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Is the yen undervalued?

SaangJoon Baak

Professor
School of International Liberal Studies
Waseda University

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ECONOMIC RESEARCH INSTITUTE FOR NORTHEAST ASIA

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SaangJoon Baak

Professor
School of International Liberal Studies
Waseda University, 1-6-1 Nishi-Waseda, Shinjuku-ku, Tokyo 169-8050, Japan email:
baak@waseda.jp

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Abstract

This paper measures to what extent the real effective exchange rate of the Japanese yen is misaligned from its equilibrium value by estimating the equilibrium value using the behavioral equilibrium exchange rate (BEER) approach. The economic fundamentals such as the terms of trade, the relative price of non-traded to traded goods, and real interest rate differentials are employed to assess the equilibrium exchange rate. The estimation results using the quarterly data from 1990Q1 to 2014Q4 indicate that the actual exchange rate of the Japanese yen was substantially overvalued from 2008Q4 to 2012Q4. In contrast, it was not substantially misaligned from the equilibrium values from 2013Q1 to 2014Q4.

JEL Classification: C22, F31
Keywords: Japanese yen, misalignment, behavioral equilibrium exchange rate

1. Introduction

Since late 2012 when the Japanese government started to implement a QE (Quantitative Easing) monetary policy aggressively, the quarterly average exchange rate of the Japanese yen has changed from 78.6 yen per dollar in the 3rd quarter of 2012 to 102.1 in the 2nd quarter of 2014, implying the value of the yen depreciated by around 30% within 2 years. Since the currency values of Japan's major trading partners have not changed so drastically for the same period, the real effective exchange rate of the yen also sharply depreciated.

The sharp depreciation of the Japanese yen provoked concerns in neighboring countries that are competing with Japan in the global market. Their major concern is that cheaper Japanese products might crowd out the products of Japan's competitors in the global market. The following quotation from the Wall Street Journal shows such a concern: *South Korea Urges Japan Not to Rely on Yen Weakness. Finance Minister Says Tokyo Should Instead Focus on Structural Reforms to Boost Economy (Wall Street Journal, Feb. 21, 2014).*

Despite the complaints of other Asian countries, however, the recent depreciation does not necessarily indicate that the Japanese yen is substantially undervalued. Rather, it might be a way to return to its equilibrium value following a sharp appreciation during the global economic crisis. As Figures 1-1 and 1-2 illustrate, the Japanese yen appreciated between 2008Q1 and 2011Q4 by as much as its recent depreciation.

<Insert Figures 1-1 and 1-2>

Against the background, this paper aims to determine whether and to what extent the real effective exchange rate of the Japanese yen is misaligned from its equilibrium value as determined by Japan's economic fundamentals. To this end, this paper estimates the equilibrium value of the Japanese yen using the behavioral equilibrium exchange rate (henceforth BEER) approach of Clark and MacDonald (1998, 1999). Examples of recent articles which have examined East Asian currency values adopting the BEER approach are Funke and Rahn (2005), Bénassy-Quéré & Lahrèche-Révil (2008), Kinkyo (2008), Koske (2008), Yajie, Xiaofeng and Soofi (2007), and Zhang and Chen (2014) among others.

The following section briefly outlines the BEER approach. Section 3 presents the specific form of the exchange rate equation used in the present paper and its estimation results along with a description of how the data was obtained and computed. The last part of section 3 reports the measured misalignments.

2. The BEER approach

Based on the risk adjusted interest parity condition, the BEER approach of Clark and MacDonald (1998) derives the following reduced form equation:[1]

$$q_t = \beta' Z_t \qquad (1)$$

where q_t is the real equilibrium exchange rate expressed as the foreign currency price of a unit of domestic currency. Z_t is a vector of some economic fundamentals, the real interest rate differential, and the risk premium. β is a vector of coefficients. Based on the findings of Faruqee (1995) and MacDonald (1997), Clark and MacDonald (1998) propose to employ three variables as economic fundamentals: the terms of trade, the relative price of non-traded to trade goods, and the net foreign assets (relative to GDP).

When empirical tests and computations are implemented in the following section of the present paper, Z_t is specifically assumed to be a vector of the terms of trade, the relative price of non-traded to trade goods, the moving average of the current account balance (relative to the trade volume) and the real interest rate differential.

The net foreign assets is not included in the equation in the following section, considering it has continuously increased in Japan for the period covered by the present research. Instead, the current account balance relative to the trade volume is used.

Clark and MacDonald (1998) used the government debt as a proxy for the risk premium, but the coefficient values of the proxy estimated for the US, Germany and Japan were insignificant and/or had wrong signs while most of the estimated coefficient values of the other explanatory variables were significant and had expected signs across the three countries. Recent papers such as Koske (2008) and Funke and Rahn (2005), Yajie,

[1] See Clark and MacDonald (1998, pp.15-16) for a more detailed explanation.

Xiaofeng and Soofi (2007) and MacDonald and Dias (2007) did not include the risk premium in their models, either. In fact, the data for the government debt are available only on the yearly basis, therefore, cannot be used in this paper in which quarterly data are analyzed. In addition, just like the net foreign asset, the government debt of Japan has continuously risen for the period covered in the research. Therefore, it is not expected to play a significant role in explaining the dynamics of the Japanese exchange rate that have been quite fluctuating.

In the meantime, the actual real exchange rate, $\tilde{q}_t$, is assumed to be a function of the following form:

$$\tilde{q}_t = \beta' Z_t + \tau' T_t + \varepsilon_t \qquad (2)$$

where T_t is a vector of transitory factors which also affect the real exchange rate, and ε_t is a disturbance term. τ is a vector of coefficients.

Accordingly, the deviation of the actual exchange rate from the equilibrium is measured by $\tilde{q}_t - q_t = \tau' T_t + \varepsilon_t$. Clark and MacDonald (1998) name this deviation "current misalignment."

In addition, the long-run equilibrium exchange rate, $\bar{q}_t$, is assumed to be determined by the long-run values of economic fundamentals:

$$\bar{q}_t = \beta' \bar{Z}_t \qquad (3)$$

where $\bar{Z}_t$ is the long-run values of economic fundamentals. Because the current values of the economic fundamentals (variables in the vector, Z_t) may deviate from their sustainable levels, Clark and MacDonald (1998) distinguish the current equilibrium exchange rate (q_t), which is determined by the current values of economic fundamentals (Z_t), from the long-run equilibrium exchange rate ($\bar{q}_t$), which is determined by the long-run values of economic fundamentals ($\bar{Z}_t$). Practically, in the work of Clark and MacDonlad (1998), and in subsequent papers that also have estimated the BEERs, the long-run equilibrium values of economic fundamentals were obtained using the Hodrick-Prescott filter. The 'total misalignment' is defined to be $\tilde{q}_t - \bar{q}_t$.

3. Estimating the BEER Equation and Measuring Misalignments

The BEER equation, or Equation (1) is estimated using conventional time series econometric tools, and the equilibrium exchange rate and the long-run equilibrium exchange rate are computed using the estimation results. This paper uses the quarterly data covering the period from 1990Q1 to 2014Q4 to estimate the BEER equation, to compute the equilibrium exchange rates and to measure exchange rate misalignments. The following subsection (section 3.1) presents the specific form of the estimation equation and provides a detailed description of the variables in the equation. In addition, the data used to calculate each variable and data sources are also revealed in the section. Section 3.2 presents the empirical test and estimation results. Finally, Section 3.3 illustrates the measured misalignments in Japanese real effective exchange rates.

3.1. The BEER equation and data

The BEER equation and the variables

The specific form of the BEER equation estimated in this paper is the following:

$$LQ = \beta_0 + \beta_1 LTOT + \beta_2 LTNT + \beta_3 RR + \beta_4 CB + \varepsilon \qquad (5)$$

where LQ is the log value of Q which is the real effective exchange rate, and LTOT is the log value of TOT which is the terms of trade. LTNT is the log value of TNT which is the relative price of non-traded to trade goods, RR is the real interest rate differential, and CB is the moving average of the current account balance relative to the trade volume.

The real effective exchange rate, Q, is the CPI (consumer price index)-based real effective exchange rate of the Japanese yen. It is calculated through the following procedure: First, the real exchange rates between the Japanese yen and each currency of Japan's twelve major trade partners are calculated using the nominal exchange rates and CPI data.[2] The real exchange rate is defined to be the foreign currency price of a unit of the Japanese yen.

[2] PPI or WPI can be considered as a replacement of CPI. But, according to Chinn (2006, p.120) the items included in the construction of PPI or WPI are more diverse across countries than the items in CPI. Besides, PPI and WPI may include 'a large component of imported intermediate goods,' which makes PPI and WPI deviate from a good measure of competitiveness. Clark and Macdonald (1998), Kinkyo (2008), Koske (2008) also used CPI.

Therefore, a decrease in the real effective exchange rate calculated using the bilateral real exchange rates means a depreciation of the Japanese yen, unlike the nominal exchange rate of the Japanese yen against the US dollar whose decline means an appreciation of the Japanese yen. The twelve major trade partners (Australia, Canada, China, Hong Kong, Indonesia, South Korea, Malaysia, Singapore, Thailand, UK, US, and the Euro area) are selected on the basis of their shares in the Japanese imports and exports from 1990 to 2014. As illustrated in Figure 2, the share of the twelve countries in the total Japanese trade volume (exports and imports) has never been below 55% since 1990.

<Insert Figure 2>

Second, bilateral real exchange rates are converted into indices whose base year is 2005. Finally, the weighted geometric average of the indices of the twelve major trade partners is calculated. Not to confuse the reader, it should be noted that the weight of a trade partner is different from its share in the total Japanese trade volume. Its weight is the relative share in the Japanese trade only with the twelve countries selected. Considering the drastic changes in their shares in the Japanese trade volume, the weights are not fixed at a base year, but they are computed for each year.

The terms of trade, TOT, is the ratio of the export unit value to the import unit value relative to the trade-weighted ratio of the twelve major trading partners. That is, the terms of trade of Japan is divided by the weighted average of the terms of trade of the twelve countries.

The effect of the terms of trade on the equilibrium exchange rate is not certain. On one hand, a rise in the terms of trade (for example, a rise in the export price with the import price being constant) improves the current account balance, hence may lead to a real appreciation of the currency value in order to restore equilibrium. On the other hand, a rise in the terms of trade (for example, a decline in the import price with the export price being constant) may induce a shift in demand from future consumption to current consumption. As a result, a decline in the current account balance may lead to a real depreciation of the currency value. Therefore, depending on the relative size of the two contradicting effects, the sign of β_1 may be either positive or negative. Clark and MacDonald (1998) report significantly positive estimates of β_1 for the US and Japan, and an insignificantly positive estimate for Germany. In contrast, Kinkyo (2008) reports a significantly negative value as the estimate of β_1 for Korea.

The relative price of non-traded to trade goods, TNT, is the ratio of consumer price index (CPI) to producer price index (PPI) relative to the twelve major trading partners. That is, the Japanese ratio of CPI over PPP is divided by the weighted average of the same ratios of the twelve trading partner countries..

Following Clark and MacDonald (1998) and Kinkyo (2008), this explanatory variable is included to capture the Balassa-Samuelson effect.[3] The CPI is a proxy for the price level of the non-tradable sector, while the PPI is a proxy for the price level of the tradable sector. According to Balassa (1964) and Samuelson (1964), the real exchange rate should be negatively related to the relative productivity of the non-tradable goods sector to the tradable goods sector. As the movements of relative productivity between the two sectors are negatively connected to the relative price between the two sectors, the relative price of non-traded to trade goods is believed to have a positive relationship with the real exchange rate. Therefore, the sign of β_2 is expected to be positive.

In addition, RR is the differential between Japan's real interest rate, r_t, and the foreign real interest rate, r_t^*. The real interest rate is defined to be the average annual government bond yield minus the CPI-based inflation rate. The findings of MacDonald and Nagayasu (1997), Meredith and Chin (1998) and Alexius (2001) show that interest rate parity holds better at long horizons. Therefore, in the present paper, long-term government bond yields are used as the Japanese and foreign interest rates to calculate the real interest differential, RR. The US real interest rate is used as the foreign real interest rate.

In the meantime, it should be noted that we tried to use a weighted average of real interest rates of the major trading partners of Japan as the foreign real interest rate, r_t^*, in our various estimation experiments which are not reported in the present paper. Due to the lack of the data of long-term government bond yields of five countries, the weighted average of real interest rates was calculated using the data of the following seven countries: Australia, Canada, Korea, Thailand, UK, US, and the Euro zone. However, because the values of RR showed similar dynamics whether to use the US data only or the weighted average and because the estimation results were also similar, we decided to use RR which is the differential of real interest rates between Japan and the US. Some more remarks will be made in the following section where the estimation results are discussed.

As is obvious from the interest parity condition, an increase in the real interest rate

[3] Due to lack of complete PPI data sets, other variables than TNT are often used to capture the Balassa-Samuelson effect. For instance, Koske (2008) and Yajie, Xiaofeng and Soofi (2007) use real GDP per capita.

differential (domestic rate minus foreign rate) induces real appreciation of the currency value. Therefore, the sign of β_3 is expected to be positive.

Finally, CB is the moving average of the ratio of Japan's current account balance to its trade volume. This variable replaces the net foreign asset relative to GDP which is typically included in the literature. As mentioned before, the net foreign asset of Japan has continuously risen for the last 30 years, therefore does not play a role in explaining the up-and-down swings of the Japanese exchange rate. In addition, this paper uses the current account balance not relative to GDP but relative to the trade volume following the findings of recent research papers such as Bleaney and Tian (2014) who argue that it is not appropriate to scale the net foreign asset by GDP. The moving average is computed from the values of the previous four quarters. The value of the current quarter is not included since it can generate indogeneity problem. CB should be positively related to the real exchange rate because if the trade balance declines, the real exchange rate should depreciate to recover the trade balance. Therefore, the sign of β_4 is expected to be positive.

Data Sources

The sources of the data used in the research are summarized in Table 1.

<Insert Table 1>

3.2. Empirical test and estimation results

Unit root tests

Because conventional unit root tests such as the ADF test may fail to detect non-stationarity when a non-stationary series has a structural break as Perron (2006) discusses, and because the economic variables of Japan are often suspected to have structural breaks, this paper performs the S-L unit root test suggested by Saikkonen and Lutkepohl (2002), which is robust in the presence of a structural break. As reported in Table 2, the null hypothesis of a unit root is accepted at the five percent significance level for the levels of all the variables. In addition, it should be noted that the S-L tests with the first differences, which are not reported in the paper, strongly indicate stationarity for all the variables involved.

<Insert Table 2>

Cointegration tests

Considering the possibility of any structural changes in the relationship among the variables in equation (5), this paper performs the S-L cointegration test (Saikkonen and Lutkepohl, 2000a, 2000b, 2000c) which is robust to a structural break in the long-term relationship. The test results reported in Table 3 indicate the presence of a long-term relationship among the variables at the ten percent significance level.

<Insert Table 3>

Estimation

Since the S-L cointegration test indicates the presence of a cointegrating vector among the variables in equation (5), the cointegrating vector is estimated by the fully modified OLS of Phillips and Hansen (1990), and the estimation results are the following:

$$\underset{}{LQ} = \underset{(0.013)}{4.520} + \underset{(0.092)}{0.292LTOT} + \underset{(0.342)}{0.771LTNT} + \underset{(0.006)}{0.008RR} + \underset{(0.254)}{0.665CB} \quad (6)$$

The numbers in the parentheses are standard errors. The asterisk beside a standard error indicates the estimated coefficient value is significantly different from zero at the five percent significance level. Even though the estimate of RR is not significant, it should be noticed that the t-statistic is 1.364. In addition, the signs are consistent as the theories predict.

3.3. Measuring misalignments

The actual real effective exchange rate (REER) is illustrated in Figure 5 along with the behavioral equilibrium exchange rate (BEER) computed by the estimated values of equation (6). In addition, the long run BEER is computed by plugging the long-run values of the explanatory variables into equation (6). Following Clark and Macdonald (1998) the long-run values of the explanatory variables are obtained by applying the Hodrick-Prescott filter to the data. The current misalignment, defined as the difference between the actual exchange rate and the BEER ($\tilde{q}_t$ -q_t), is illustrated in Figure 3, along with the total misalignment defined as the difference between the actual exchange rate and the long-run BEER ($\tilde{q}_t$ -$\bar{q}_t$). The current misalignments are computed by dividing the difference between the REER and the BEER (more specifically, REER minus BEER). Then, they are transformed into percentage terms. The total misalignments are computed in the same way by replacing the BEER with the long-run BEER.

<Insert Figures 3 and 4>

The misalignments illustrated in Figures 3 and 4 show that the actual exchange rate of the Japanese yen was overvalued for the periods from 2008Q4 to 2012Q4. Then, it was undervalued from 2013Q1. However, while it was overvalued as much as 15.3% according to the BEER and as much as 18.0% according to the long-run BEER during the global financial crisis, it was undervalued by 5.5% at the most until 2014Q3. In 2014Q4, it was undervalued by 7.4 according to the BEER and by 8.5% according to the long-run BEER.

4. Conclusions

This paper measures to what extent the real effective exchange rate of the Japanese yen is misaligned from its equilibrium value by estimating the equilibrium value using the behavioral equilibrium exchange rate (BEER) approach. Twelve countries are chosen as the major trading partners of Japan. Then, the real effective exchange rate of Japan is computed using the nominal exchange rates of the countries involved and their consumer price indices.

The economic fundamentals, that are used as explanatory variables in the equation in which the real effective exchange rate is the dependent variable, are the terms of trade, the relative price of non-traded to traded goods, the real interest rate differential between Japan and the US, and the current account balance of Japan relative to its trade volume. The estimation results using the quarterly data from 1990Q1 to 2014Q4 indicate that the actual exchange rate of the Japanese yen was substantially overvalued from 2008Q4 to 2012Q4. For example, in 2013Q4, it was overvalued as much as 15.3% according to the BEER and as much as 18.0% according to the long-run BEER.

In contrast, the greatest undervalued misalignment since 2013Q1 is found in 2014Q4 and it is only by 7.4% according to the BEER and by 8.5% according to the long-run BEER. Considering the exchange rate of the Japanese yen against the US dollar have moved around 120 from December 2014 to September 2015, it is believed that the undervaluation of the yen did not become severe even in 2015 which is not covered in the analysis of the paper. Therefore, the results obtained in the present paper indicate that the depreciation of the Japanese yen after the so-called Abenomics policies was a way to restore its equilibrium path.

References

1. Alexius, A., 2001, Uncovered interest parity revisited, Review of International Economics, vol. 9, 505-17.
2. Balassa, B., 1964, The purchasing power parity doctrine: a reappraisal, Journal of Political Economy, vol. 72, 584-96.
3. Bénassy-Quéré, A., and Lahrèche-Révil, A., 2008, Is Asia responsible for exchange rate misalignments within the G20? Pacific Economic Review, 13(1), 46–61.
4. Bleaney, M. and M. Tian, 2014, Net foreign assets and real exchange rates revisted, Oxford Economic papers 66, 1145-1158.
5. Cheung, Y.W., M.D. Chinn, and E. Fujii, 2009, Pitfalls in measuring exchange rate misalignment, Open Economies Review, vol. 20, 183-206.
6. Chinn, Menzie D., 1998, Before the fall: Were East Asia currencies overvalued? NBER Working Papers, No. 6591.
7. Chinn, M.D., 2006, A primer on real effective exchange rates: determinants, overvaluation, trade flows and competitive devaluation, Open Economies Review, vol. 17, 115-143.
8. Chionis, D. and R. MacDonald, 2002, Aggregate and disaggregate measures of the foreign exchange risk premium, International Review of Economics and Finance, vol. 11, 57-84.
9. Clark, P. and R. MacDonald (1998), Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs, IMF working paper, WP/98/67, International Monetary Fund.
10. Clark, P. and R. MacDonald (1999), Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs, in Stein, J. and R. MacDonald (eds), Equilibrium Exchange Rates, Boston, Kluwer.
11. Clark, P. and R. MacDonald (2000), Filtering the BEER: A permanent and transitory decomposition, IMF working paper, WP/00/144, International Monetary Fund.
12. Doornik, J. A. and H. Hansen, 1994, A practical test of multivariate normality, unpublished paper, Nuffield College, Oxford.
13. Faruqee, H., 1995, Long-run determinants of the real exchange rate: A stock-flow equilibrium approach, IMF Staff Papers, vol. 42, pp. 80-107.

14. Funke, M. and J. Rahn (2005), “Just how undervalued is the Chinese renminbi? World Economy, pp. 465-631.
15. Goldfain, Ilan and Taimur Baig, 1998, Monetary Policy in the Aftermath of Currency Crisis: The Case of Asia, IMF Working Papers WP/98/170.
16. Hansen, H. and S. Johansen, 1999, Some tests for parameter constancy in cointegrated VAR-models, Econometrics Journal, vol. 2, 306-333.
17. Kinkyo, T. (2008), “Disorderly adjustments to the misalignments in the Korean won”, *Cambridge Journal of Economics*, vol. 32, pp. 111-124.
18. Koske, I., 2008, Assessing the equilibrium exchange rate of the Malaysian ringgit: A comparison of alternative approaches, Asian Economic Journal, vol. 22, no. 2, 179-208.
19. MacDonald, R., 1997, What determines real exchange rates: The longand short of it, IMF working paper 97/21, International Monetary Fund.
20. MacDonald, R. and P. Dias, 2007, Behavioral equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries, unpublished manuscript, Perterson Institute of International Economics.
21. MacDonald, R. and J. Nagayasu, 1999, The long-run relationship between real exchange rates and real interest differentials: a panel study, IMF working paper, no. 99/37, International Monetary Fund.
22. Meredith, G and M. Chin, 1998, Long-horizon uncovered interest rate parity, NBER working paper, no. 6797, National Bureau of Economic Research.
23. Perron, P., 2006, “Dealing with Structural Breaks,” in Palgrave Handbook of Econometrics, Vol. 1:Econometric Theory, K. Patterson and T.C. Mills (eds.), Palgrave Macmillan, 278-352.
24. Phillips, P.C.B. and B.E. Hansen, “Statistical Inference in Instrumental Variables Regression with I(1) Processes,” Review of Economic Studies, 57, 1990, pp. 99-125.
25. Saikkonen, P. and H. Lutkepohl (2000a), Testing for the cointegrating rank of a VAR process with an intercept, ECONOMETRIC THEORY 16 (3): 373-406.
26. Saikkonen, P. and H. Lutkepohl (2000b), Testing for the cointegrating rank of a VAR process with structural shifts, **Journal of Business & Economic Statistics,** Vol. 18, Iss. 4, p. 451~464.
27. Saikkonen, P. and H. Lutkepohl (2000c), Trend adjustment prior to testing for the cointegrating rank of a vector autoregressive process, JOURNAL OF TIME SERIES ANALYSIS 21 (4): 435-456.

28. Saikkonen, P. and H. Lutkepohl (2002), Testing for a unit root in a time series with a level shift at unknown time, ECONOMETRIC THEORY 18 (2): 313-348.
29. Samuelson, P., 1964, Theoretical notes on trade problem, Review of Economics and Statistics, vol. 46, 145-54.
30. Wang, Y., X. Hui and A. Soofi (2007), Estimating renminbi (RMB) equilibrium exchange rate, Journal of Policy Modeling, vol. 29, 417-429.
31. Williamson, J., 1994, ed., Estimating Equilibrium Exchange Rates, Institute for International Economics, Washington, DC.
32. Zhang, Z., and L. Chen, 2014, A new Assessment of the Chinese RMB exchange rate, China Economic Review 30, 113-122.

<Table 1> Data Sources

	Exchange rate	CPI	PPI	Unit Value of Exports	Unit Value of Imports	Govt. Bond rate
Australia	IFS	IFS	IFS	IFS	IFS	IFS
Canada	IFS	IFS	IFS	IFS	IFS	IFS
China	IFS	IFS	IFS	IFS	IFS	IFS
Euro Area	IFS/Euro Stat	DS	DS	See note 3	See note 4	IFS
Hong Kong	IFS	DS	DS	IFS	IFS	NA
Indonesia	IFS	IFS	IFS			
Japan	IFS	IFS	IFS	IFS	IFS	IFS
Korea (ROK)	IFS	IFS	IFS	BOK	BOK	IFS
Malaysia	IFS	IFS	IFS			IFS
Singapore	IFS	IFS	IFS	IFS	IFS	
Thailand	IFS	IFS	IFS	IFS	IFS	IFS
UK	IFS	IFS	IFS	IFS	IFS	IFS
USA	IFS	IFS	IFS	IFS	IFS	IFS

IFS: International Financial Statistics

BOK: Bank of Korea

DS: Data Stream

(3) The data are available at IFS from 1998Q1. On the other hand, the export unit value index based on Euro are available at the Data Stream from 1980Q1. The export unit value index used in this paper are computed by dividing the Data Stream data by the Euro/$ exchange rate. It was confirmed that the data computed in the way are almost the same as the IFS data for the period when the IFS data are available.

(4) The data are available at IFS from 1995Q1. On the other hand, the import unit value index based on Euro are available at the Data Stream from 1980Q1. Therefore, the import unit value index used in this paper are computed in the same way explained in footnote 3. It was confirmed that the data computed in the way are almost the same as the IFS data for the period when the IFS data are available.

<Table 2> SL Unit Root Test for the Levels

Variable	SL Statistic	lag[2)]	Suggested break[3)]
LQ	-0.684	3	2008Q4
LTOT	0.777	2	2009Q1
LTNT	-2.059	5	2008Q4
RR	-1.646	4	1996Q2
TB	-0.764	2	2010Q2

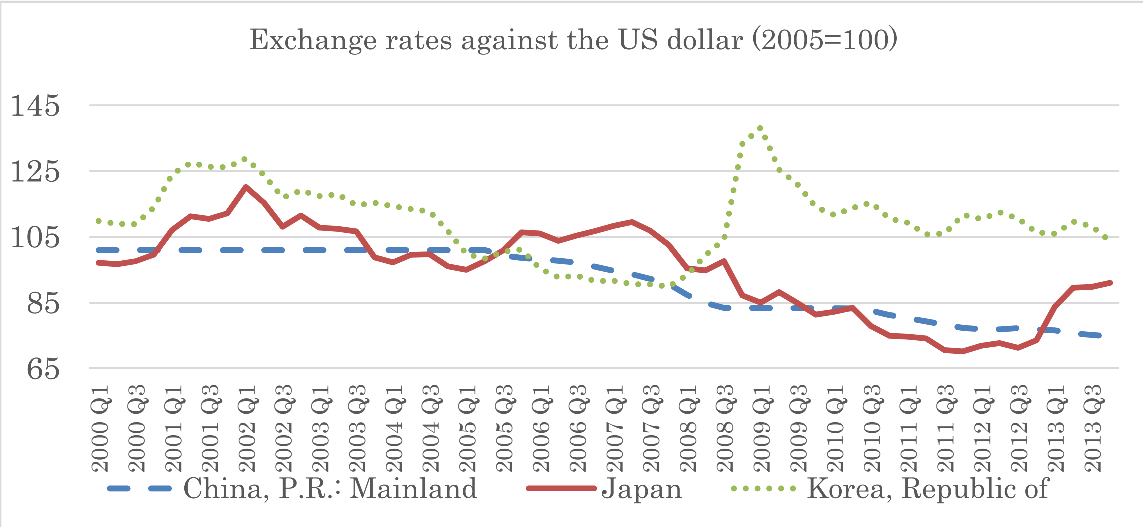
Notes: (1) The lags were determined by the four criteria used in JMulti. (3) The breaks reported in the table are those suggested by JMulTi. (4) The 1%, 5% and 10% critical values are -3.48, -2.88, and -2.58, respectively. The critical values for the null hypothesis of the unit root were obtained from Lanne et al. (2002).

<Table 3> Cointegration Tests with a Structural Break

Statistic						
	H_0:	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
	H_A:	$r \geq 1$	$r \geq 2$	$r \geq 3$	$r = 4$	$r = 5$
S-L Statistic[(3)]		57.63*	30.61	19.58	6.77	1.69
(p-value)		0.078	0.329	0.177	0.354	0.226

Notes: (1) r denotes the number of cointegrating vectors. (2) The lag length included in the test equation is set to be 2 based on Hannan-Quinn Criterion. (3) Refer to Saikkonen and Lutkepohl (2000a,b,c). (5) The asterisk (*) indicates the rejection of the null hypothesis of no cointegration at the 10 percent significance level.

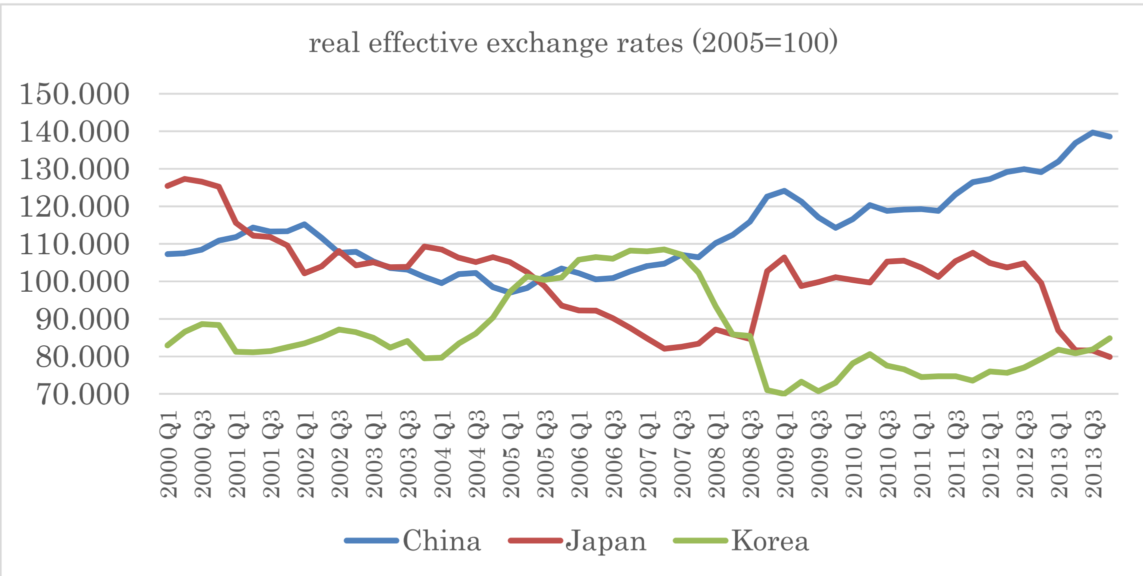
<Figure 1-1> Exchange Rates against the US Dollar



Note: This graph illustrates the indices (2005=100) computed from quarterly average exchange rates against the US dollar.

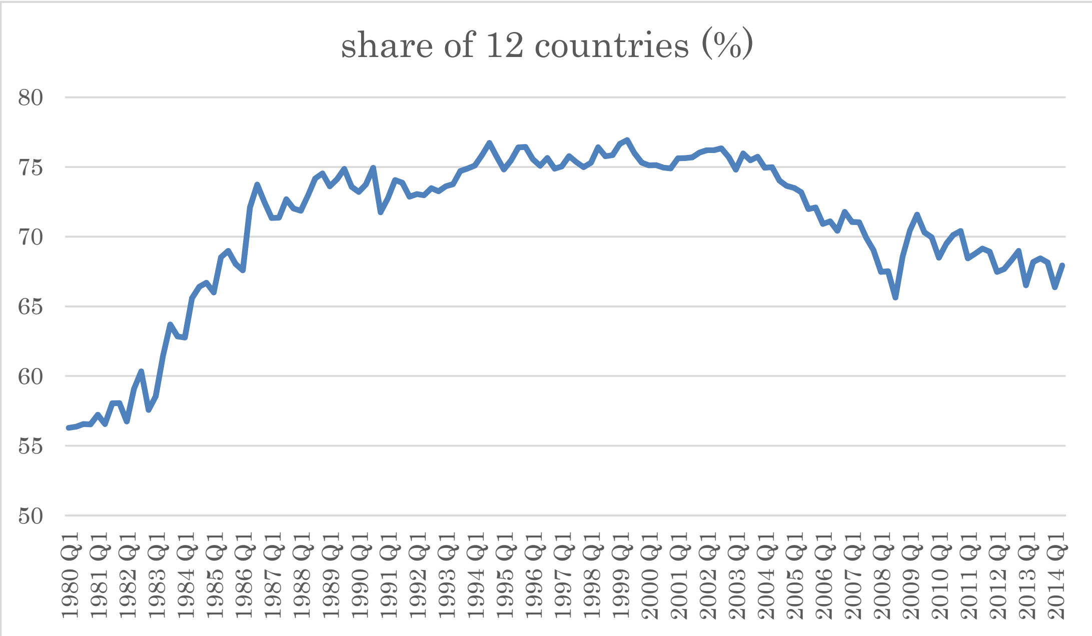
Data Source: IFS

<Figure 1-2> Real Effective Exchange Rates

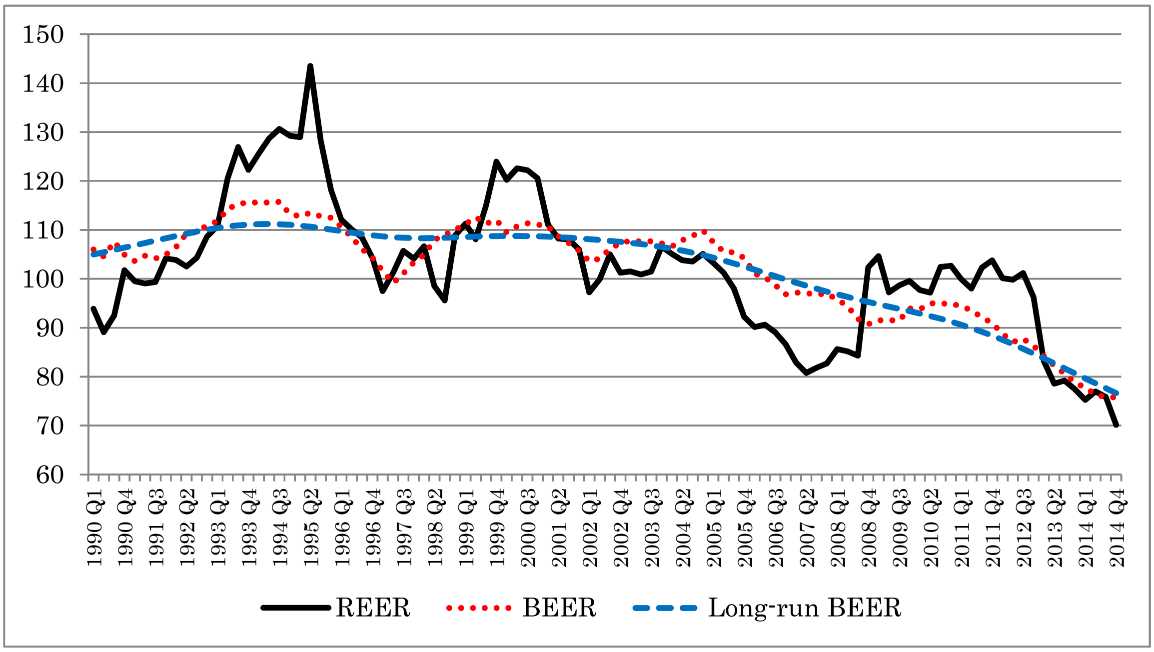


Data Source: IFS

<Figure 2> Shares in the trade of Japan (1990Q1~2014Q2)



<Figure 3> REER, BEER, and long-run BEER



REER=$\tilde{q}_t$ =real effective exchange rate

BEER=q_t=behavioral equilibrium exchange rate

Long-run BEER=$\bar{q}_t$

<Figure 4> Misalignments of the Japanese real effective exchange rate (%)