.

But, it is not the whole story. RMB is not a small currency and its exchange rate against the euro, or any currencies other than the dollar, is not a passive response to changes in the dollar euro exchange rate; and the dollar euro exchange rate would have been changing in a different manner if RMB had not been narrowly linked to the dollar. RMB influences the dollar euro exchange rate through the flexible arm of the triangle, γ. Suppose that RMB is undervalued while the dollar is overvalued at the exchange rate α. If the exchange rate between the euro and the dollar is reasonable at the exchange rate β, then RMB is also undervalued relative to the euro at the exchange rate γ = αβ, to the same extent as it is undervalued relative to the dollar, if the fact that RMB is not a small currency is ignored. However, the RMB monetary authority cannot fix the exchange rate between RMB and the euro when RMB is effectively pegged to the dollar almost exclusively[2]. The extent to which RBM is undervalued relative to the euro would be

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[2] If the RMB monetary authority refers to the euro in setting the exchange rate to such an extent that γ is considerably different from the product of α and β, then either β is forced to adjust to β =γ/α and the no-arbitrage condition is restored soon between the three currencies if RMB is influential enough on the foreign exchange market, or it does not matter practically with regard to the exchange between the euro and dollar when RMB remains largely unconvertible, though it does matter with regard to the authority's RMB payment to and receipt from relevant parties. The monetary authority should, however, avoid the latter situation for the sake of policy credibility and consistency.

reduced so that β decreases to β', as demonstrated by Figure 2. At this point, the euro becomes undervalued relative to the dollar whereas the extent to which the euro is overvalued relative to RMB is reduced, as illustrated in the case below:

Case 2

Suppose α=8 is the right parameter for the \$:¥ exchange rate, i.e., 1\$ for 8¥ is the right exchange rate between the two currencies; suppose 1\$ for 1€ is the right exchange rate between \$ and €, and then 1€ for 8¥ is the right exchange rate between € and ¥. At α=10 or 1\$:10¥, ¥ is undervalued against \$ by 25%. ¥ is also undervalued against € by 25% at γ=αβ=10, without taking into account that ¥ is not a small currency. Since the ¥ monetary authority cannot fix the exchange rate between ¥ and € when ¥ is effectively pegged to \$ almost exclusively, the γ arm of the triangle is flexible to change under the influence of market forces which tends to revert the exchange rate to the right level. Then the €:¥ exchange rate would change and adjust to the distorted relationship between \$ and ¥, so that the extent to which ¥ is undervalued against € is smaller than that of the undervaluation of ¥ against \$. Suppose the quasi flexible €:¥ exchange rate is then 1€ for 9¥, ¥ is undervalued against € by 12.5%. At γ=9, β=γ/α= 9/10=0.9, i.e., 1€=0.9\$, indicating € is undervalued against \$ by 10%.
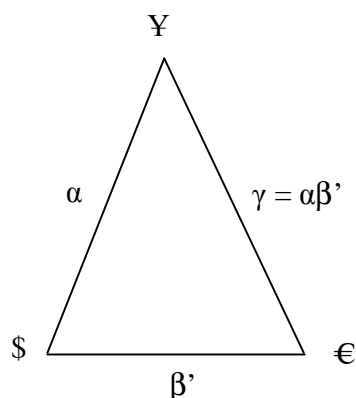
Figure 2. Exchange rate adjustments and interactions between €, \$ and ¥

One landmark is at the point where β' becomes small enough that the ¥:€ exchange rate is right and all the overvaluation of € on ¥ is removed and shifted to its undervaluation on $. The following shows one example of this kind:

> *Case 3*
>
> Continuing from the above example, at γ=8, β=γ/α=8/10=0.8, all the undervaluation of ¥ against € due to the undervaluation of ¥ against $ is removed and shifted to the undervaluation of € against $. In this case, 1€=8¥ and 1€=0.8$, with which € is undervalued against $ by 20%. That is, the consequence of the distortion in the $:¥ exchange rate is not shared between the distortions in the €:¥ exchange rate and €:$ exchange rate but is exclusively loaded on to the €:$ exchange rate.

These adjustments are shown in Figure 2. Further reduction in β would result in an overvalued RMB against the euro. In reality, the shift of overvaluation of the euro against RMB to its undervaluation against the dollar would depend on the relative significances of the three currencies in international trade and on the foreign exchange market, and on specific patterns in trade and capital flows.

The above analysis suggests that when RMB is overvalued relative to the dollar, i.e., α is too small, the euro would tend to be overvalued relative to the dollar, i.e., β'>β; when RMB is undervalued relative to the dollar, i.e., α is too large, the euro would tend to be undervalued relative to $, i.e., β'<β. This in turn leads to a means to examine whether RMB is undervalued or overvalued against the dollar, an argument all stemming from the effective peg of RMB to the dollar. It is to scrutinize the exchange rate of the dollar vis-à-vis the euro to establish ultimately whether RMB is undervalued or overvalued vis-à-vis the dollar. That is, an overvalued euro vis-à-vis the dollar would imply an overvaluation of RMB vis-à-vis the dollar or, put it another way, an undervalued euro vis-à-vis the dollar would justify that RMB is undervalued vis-à-vis the dollar.

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3.   Is RMB undervalued? Or is it overvalued?

Applying the triangular analytical framework developed in the previous section, the exchange rates between the three currencies of the euro, the dollar and RMB and their changes are scrutinized over various time periods and divided into pre and post July 2005, with the latter being further partitioned into two taking the financial crisis into account.

The euro was launched on the first day of January in 1999 at par with the US dollar; it lost ground against the dollar initially and then recovered gradually. By the end of January, it stood at almost the same level as at its launch with an exchange rate of $1.0056/€. For the next two years the euro remained below par with the dollar until it picked up at the end of 2002 at $1.0487/€. The euro had since stood above par with the dollar, peaking in the spring and summer of 2008 worthy nearly 1.6 dollars per euro, amid an escalating storming of the financial crisis. Our RMB euro exchange rates are from the PBC, starting in April 2002.

The world's economy enjoyed one of the remarkable prosperous periods since the new Millennium until the financial crisis and the western economies grew more or less at the same pace and performed similarly well in this period. If we take a par of the euro with the dollar to be about right, then it is inferred that the euro has been overvalued relative to the dollar since 2003 and the extent of overvalution has become greater and greater. If the above estimation is too modest about the value of the euro and if we conservatively place the euro dollar exchange rate estimation at $1.2/€, then a consistent overvaluation of the euro against the dollar set in motion from 2006. What do these patterns of euro dollar exhange rate movements tell us about the valuation of the RMB dollar exchange rate and the effect on the euro dollar ecchange rate?

The three pairs of exchange rates are plotted in Figure 3 over the period from April 2002 to March 2010, and in Figure 4 for the period between July 2005 and March 2010, the

latter being a more flexible peg regime of RMB[3]. Relevant summary statistics are reported in Table 1. Referring to the cases in section 2, we present two pieces of assessment of the RMB dollar exchange based on the two scenarios for the right or reasonable euro dollar exchange rate. With the first assessment one euro is valued at one dollar and the average euro dollar exchange rate between April 2002 and June 2005 is $1.1572/€, and the euro is overvalued by 15.72%, which indicates RMB is overvalued against the dollar by some 30% and against the euro by 15% approximately if the overvaluation of RMB is equally spreaded to the euro dollar relationship and RMB euro relationship. We may consider this assessment of the euro dollar exchange rate is too radical and therefore adopt the assessment in the second scenario that the right euro dollar exchange rate is about $1.2/€. This seems to be more reasonable and, indeed, the euro dollar exchange rate was settling down at around this level in spring/summer 2005, after a period of fluctuations with its peaking at $1.3621/€ by the end of 2004. What followed is interesting. The PBC announced/adopted managed floating in July 2005[4]. The RMB dollar exchange rate was managed to fall steadily and RMB appreciated vis-à-vis the dollar by 16.50% between July 2005 and March 2008, while the euro also appreciated vis-à-vis the dollar steadily by 27.42% in the same period. At $1.5812/€ in March 2008 the euro was obviously overvalued against the dollar by a large margin. Did the euro zone economy perform particularly well and much better than that of the US in this period? Or did the steady appreciation of RMB against the dollar assert momentous influence on the rise of the euro? If the answer is no to the first question and yes to the second, then an exchange rate of ¥8.2765/$ between RMB and the dollar was actually fairly right. Against this benchmark, by March 2008, RMB was overvalued against the dollar by 16.50% but was compensated by an 10.80% undervaluation against the euro; the dollar was undervalued against the euro by 27.42% as well as a 16.50% undervaluation against RMB; the euro was overvalued against RMB by 10.80% and in the meantime, overvalued

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[3] The IMF classification of the RMB de facto exchange rate regime is crawling peg dated February 25, 2009 with data as of April 2008, and conventional fixed peg dated December 22, 2006 with data as of July 2006 and dated July 18, 2006 with data as of December 2005. However, the date for changeover ought to be July 2005 according to changes in fluctuations in the exchange rate. Although the range of fluctuations was narrower than that defined by the IMF for another two years, it was much greater than that (zero standard deviation) of pre July 2005.

[4] See note 2.

against the dollar by 27.50%. Under such a scenatio, the dollar was towed down by the effective peg of an overvalued RMB and was undervalued overall, which seems to be reasonable. Table 2a submits the assessment of relative overvaluation and undervaluation of the three currencies in March 2008 and Table 2b submits the assessment for March 2010. ¥/$(1/2) indicates the extent of overvaluation (undervaluation) of RMB against the dollar if the overvaluation (undervaluation) affects the euro dollar exchange rate and the euro RMB exchange rate equally; ¥/$(2/3) indicates the extent of overvaluation (undervaluation) of RMB against the dollar if the overvaluation (undervaluation) affects the euro dollar exchange rate more (2/3) than the euro RMB exchange rate (1/3); ¥/$(1) indicates the extent of overvaluation (undervaluation) of RMB against the dollar if the overvaluation (undervaluation) affects the euro dollar exchange rate only. A negative (positive) sign means RMB overvaluation (undervaluation) relative to the dollar. Three fair euro dollar exchange rates are assumed, against which the assessment on the RMB dollar exchange rate is made. It can be inferred that by any conventional wisdom RMB was overvalued vis-à-vis the dollar as in March 2008, as was the euro. Depending on one's belief in the fair euro dollar exchange rate, RMB could be considered to be overvalued vis-à-vis the dollar by some 4%-20% in March 2010 if the fair exchange rate between the euro and the dollar is in the range of $1.2-1.3/€; or undervalued vis-à-vis the dollar by a single percentage digit if one thinks a fair euro dollar exchange rate is about $1.4/€, which seems unlikely.

Table 1. Summary statistics of exchange rates

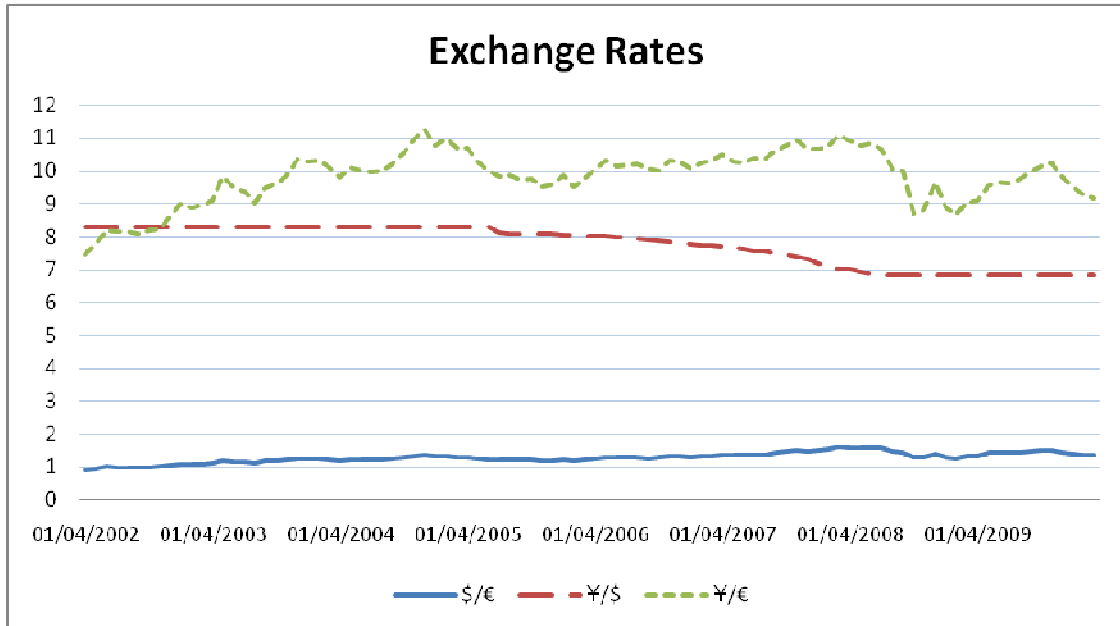|	Time period	$/€	¥/$	¥/€
Standard deviation	04/2002-03/2010	3.08%	0.40%	3.13%
	07/2005-03/2010	3.15%	0.41%	3.19%
	04/2002-06/2005	3.02%	0.00%	3.03%
Average	07/2005-03/2008	0.83%	-0.50%	0.33%
	07/2005-03/2010	0.24%	-0.34%	-0.10%
	04/2008-03/2010	-0.57%	-0.11%	-0.70%
Cumulative	07/2005-03/2008	27.42%	-16.50%	10.80%
	07/2005-03/2010	13.63%	-19.18%	-5.91%
	04/2008-03/2010	-13.79%	-2.68%	-16.71%

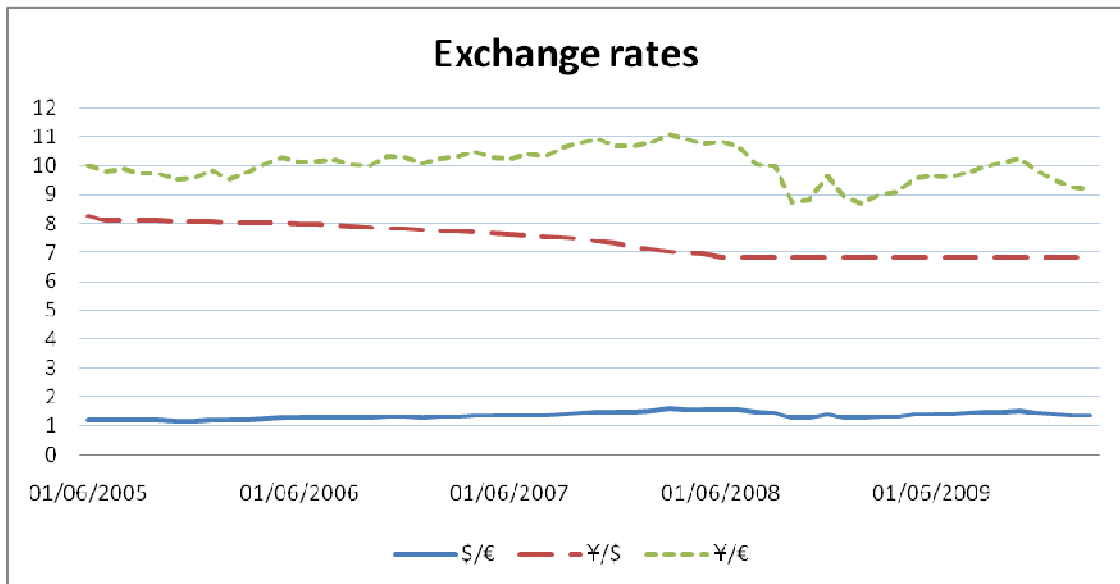**Figure 3.** Movements of exchange rate pairs between €, $ and¥: 2002-2010

Figure 4. Movements of exchange rate pairs between €, $ and¥: 2005-2010

Let us inspect the relevant summary statistics of exchange rates over the whole period and the pertinent sub-periods in Table 1. The correction or reversion in the euro dollar exchange rate started in April 2008, marked by Bear Stearn's collapse and sale to JP Morgan Chase. The euro depreciated against the dollar by 13.79% since then, offsetting half of its gain of 27.50% against the dollar from July 2005 and netting a 13.63% appreciation for the period from July 2005 to March 2010. RMB appreciated against the dollar by a small amount of 2.68% in 24 months from April 2008 to March 2010, in contrast to a significant appreciation of 16.50% in 33 months from July 2005 to March 2008; whereas RMB apppreciated against the euro by 16.71% in 24 months from April 2008 to March 2010. After the corrections in the foreign exchange rates, RMB was overvalued against the dollar by 19.18% and overvalued against the euro by 5.91%; the overvaluation of the euro against the dollar dropped to 13.63% while having a 5.91% undervaluation against RMB; the dollar was 19.18% overvalued against RMB but was undervalued against the euro by 13.63%. On average, RMB appreciated against the dollar by 0.34% per month and appreciated against the euro by 0.10% per month from July 2005; while the euro appreciated against the dollar by 0.24% per month in the same period.

The standard deviation of the RMB dollar exchange rate is much smaller than that for the euro dollar exchange rate and for the RMB euro exchange rate. Actually the standard deviation of the RMB euro exchange rate is slightly larger than that of the euro dollar exchange rate, reflecting the fact of RMB's one sided steady small change against the dollar post July 2005; and the two standard deviations have hardly changed post July 2005. With these figures of exchange rate fluctuations, it is hardly convincing that any currency, other than the US dollar in the basket of reference currencies, has a role in RMB exchange rate changes since 2005, without the need to know the reference currencies in the basket and their weights that are rightly conventionally kept undisclosed. Nevertheless, RMB does have fluctuated against the US dollar since then, though steady and gradual appreciation is almost solely intended.

Table 2a. Assessment of currency valuation: March 2008

Fair exchange rate of $/€	$/€	¥/$(1/2)	¥/$(2/3)	¥/$(1)
$1.3/€	21.63%	-43.26%	-32.45%	-21.63%
$1.4/€	12.94%	-25.89%	-19.41%	-12.94%
$1.5/€	5.41%	-10.83%	-8.12%	-5.41%

Table 2b. Assessment of currency valuation: March 2010

Fair exchange rate of $/€	$/€	¥/$(1/2)	¥/$(2/3)	¥/$(1)
$1.2/€	12.33%	-24.65%	-18.49%	-12.33%
$1.3/€	3.68%	-7.37%	-5.53%	-3.68%
$1.4/€	-3.72%	7.44%	5.58%	3.72%

To conclude this section's analysis, RMB is unlikely to be significantly undervalued or overvalued in the short to medium terms, due to the flexible arm between the dollar and the euro, unless the euro dollar exchange rate is also significantly distorted, as shown in Table 2; or worse still, the euro dollar exchange rate is distorted to a substantial extent by RMB's valuation. Bear also in mind that the value of RMB reflected by its dollar exchange rate is far from being detached from its real value or purchasing power, relative to the likely distortions in exchange rates between other currencies. Further, the RMB exchange rate is unlikely to matter significantly in the long run due to adjustments in other variables; it can well be settled down or may have swung to the other side of valuation in terms of economics, as in the cases of Germany and Japan decades ago, before the lingering argument fades away geo-politically. Competitive advantages in international trade in the long run can rarely benefit from distorted exchange rates. Large swings in commodity prices and trade tariff measures have much greater impact on the national economy and the profitability of companies. But a notion of currency undervaluation seems to be more problematic than the problem itself. In a sense, dispelling the notion of currency undervaluation appears more critical than solving the problem, which may or may not exist.

4.   Analysis of factors that influence trade balance

Accompanied with flows of goods and services are flows of funds or capital. Thereby improvement or deterioration in trade balance or the current account is associated with certain patterns in international flows of capital or changes on the capital and financial account of the balance of payments. As one of the channels that facilitate international trade and fund movements is the foreign exchange market, changes in the exchange rate, depreciation or appreciation of a currency, have been claimed to have a significant effect on trade balance and profound implications for the balance of payments, as often observed in the news, economic commentaries and financial columns. Therefore, major approaches dealing with balance of payments issues have been developed over decades, including those that study explicitly the effect of exchange rate changes on the balance of payments, together with those where exchange rate changes do not play an explicit role in balance of payments issues. The former is represented primarily by the elasticity approach and the absorption approach, and the latter by the monetary approach to the balance of payments. A new approach to balance of payments issues has been proposed by analyzing of the components of the financial account and, in particular, paying attention explicitly to the different roles of FDI and international portfolio investment (IPI). This is in response to, and an acknowledgment of, a noticeably changed international economic environment that is rather different from those in which the above-mentioned three approaches came to light and were applied.

The elasticity approach to the balance of payments features a Keynesian analysis. This approach is based on the analysis of the price elasticity of demand for export goods and that of demand for import goods, with respect to changes in exchange rates. Therefore, this approach is all about the current account of the balance of payments, paying no attention to the capital and financial account of the balance of payments. Although the model is on the interaction between the exchange rate and the current account balances, it is largely applied to evaluate the effect of currency depreciation or currency appreciation on the balance of payments current account. In particular, it is applied to examine if a kind of currency depreciation helps improve current account balances. The approach is

most featured by the Marshall-Lerner condition (Marshall 1923; Lerner 1944), which states that for depreciation of the domestic currency to be effective in terms of improving trade balance, the sum of the export elasticity and the import elasticity must be greater than unity.

The absorption approach studies the effects of exchange rate changes on income, relative prices, absorption and trade balance. It is mainly advocated by Alexander (1952), Harberger (1950), Laursen and Metzler (1950) and Meade (1951a,b). According to the name of the approach, it investigates the effect of exchange rate changes on trade balance through the absorption channel whereby income and relative prices change and adjust. Quantitatively, a change in the exchange rate which leads to an increase in absorption worsens trade balance, and a change in the exchange rate which leads to a decrease in absorption improves trade balance, other things being equal and unchanged.

The main characteristic of the monetary approach to the balance of payments, as summarized by Frenkel and Johnson (1976) in the first sentence of the first chapter of their edited book entitled The Monetary Approach to the Balance of Payments, is the proposition that the balance of payments is essentially a monetary phenomenon. This is basically the statement of the Chicago School, though Frenkel and Johnson (1976) claim that the approach is described as monetary, not monetarist, with its essential foundation disposing of the criticism that it is not a theory but merely a tautology like the quantity theory of money, old and restated. Contributions to the monetary approach and its development also come from the IMF, such as Polak (1957), Prais (1961), Polak and Argy (1971) and the IMF (1977), as reviewed by Polak (1997). The two monetary approaches to the balance of payments, Keynesian versus Johnson, are contrasted in Polak (2001), to which interested readers can refer.

The elasticity and absorption approaches do not take into account the role of the financial account. While the monetary approach does consider the financial account, it focuses on official reserves and domestic credit and how they influence trade balance. Particularly in Johnson's model, trade balance is merely changes in reserves whereby balance on the

financial account exclusive of changes in official reserves is not considered. This might be acceptable four decades ago, especially with a fixed exchange rate regime, but has become increasingly unrealistic ever since. Balance on the financial account exclusive of changes in official reserves is no longer negligible or inconsequential, and can no longer be overlooked. For instance, the US financial account balance is predominantly private sector activity. Amongst $1,289,854 million US owned net assets abroad in 2007, official reserves and other government assets only accounted for two percent with a figure of $22,359 million. In the same year, foreign owned net assets in the US mounted to $2,057,703 million with $411,058 million being foreign official assets that accounted for 20 percent of the total.

It is apparent that nowadays trade balance deficits or surpluses are, to the greatest extent, offset or balanced by the non-official parts of the financial account. They are not offset or balanced by official reserves, which become negligible in quantity from the debit side of the US financial account, and indeed of other countries adopting a flexible exchange rate regime. Therefore, attention should be paid to the non-official reserve parts of the financial account as they are predominantly the largest on the financial account. Moreover, the composition and constituents of the financial account matter for the roles of FDI and IPI differ in countries' international economic relations, with different effects of FDI and IPI on trade and trade balance in particular. Intuitively, inward FDI produces import substitution when previously imported goods and brands are manufactured locally, hence reducing imports and improving trade balance. To a certain extent, FDI financed companies tend to be export-oriented, and for this reason inward FDI may promote exports and improve trade balance. The import substitution effect and the export promotion effect of inward FDI may not be associated with IPI activity. Most companies that attract foreign investors in terms of IPI are large and/or multinational. Inward IPI may help their international activity or expansion overseas and, consequently, reduce other countries' import requirements and boost other countries' exports, which have a negative effect on the reporting economy's exports and trade balance. Inward IPI may also have an income effect on imports, which deteriorates trade balance. Therefore, attention should be paid to the analysis of the components of private investments on the

financial account, in addition to paying attention to the private investment activity on the financial account as a whole.

According to Table 3 with figures from World Trade Organization (WTO), China's exports to the US have increased from $42.0 billion in 1999 to $308.2 billion in 2008; while China's exports to the EU have increased more than 10 fold in the same 10 years period from $32.1 billion in 1999 to $351.7 billion in 2008. In the same period, China's imports from the US have increased from $19.5 billion in 1999 to $81.7 billion in 2008; while China's imports from the EU have increased from $25.8 billion in 1999 to $132.8 billion in 2008. The EU overtook the US as China's largest trading partner in 2007 and remained so in 2008, and it is similarly important to China compared with the US in terms of bilateral economic relations, which justifies our analysis in Section 2 and Section 3. The EU runs a trade deficit with China though the deficit is not as large as the US trade deficit with China, albeit Germany enjoys a surplus in trade with China. On the other hand, Japan has always run a trade surplus with China, with its exports to China increasing from $54.1 billion in 1999 to $150.6 billion in 2008 and its imports from China increasing from $32.4 billion in 1999 to $138.5 billion in 2008. The contrast in patterns between China's trade with the US and that with Japan suggests that the exchange rate is not a major cause to US trade deficits – if RMB is undervalued against the US dollar and the exchange rate between the Japanese yen and the US dollar is rightly determined by the market force, RMB would also be undervalued against the Japanese yen, but Japan still runs a trade surplus with China.

Table 3. Merchandise trade by region and selected economies 1998-2008
      - China ($ billion)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Exports											
United States	38.0	42.0	68.2	71.1	91.4	119.2	159.7	204.9	255.0	289.4	308.2
European Union (27)	29.8	32.1	49.1	53.4	64.7	96.5	134.4	178.3	231.4	299.2	351.7
Japan	29.7	32.4	44.3	49.0	55.3	70.8	89.6	102.4	112.0	124.8	138.5
Imports											
United States	16.9	19.5	22.4	26.2	27.3	33.9	44.8	48.7	59.3	69.5	81.7
European Union (27)	20.9	25.8	31.3	36.4	39.8	55.0	70.5	74.0	90.6	110.9	132.8
Japan	47.6	54.1	41.5	42.8	53.5	74.1	94.3	100.4	115.7	133.9	150.6

Source: WTO

Let us now turn to FDI. Table 4 presents US outward FDI into China and China's outward FDI into the US since 2002 with figures from the Bureau of Economic Analysis (BEA) of the US. On average the US FDI into China is 35 times of China's FDI into the US. China's FDI in the US is negligible, compared with the US FDI in China. Stood at $45,695 million in 2008, it accounted for 20% of US trade deficit with China. Moreover, China's international investment in the US is primarily IPI, which further fuels US MNCs expansions overseas, China included. Taking into account the effect of outward FDI and IPI on export promotion and import substitution, this pattern of imbalance in FDI and IPI flows may explain most concerns in trade imbalance.

Table 4. FDI between China and US ($ million)

	2002	2003	2004	2005	2006	2007	2008
US FDI to China	10570	11261	17616	19016	26459	28579	45695
China's FDI to US	385	284	435	574	785	916	1235

Source: BEA

Another factor to cause US trade deficit with China is the well known Triffin dilemma or paradox (Triffin 1960) that the role of the US dollar as reserve currency or anchor currency has attributed to US balance of payments problems, as the US has to run deficits on the current account of the balance of payments to supply the world with US dollars as reserves. With this dilemma, the US trade deficit seems to be inevitable in the current system and under the current arrangements. This study does not deliberate on this issue, which can be viewed from various sources, including, but not limited by, Heldring (1988) who also raised the question "can the US dollar survive as a world reserve currency?"

5.   A triangular rotation approach

The overtaking of the US by the EU as China's largest trading partner, a noticeably changed international economic environment and the above dilemma, amongst others, call for new RMB exchange rate arrangements. The analysis in Section 3 demonstrates that the extent to which RMB is undervalued (overvalued) against the euro would be smaller than that to which RMB is undervalued (overvalued) against the dollar if the euro dollar exchange rate is largely determined by the market force and fair; or an undervaluation (overvaluation) of RMB against the dollar can be associated with an overvaluation (undervaluation) of RMB against the euro but to a smaller extent.   A corollary derived from the above analysis is a triangular rotation approach to anchoring currencies, i.e., to switch from pegging the dollar to pegging the euro and rotate the pegging between them subsequently, which may serve more than one purpose. The approach may help determine and then reduce the extent to which RMB is overvalued (undervalued), if the attainment of a fair exchange rate is aimed. It may help find out whether RMB is undervalued or actually it is overvalued against the dollar. Last but not least, it may help float RMB at the right exchange rate and at the right time, if a freely convertible RMB is favored ultimately.
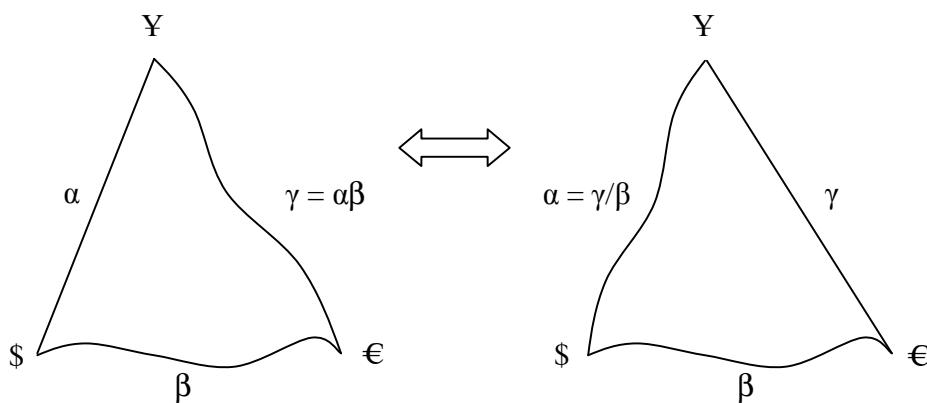
Figure 5. Triangular rotation approach to pegging between $ and €

Figure 5 demonstrates the triangular rotation approach. A curved line linking two currencies indicates the exchange rate between the two currencies is flexible to change, while a straight line linking two currencies implies a rigid exchange rate between them. On the left hand side, RMB is pegged to the dollar, and on the right hand side it is pegged to the euro. Suppose RMB is overvalued vis-à-vis the dollar by 12.5%. The scenario, adjustments and results are exhibited in the following example:

Case 4

Suppose α=8 is the right $:¥ exchange rate; suppose 1.25$ for 1€ is the right exchange rate between $ and €, and then 1€ for 10¥ is the right exchange rate between € and ¥. At α=7 or 1$:7¥, ¥ is overvalued against $ by 12.5%, which causes the €:$ exchange rate and €¥ exchange rate to deviate to 1€:1.5$ and 1€:10.5¥. € is overvalued against $ by 20% and ¥ is undervalued against € by 5%. The system is in equilibrium.

The pegging of RMB can then be switched to the euro at the exchange rate of 1€:10.5¥, leading to a cycle of adjustment. The RMB dollar exchange rate is up to 1$:7.5¥, the overvaluation of RMB being reduced to 6.25%; and the dollar euro exchange rate is down to 1€:1.4$, representing a reduced overvaluation of 12% of the euro relative to the dollar. The two pairs of exchange rates of $:¥ and €:$ are settled down, following a period of adjustment after the pegging of RMB is switched to the euro, and the system is in a new equilibrium.

In the next cycle, the pegging of RMB is switched back to the dollar at the exchange rate of 1$:7.5¥, resulting in adjustments in the €:$ exchange rate and €¥ exchange rate. The RMB euro exchange rate is down to 1€:9.675¥, turning a 5% undervaluation of RMB to a 3.25% overvaluation. The dollar euro exchange rate is down to 1€:1.29$, the overvaluation of the euro relative to the dollar is reduced to 3.2%.

In the third cycle, the pegging of RMB is switched to the euro again at the exchange rate of 1€:9.675¥, causing the €:$ exchange rate and $:¥ exchange rate to adjust. The RMB dollar exchange rate is further up to 1$:7.8659¥, the overvaluation of RMB being further reduced to 1.68%; and the dollar euro exchange rate is down to 1€:1.23$, turning the overvaluation of the euro into a small undervaluation of 1.6% relative to the dollar.

The above case demonstrates that all three exchange rates converge to their fair values following several rounds of triangular rotations. This triangular rotation approach to anchoring currencies is therefore appropriate and feasible to achieve the objective of floating RMB at the right exchange rate.

6.   Summary

A triangular analytical framework for exchange rate determination has been developed in this study involving three currencies of comparable size, RMB, the US dollar and the euro, mimicking the exchange rate arrangements between them. Applying this analytical framework, the study has then examined the exchange rate between the US dollar and RMB via scrutinizing the exchange rate of the US dollar vis-à-vis the euro, to establish whether RMB is overvalued or undervalued against the US dollar. By any conventional measures the euro appears to be overvalued vis-à-vis the US dollar, leading the study to suggest that RMB is also overvalued vis-à-vis the US dollar.

It has been maintained that there are more factors and more important factors, other than exchange rates, playing a role in the improvement or deterioration in the balance of payments current account or trade balance. To this end, bilateral imports and exports figures, and patterns in international capital flows with specific reference to FDI, among others, are inspected in the study to find out the causes to trade imbalance. The pattern of imbalance in FDI and IPI flows may explain most concerns in trade imbalance between China and the US.

A triangular rotation approach to pegging currencies has then been put forward as a corollary derived from the triangular analysis of exchange rate determination. It has been demonstrated that distorted exchange rates converge to their fair values gradually, following several rounds of triangular rotations. Therefore, a kind of triangular rotation approach can be appropriate and may help achieve the objective of floating RMB at the right exchange rate above all, in addition to its functions for discovery of fair exchange rates and reduction in currency undervaluation or overvaluation. While the RMB exchange rate is unlikely to matter significantly in terms of economics, adopting a floating exchange rate regime seems beneficial to let the lingering argument on currency undervaluation fade away geo-politically.

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