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Measuring Misalignments in the Korean Exchange Rate

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Abstract

This paper measures to what extent the real effective exchange rate of the Korean won 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, net foreign assets and real interest rate differentials are employed to assess the equilibrium exchange rate. Considering the drastic changes in Korea's trade pattern, the trade partner weights, which are used to compute the real effective exchange rate, are not fixed, but variable. The estimation results using the quarterly data from 1982Q1 to 2009Q4 indicate that the actual exchange rate of the Korean won was substantially overvalued for the period from 2005Q1 to 2007Q4, and substantially undervalued for the period from 2008Q2 to 2009Q3. The actual exchange rate deviates from the BEER and from the long-run equilibrium (or sustainable value) of the BEER by 32 percent and by 24 percent respectively in 2008Q4.

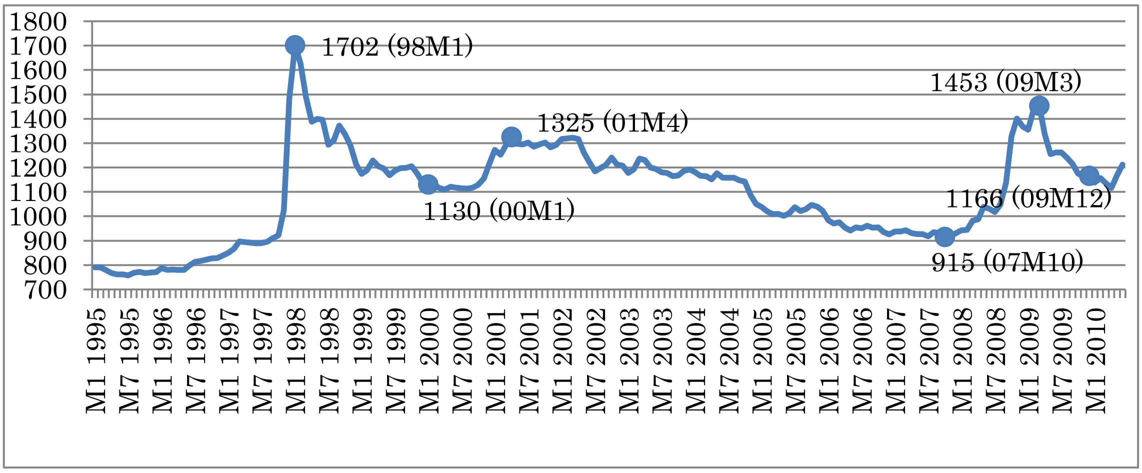
JEL Classification: C22, F31
Keywords: Korean won, misalignment, behavioral equilibrium exchange rate

1. Introduction

Over the last decade, the Korean won has been one of the most volatile East Asian currencies. When the standard deviations of the log-valued monthly exchange rates of East Asian currencies against the US dollar from 2000M1 to 2009M12 are computed, Korea's standard deviation, 0.123, is the highest, followed by 0.100 of Thailand, 0.093 of the Philippines, and 0.088 of Indonesia. With respect to the difference between the highest log value and the lowest log value during the same time period, Korea's difference, 0.463, is the second highest in East Asia following 0.489 of Indonesia.

As shown in Figure 1, the monthly average exchange rate of the Korean won against the US dollar, which started the new millennium at 1130 after a quick recovery from its crisis-affected peak at 1702 in January of 1998, rose to 1325 in April of 2001. While fluctuating, the Korean exchange rate recorded its lowest point in the first decade of the new millennium at 915 in October 2007, but then began to increase as the world economy was hit by the so-called "sub-prime mortgage crisis." When the Korean economy was severely hit by the Lehman shock in September of 2008, the Korean exchange rate sharply increased. In March 2009, it recorded the highest point since the 1997 crisis at 1453, and then decreased gradually as the Korean economy recovered from the Lehman shock. When the first decade of the new millennium ended, the Korean exchange rate against the US dollar was 1166.

<Figure 1> The won/dollar exchange rate (1995M1~2010M6)



Note: This graph illustrates the monthly average exchange rate of the Korean won against the US dollar.

In the literature that discusses the dynamics of exchange rates, it is often pointed out that it is highly probable that volatile exchange rates are misaligned from economic fundamentals because they are not as volatile. Although some economic fundamentals have been somewhat unstable in Korea over the last decade, especially when Korea was hit by external shocks, it remains questionable whether the highly volatile dynamics of the value of the Korean won can be explained by the movement of Korea's economic fundamentals.

Korea's macroeconomic indicators soon stabilized after a short period of instability caused by the Lehman shock in 2008. For example, the quarterly real GDP growth rate, which was as low as -4.3 percent in 2009Q1, has been higher than 6 percent for three consecutive quarters since 2009Q4. In addition, the current account balance, which was negative in 2008 for the first time in the 2000s on an annual basis, became positive in 2009. However, the exchange rate did not recover its pre-2008 crisis value, implying a possibility of exchange rate misalignments.

Although the value of the Korean won has fluctuated considerably in the last decade, the misalignment of the Korean won during this time period has rarely been explored. Papers that do address this issue such as Chinn (1998), Goldfain and Baig (1998), and Kinkyo (2008) mostly focus on the 1997 financial crisis period, therefore, we cannot conclude whether and to what extent the won is under- or over-valued from the equilibrium rate assumed by economic fundamentals for the last decade. This is especially germane regarding the last few years in which the won fluctuated severely due to the turmoil of the global financial crisis.

The issue of the misalignment of the Korean won is important not only for understanding the Korean economy, but also in the global context because an increasing number of papers point to under-valued Asian currencies as one of the major causes of the so-called "global imbalance." However, the current literature does not give enough information concerning whether and to what extent, if at all so, the Asian currencies have been undervalued.

Considering this background, this paper aims to measure to what extent the real effective exchange rate of the Korean won is misaligned from its equilibrium value as determined by Korea's economic fundamentals. To this end, this paper estimates the equilibrium value of the Korean won 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), Kinkyo (2008), Koske (2008) and Yajie, Xiaofeng and Soofi (2007) among others.[1]

The following section briefly outlines the BEER approach. The reduced form of the equilibrium exchange rate equation is presented in this section. In addition, the definitions of 'current misalignment' and 'total misalignment' are explained. 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.

[1] An alternative approach, which is also widely used to measure exchange rate misalignments is the FEER (fundamental equilibrium exchange rate) approach of Williamson (1994). Because the FEER approach requires independently specified equilibrium capital account and domestic and foreign potential outputs the data of which are unavailable in the case of Korea, the present paper has adopted the BEER

The last part of section 3 reports the measured misalignments and discusses related issues. Finally, the conclusion appears in Section 4.

2. The BEER approach

Behavioral equilibrium exchange rate (BEER)

This paper adopts the behavioral equilibrium exchange rate (BEER) approach, which computes the equilibrium exchange rate using econometric tools and compares it to the actual exchange rate to determine whether the actual exchange rate is undervalued or overvalued. To compute the equilibrium exchange rate, the BEER estimates a reduced-form equation that explains the behavior of the real effective exchange rate over the sample period.

In particular, the BEER derives a reduced form equation based on the following risk adjusted interest parity condition:[2]

$$q_t = E_t[q_{t+k}] + (r_t - r_t^*) - \delta_t \qquad (1)$$

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

where q_t is the real equilibrium exchange rate expressed as the foreign currency price of a unit of domestic currency, and $E_t[q_{t+k}]$ is the conditional expectation of the real exchange rate in time t+k when the bonds mature. r_t and r_t^* are the domestic and foreign real interest rates with a maturity of t+k, respectively. δ_t is the risk premium.

$E_t[q_{t+k}]$ is then assumed to be a function of economic fundamentals. Based on the findings of Faruqee (1995) and MacDonald (1997), Clark and MacDonald (1998) employ three variables as economic fundamentals explaining $E_t[q_{t+k}]$. The three variables are the terms of trade, the relative price of non-traded to traded goods[3], and net foreign assets. Inducing from this assumption and equation (1), the BEER approach assumes that the equilibrium real exchange rate, q_t, is a function of the following form:

$$q_t = \beta' Z_t \qquad (2)$$

where Z_t is a vector of economic fundamentals, the real interest rate differential, and the risk premium. β is a vector of coefficients. When empirical tests and computations

[3] The relative price of non-traded to traded goods is included to capture the Balassa-Samuelson effect. Some extant papers in this research area employ different variables depending on data availability. Adding on or replacing the variables originally proposed by Clark and MacDonald (1998), recent papers have included such variables as government expenditure, per capita GDP, and openness. See Koske (2008) for a survey of recent papers that applied the BEER to developing economies.

are implemented in the following section of the present paper, $\mathrm{Z_t}$ is assumed to be a vector of the terms of trade, the relative price of non-traded to trade goods, net foreign assets, and the real interest rate differential $(\mathrm{r_t} - \mathrm{r_t^*})$.[4]

The risk premium is not included in the empirical studies in the following section because the data of the proxies for the variable are not available for the whole period covered in the paper.

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. Kinkyo (2008) used the fiscal balance divided by the GDP as a proxy for the Korean risk premium and reported a significant coefficient with the expected sign. However, a consistent data set for Korea's fiscal balance is not available for the whole period covered in the present research. The IMF data which was used by Kinkyo (2008) is only available up to 2000Q3, and the Korean government data is only available from 2000Q1. Besides, the fiscal balance data from the two data sources for the overlapping periods (2000Q1 through 2000Q3) are quite different. For example, the

[4] More detailed description of the variables employed in this paper will be provided in section 3.

fiscal balance of the Korean government in 2000Q3 is around -4 trillion won in the IMF data, but is 55trillion won in the Korean government data. In fact, as Chionis and MacDonald (2002) show, no economic variable is strongly supported as a measure of the risk premium in the literature.[5]

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

$$\tilde{q}_t = \beta' Z_t + \tau' T_t + \varepsilon_t \qquad (3)$$

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, $\overline{q}_t$, is assumed to be determined by the long-run values of economic fundamentals:

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[5] Recent papers such as Koske (2008) and Funke and Rahn (2005), Yajie, Xiaofeng and Soofi (2007) and MacDonald and Dias (2007) did not include the risk premium in their models, either.

$$\bar{q}_t = \beta' \bar{Z}_t \qquad \text{----------------} \ (4)$$

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 (2) 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 1982Q1 to 2009Q4 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 Korean 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:

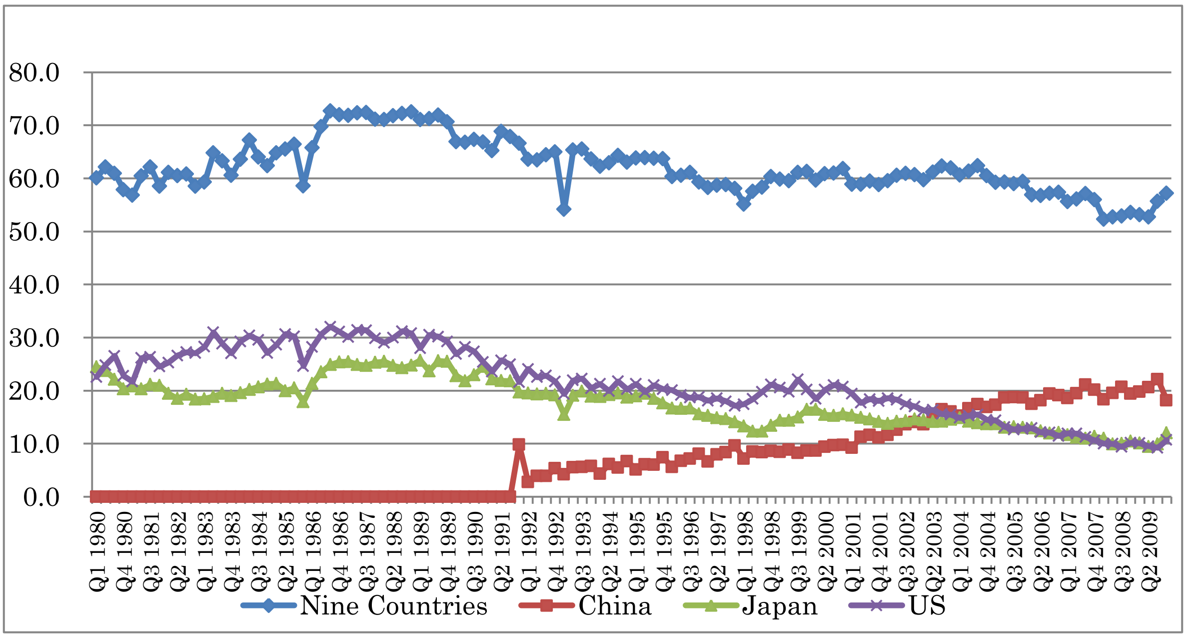
$$\mathrm{LQ} \quad = \beta_0 + \beta_1 \mathrm{LTOT} + \beta_2 \mathrm{LTNT} + \beta_3 \mathrm{NFA} + \beta_4 \mathrm{RR} + \varepsilon \qquad (5)$$

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. NFA is net foreign assets, and RR is the real interest rate differential.

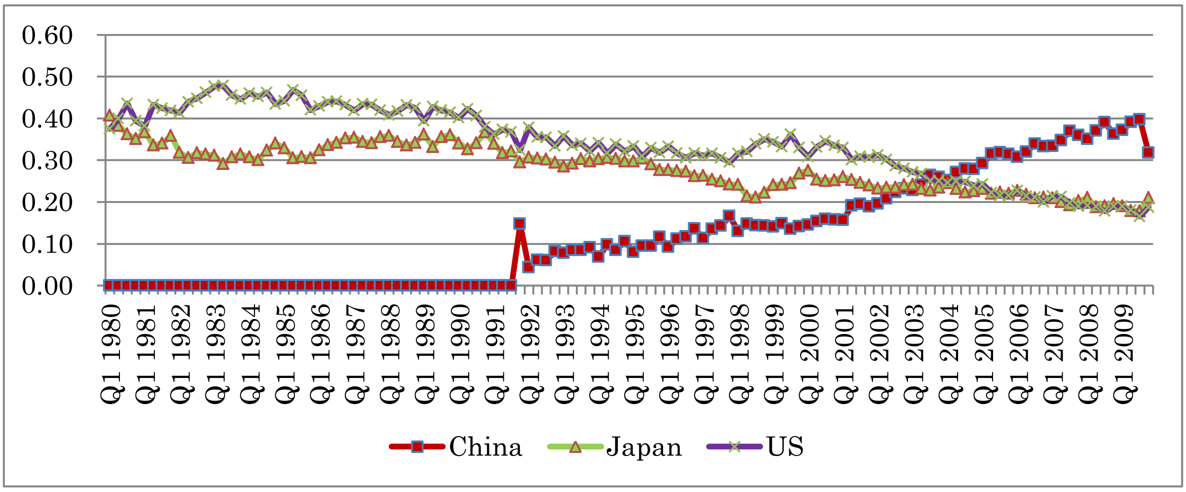
The real effective exchange rate, Q, is the CPI (consumer price index)-based real effective exchange rate of the Korean won. It is calculated through the following procedure: First, the real exchange rates between the Korean won and each currency of Korea's nine major trade partners are calculated using the nominal exchange rates and CPI data.[6] The real exchange rate is defined to be the foreign currency price of a unit of the Korean won. Therefore, a decrease in the real effective exchange rate calculated using the bilateral real exchange rates means a depreciation of the Korean won, unlike the nominal exchange rate of the Korean won against the US dollar whose decline means an appreciation of the Korean won. The nine major trade partners (Australia, Canada, China, Germany, Hong Kong, Japan, Singapore, UK and US) are selected on the basis of their shares in the Korean imports and exports from 1980 to 2009. As illustrated in Figure 2-1, the share of the nine countries in the total Korean trade volume (exports and imports) has never been below 50% since 1980.

[6] 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.

<Figure 2-1> Shares in the trade of Korea (1980Q1~2009Q4)



<Figure 2-2> Weights of three major trade partners in the calculation of Q (1980Q1~2009Q4)



Second, bilateral real exchange rates are converted into indices whose base year is 2005. Finally, the weighted geometric average of the indices of the nine 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 Korean trade volume. Its weight is the relative share in the Korean trade only with the nine countries selected. Considering the drastic changes in their shares in the Korean trade volume, the weights are not fixed at a base year, but they are computed for each year. As illustrated in Figure 2-1, China's share in Korean trade moves between 0 and 22.1%, and the US's share in Korean trade moves between 9.2 and 32.0%. Accordingly, their weights in the computation of the Korean real effective exchange rate also change as shown in Figure 2-2.[7]

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 nine major trading partners. That is, the terms of trade of Korea is divided by the weighted average of the terms of trade of the nine 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,

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[7] Kinkyo (2008) does not include China and Hong Kong in his construction of the Korean real effective exchange rate. Because the analysis of Kinkyo (2008) covers the period from 1981Q1 to 2000Q3, it is not unreasonable not to include China. In contrast, as the analysis of the present paper covers up to 2009Q4, the impact of China cannot be ignored.

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. Kinkyo (2008) seeks the reason for a negative value from the fact that Korea's manufacturing sector heavily relies on imported intermediate goods.

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 eight major trading partners. That is, the Korean ratio of CPI over PPP is divided by the weighted average of the same ratios of the eight trading partner countries. Hong Kong is excluded in the computation of TNT because the PPI data of Hong Kong is available only from 1993. Accordingly, the weights of the trading partners are computed excluding Hong Kong.

Following Clark and MacDonald (1998) and Kinkyo (2008), this explanatory variable is included to capture the Balassa-Samuelson effect.[8] 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.

NFA is the ratio of Korea's net foreign assets to Korea's GDP. It is positively related to the real exchange rate because, as Koske (2008) explains, if the net foreign asset decreases the real exchange rate should depreciate to generate a trade surplus which is needed to finance more interest payments induced by a decline in net foreign assets. Therefore, the sign of β_3 is expected to be positive.

Finally, RR is the differential between Korea'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

[8] 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.

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 Korean and foreign interest rates to calculate the real interest differential, RR. The foreign real interest rate is the weighted average of the real interest rates of six major trading partners: Australia, Canada, Germany, Japan, UK, and US. The other three countries are excluded due to lack of data. Accordingly, the weights of the trading partners are computed excluding China, Hong Kong, and Singapore.

As is obvious from the interest parity condition (or, equation (1) in the present paper), an increase in the real interest rate differential (domestic rate minus foreign rate) induces real appreciation of the currency value. Therefore, the sign of β_4 is expected to be positive. The data of all variable in equation (5) are illustrated in Figure 3.

<Figure 3> Graphs of the variables

Data Sources

The data for price indices such as CPI, PPI, the export unit value and the import unit value were obtained from the IFS (International Financial Statistics) of the IMF except for China. The Chinese CPI data from October 1995 to September 1996 was obtained from the CEIC data base. The Chinese CPI data from 1986M1 to 2009M12 was computed using the CEIC data and the IFS data for the Chinese CPI growth rates. Therefore, the Chinese quarterly CPI data is available only from 1986Q1. But, because the Chinese weights are zero during the time period when that data is not available, it does not affect the calculations in this research. The Chinese PPI data from 1995M10 to 2009M12 was computed using the CEIC data for the Chinese PPI growth rates which is available from 1996M10. The monthly data before 1995M10 was obtained by converting the annual data from the CEIC into monthly data using E-views (version 6).

The Chinese export and import unit value indices were obtained from the CEIC for the period from 2005Q1. The data from 1982Q1 to 2004Q4 was obtained by converting the annual data of the OECD into quarterly data using E-views (version 6).[9]

The net foreign assets of Korea, the GDP of Korea, government bond yields of the involved countries, and nominal exchange rates were obtained from the IFS. Finally,

[9] The annual import and export price indices for China are available from the CEPII, too, but because the CEPII data cover relatively shorter period (1996-2004), this paper used the OECD data.

the total and bilateral trade data of Korea was obtained from DOTS (Direction of Trade Statistics).

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 Korea 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 1, the null hypothesis of a unit root is accepted at the five percent significance level for the levels of all the variables except for LQ. The null hypothesis of a unit root is accepted for the level of LQ at the one percent significance level. 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.

<Table 1> SL Unit Root Test for the Levels

Variable	SL Statistic	lag[2)]	Suggested break[3)]
Q	-3.120	3	1998Q1
LTOT	-0.577	0	2008Q4
LTNT	-1.021	4	1998Q1
NFA	-0.967	6	2008Q3
RR	-2.470	7	1998Q4

Notes: (1) The trend is not included in each test equation because the coefficients of the trend turn out to be insignificant when the trend is included. (2) 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).

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 2 indicate the presence of a long-term relationship among the variables at the five percent significance level.

<Table 2> Cointegration Tests with a Structural Break

Statistic						
	H_0:	$r = 0$	$r \le 1$	$r \le 2$	$r \le 3$	$r \le 4$
	H_A:	$r \ge 1$	$r \ge 2$	$r \ge 3$	$r = 4$	$r = 5$
S-L Statistic[(4)]		68.69*	29.33	15.01	4.48	0.11
(p-value)		0.029	0.684	0.766	0.911	0.993

Notes: (1) *r* denotes the number of cointegrating vectors. (2) The lag length included in the test equation is set to be 3 because two out of four JMulti criteria suggested a lag length of 3. (3) The linear trend and two dummy variables capturing crisis periods are included in the test equation. The first dummy is for the period of 1997Q4 and 1998Q1. The second dummy is for the period of 2008Q4 and 2009Q1. (4) Refer to Saikkonen and Lutkepohl (2000a,b,c). (5) The asterisk (*) indicates the rejection of the null hypothesis of no cointegration at the 5 percent significance level.

Estimation

Since the S-L statistic indicates the presence of one cointegrating vector among the variables in equation (5), the cointegrating vector is estimated by the Johansen (1995) method.[10] The estimation results are the following:[11]

$$\mathrm{LQ} = 6.194 - 1.466\mathrm{LTOT} + 3.314\mathrm{LTNT} + 0.234\mathrm{NFA} + 0.041\mathrm{RR} - 0.019\mathrm{TREND} \quad (6)$$

(36.197) (-7.112) (8.314) (3.337) (4.862) (-8.548)

The numbers in the parentheses are t-statistics and they imply that all of the estimates are significantly different from zero at the five percent significance level. The estimated coefficient values for LTNT, NFA and RR have expected signs. The

[10] The Johansen method estimates the VECM which includes the cointegrating vector as the error correction term. Two dummy variables, one for the period of 1997Q4 and 1998Q1 and the other for the period of 2008Q4 and 2009Q1, are included as deterministic variables in the VECM. The lag length of the VEMC is set to be 2 based on the Akaike criterion.

[11] The estimation and the following diagnostic and stability tests were all implemented using the computer software program, Jmulti.

coefficient of LTOT can be either positive or negative as explained in the previous section, and the estimated coefficient value for LTOT turns out to be negative as was also found in the work of Kinkyo (2008).

It should be also reported that the adjustment coefficient (or, the coefficient of the error correction term) for the first difference of LQ in the VECM is estimated to be -0.133 and that its t-statistic is -3.353, indicating that it is significant even at the 1 percent significance level. This result also confirms the existence of one cointegrating vector as was indicated by the S-L cointegration test.

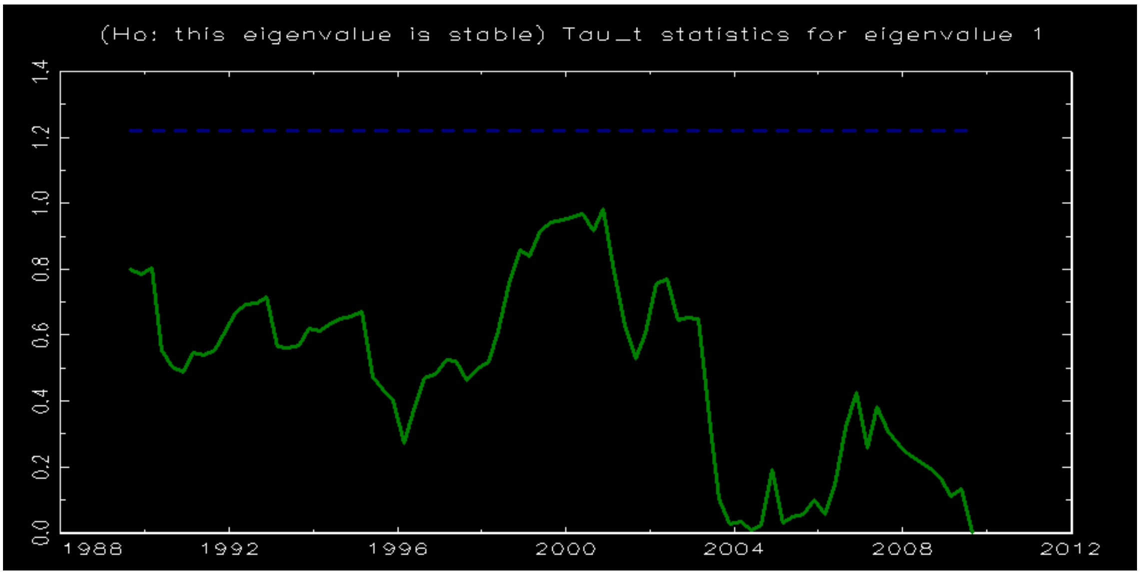
Table 3 reports the results of some diagnostic tests that analyze the residuals to examine the possibility of misspecification. As Clark and MacDonald (1998) note, if the BEER equation is mis-specified, the measured misalignments may be just specification errors. As can be seen from Table 3 however, the tests for autocorrelation, non-normality, and heteroskedasticity indicate that there is not a serious misspecification problem in equation (6). In addition, the stability of the estimation is tested by the eigenvalue method proposed by Hansen and Johansen (1999). As illustrated in Figure 4, the null of stability is accepted even at the 10% significance level.

<Table 3> Diagnostic Tests

Statistic	Autocorrelation Portmanteau Test(1)	Non-Normality DH Test(2)	Heteroskedasticity ARCH-LM Test(3)
Statistic	335.1	6.872	1118.5
(p-value)	(0.639)	(0.738)	(0.549)

Notes: (1) This test examines the null hypothesis of no autocorrelation up to h^{th} lag against the alternative that at least one autocorrelation is non-zero. The lag length, h, is set to be 16, but the test result is not sensitive to the lag length. (2) The DH test statistic was proposed by Doornik and Hansen (1994). This test examines the null hypothesis of normality. (3) The multivariate ARCH-LM test examines the null hypothesis of homoskedasticity.

<Figure 4> Stability Test

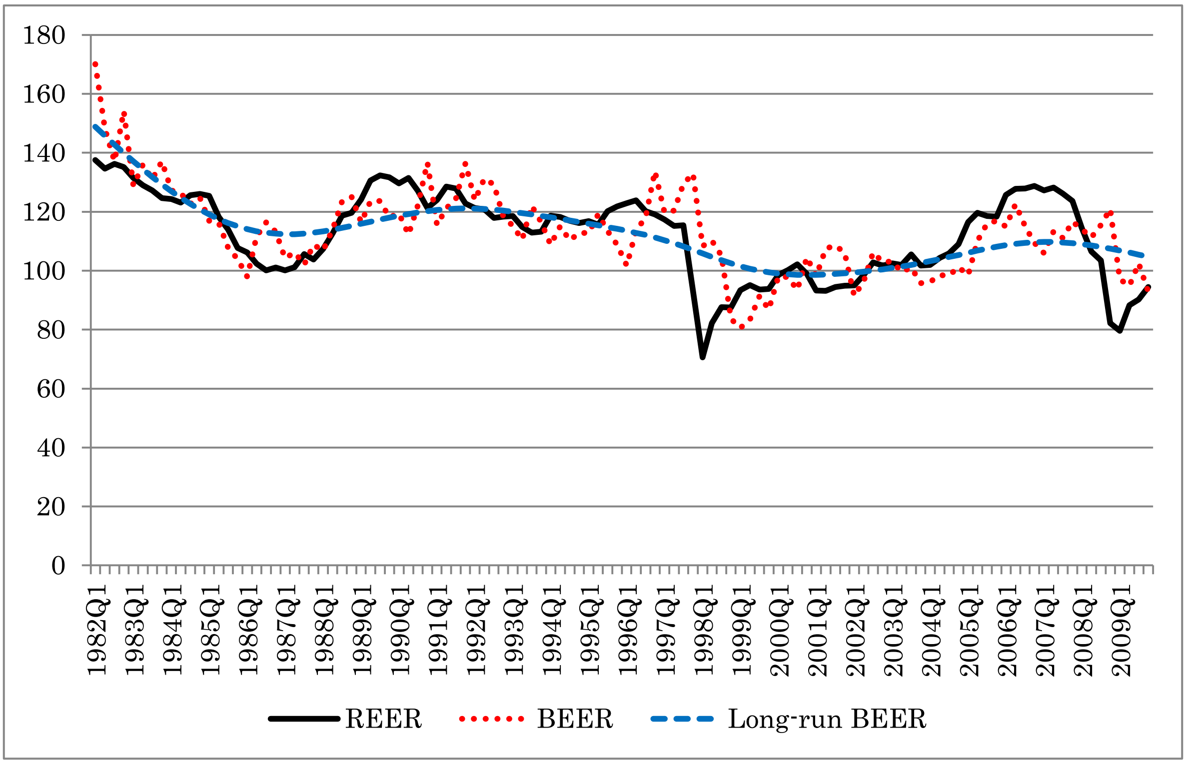


Notes: (1) The dotted line is the critical value at the 10% significance level. The real line under the dotted line is the test statistic. If the real line exceeds the dotted line, the null hypothesis of stability is rejected at the 10% significance level.

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 6, along with the total misalignmen,t defined as the difference between the actual exchange rate and the long-run BEER ($\tilde{q}_t$ -$\overline{q_t}$). The current misalignments are computed by dividing the difference between the REER and the BEER (more specifically, REER minus BEER) by the 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.

<Figure 5> REER, BEER, and long-run BEER

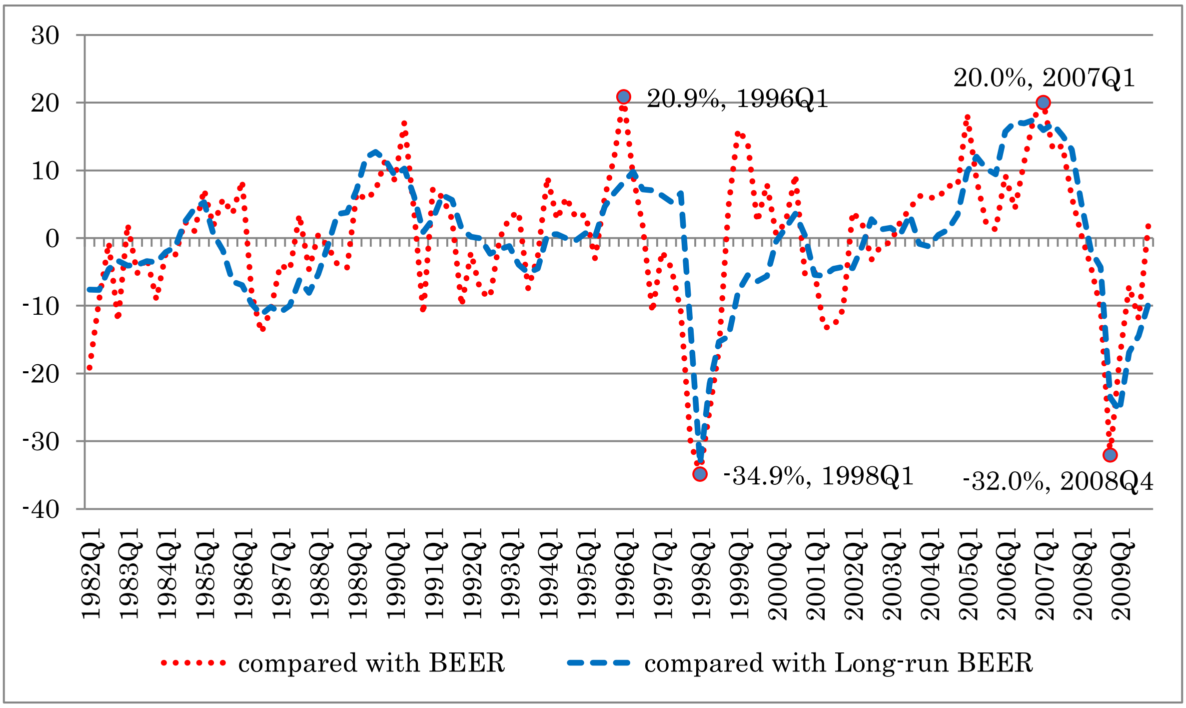


REER=$\tilde{q}_t$ =real effective exchange rate

BEER=q_t=behavioral equilibrium exchange rate

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

<Figure 6> Misalignments of the Korean real effective exchange rate



The misalignments illustrated in Figure 6 show that the actual exchange rate of the Korean won was overvalued for several quarters before the 1997 financial crisis. But, depending on whether it is compared with the BEER value or with the long-run BEER value, the time duration of overvaluation is different. Comparison with the BEER shows that the Korean won became slightly undervalued a few quarters before the burst of the crisis in the fourth quarter of 1997, while comparison with the long-run BEER shows that undervaluation started exactly along with the burst of the 1997 crisis. It implies that the macroeconomic indicators were under its long-run values even before the fourth quarter of 1997. At the trough of the 1997 crisis in 1998Q1, the REER turns out to be undervalued by 34.9% and 33.3% compared with the BEER and the long-run BEER respectively. Then, it quickly restores its equilibrium value and fluctuates around the equilibrium value. The REER was relatively close to the equilibrium values for the first five years of 2000s (2000Q1 ~ 2004Q4). In particular, the misalignments from the long-run BEER were between -5.6% and 3.6% in that time period. However, it has become substantially overvalued since 2006Q1.

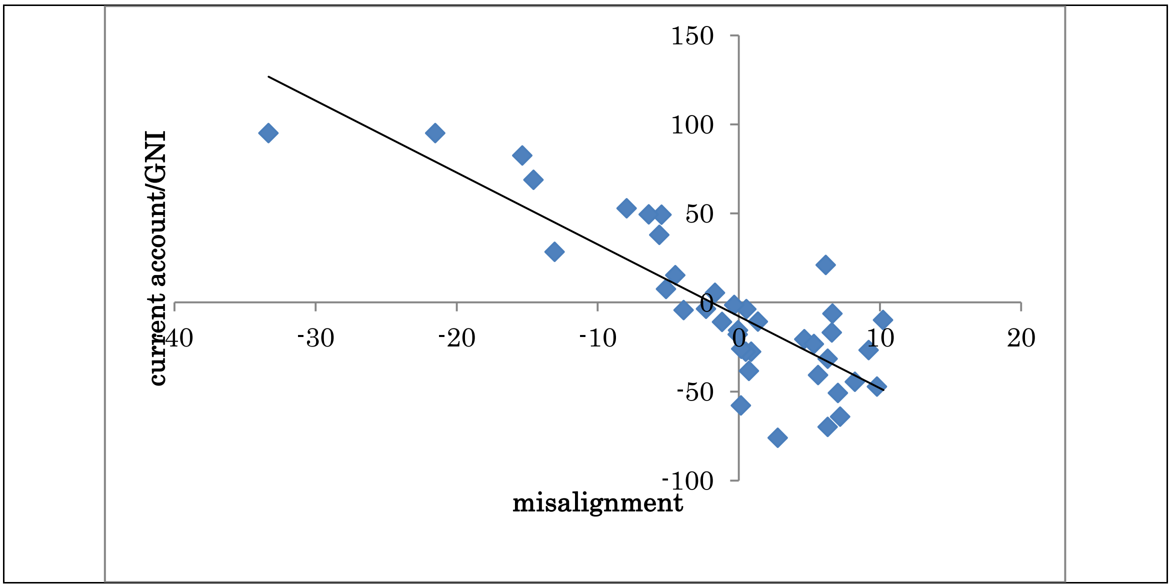
Of interest is the fact that the misalignments of the REER in the two crisis periods (1997 crisis and 2008 crisis) illustrate quite similar patterns.[12] The Korean won was substantially overvalued right before the two crises and substantially undervalued right after the two crises. In 2007Q1, the Korean won was overvalued by 20%, then in 2008Q4 it was undervalued by 32% on the basis of the BEER. Similarly, it was overvalued by 20.9% in 1996Q1, and undervalued by 34.9% in 1998Q1 on the same basis. In other words, the Korean won was misaligned from the BEER values during the 2008 crisis almost as much as during the 1997 crisis, even though the macroeconomic damage was much more severe during the 1997 crisis. In addition, the misalignments from the long-run BEER were greater during the 2008 crisis than during the 1997 crisis.

[12] Hereafter, the 1997 or the 2008 crisis period means a few quarters before and after the trough of each crisis.

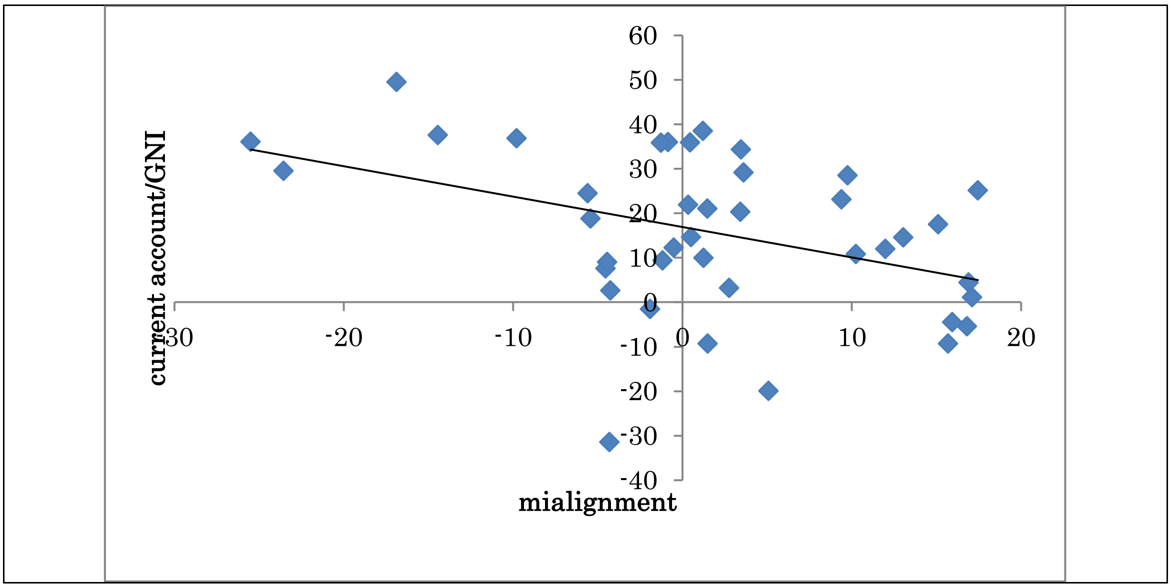
As is well known, East Asian countries, including Korea, have accumulated large foreign currency reserves in the last decade. As of the end of 2009, Korea had the fifth largest (265 billion) foreign currency reserve in the world. Because it is often argued that the accumulation of a large reserve of foreign currency is due to undervalued currencies, it should be of interest to see whether the Korean current account balance has a systematic relationship with the misalignments of the Korean exchange rate.[13] For this purpose, Figures 7-1 and 7-2 plot the exchange rate misalignments along with the current account balances in the 1990s and the 2000s respectively. The misalignments illustrated in the figures are those misaligned from the BEER.

[13] The purpose of this paper is to measure the misalignments of the Korean exchange rate, and this paper does not aim at investigating the determinants of the Korean current account. Therefore, this paper simply sketches below if the amount of current account has a systematic relationship with the misalignments of the exchange rate.

<Figure 7-1> Misalignments of the Korean won and Korea's current account balance (1990Q1 to 1999Q4)



<Figure 7-2> Misalignments of the Korean won and Korea's current account balance (2000Q1 to 2009Q4)



As shown in Figure 7-1, in the 1990s, Korea usually had a positive current account when the Korean won was undervalued, and a negative current account when was overvalued. In addition, the value of the Korean won had a statistically significant negative relationship with the amount of the current account. The slope of the OLS line in Figure 7-1 is estimated to be -4.03 with a t-statistic of -9.30.

In contrast, in Figure 7-2 which describes the 2000s during which Korea accumulated a large quantity of foreign currency reserves, the current account balance is usually positive regardless of the misalignment, even though the negative relationship between the amount of current account and the value of the Korean won still holds. The slope of the OLS line in Figure 7-2 is estimated to be -0.68, much smaller than the -4.03 of the 1990s in the absolute value, with a t-statistic of -2.77. The findings in Figures 7-1 and 7-2 imply that there was a structural change in the relationship between the currency value and the amount of the current account in Korea, and that the undervaluation of the Korean won may explain the accumulation of foreign currency reserves in the 2000s only very limitedly.

4. Conclusion

This paper measured the misalignments of the Korean real effective exchange rates. In particular, the actual real effective exchange rate was compared with the equilibrium exchange rate and with the long-run equilibrium exchange rate. The equilibrium exchange rate was calculated using the BEER approach and the long-run equilibrium exchange rate was calculated by plugging the long-run values of economic fundamentals into the BEER equation.

Of interest from the findings is that the Korean won turned out to be misaligned from its equilibrium values in the 2008 crisis period almost as much as in the 1997 crisis period, even though the Korean economy was more severely damaged during the 1997 crisis. The Korean won was overvalued by 20.9% a few quarters before the trough of the 1997 crisis, and by 20% several quarters before the trough of the 2008 crisis. On the other hand, it was undervalued by 34.9% at the trough of the 1997 crisis and by 32% at the trough of the 2008 crisis.

In the meantime, it was also found that a positive current account balance is not necessarily associated with the undervaluation of the Korean currency in the 2000s. In 1990s, overvaluation and undervaluation were associated with negative and positive current account balances respectively. In contrast, in the 2000s, the current account balance was positive, in general, regardless of whether the Korean currency was overvalued or undervalued, even though the negative relationship between the current account balance and the value of the Korean won still holds.

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