Cointegration Testing of Multi-Country Purchasing Power Parity: The Case of Korea

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This paper investigates whether or not multi-country purchasing power parity holds and with what kind of variables the deviation from multi-country PPP has a stable long-term relationship through cointegration tests.

The result of the empirical analysis shows that considering structural changes the won-dollar exchange rate has a stable long-term relationship with interest rate differentials, current account, and long-term competitive won-dollar exchange rates.

After the structural change, the interest differentials and accumulated current account balance have had effects on the exchange rate in expected directions and the nominal exchange rate has moved appropriately to maintain competitiveness. Therefore, the won-dollar exchange rate after structural changes satisfies multi-country PPP in a broad sense. (*JEL* Classification: F31)

I. Introduction

The purpose of this paper is to set up a long-term model for the won-dollar exchange rate, using the cointegration test between the exchange rate and the major macroeconomic variables. Most of the previous studies followed the monetaristic approach in constructing the long-term exchange rate model. In this paper, however, the long-term exchange rate model is based on the empirical results from the cointegration test of the validity of Purchasing Power Parity (PPP).

There have been a number of empirical studies on PPP. The results of the traditional studies are presented in Frenkel(1978). He claimed that PPP held during the inter-war period when monetary factors were dom-

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inant, while PPP did not hold during the period of floating exchange rates after the 1970s when both monetary and real factors were dominant. However, the traditional empirical methods such as least squares estimation result in spurious regression when the time series data are nonstationary.[1] The major studies using the recently developed cointegrating regression to solve such a problem of spurious regression are Corbae and Ouiliaris(1988), Kim(1990), Taylor(1988), and Fisher and Park(1991). Except for the study of Fisher and Park, they conclude that PPP does not hold in the long run. Bahmani-Oskooee and Rhee(1992), and Lee(1993) also supported this result using the won-dollar exchange rate.

Thus, most empirical studies on PPP showed negative results on the long-term exchange rate model based on PPP. However, if the deviation from PPP has cointegrating relations with other economic variables, then it is possible to determine the long-term exchange rate model through the stable relationship between the deviation from exchange rates which maintain PPP and other relevant variables. Johansen and Juselius(1992), Sul(1993), and Park(1994) analyzed the cause of the deviation of exchange rates from those which maintain PPP using a cointegration test. Johansen and Juselius(1992) claimed that the capital account imbalance in the U.K. was the main reason for the deviation from the exchange rate which maintained PPP and they performed a cointegration test between the deviation and the deviation from uncovered interest parity(UIP). Sul(1993) used an expanded data set for the same test and obtained positive results. Park(1994) showed that the deviation from PPP of the won-dollar exchange rate had no relationship with the deviation from UIP, but had some cointegrating relationship with the deviation from the Korean capital account imbalance.

There are several problems in the papers dealing with Purchasing Power Parity. First, there is the problem involved in defining PPP in the world of multilateral trade and calculating the deviation of nominal exchange rates from the exchange rates which maintain PPP. Most previous studies assume that PPP is held and price competitiveness is maintained when the real exchange rates between two countries remain constant. In the real world of multilateral trade, however, price competitiveness is maintained when real effective exchange rates are maintained constant over the period. Second, there are methodological problems. Most papers did not consider structural changes in estimat-

[1]Granger and Newbold(1974).

ing the cointegrating relation. Even if there is a long run cointegrating relation between exchange rate and other macro variables, the result can show that there exists no stable relationship when there is a structural break during the estimation period. Therefore, in the presence of possible structural changes, one should consider this fact in estimating cointegrating regressions. Third, most papers failed to obtain a cointegrating relationship between the deviation from PPP and major macro variables which indicate current and capital account imbalances.

This paper analyzes these problems and derives a long-term won-dollar exchange rate model as follows. After a brief introduction, in the second section, I will discuss the relationship between price competitiveness and multi-country PPP. I will also calculate won-dollar exchange rates which satisfy multi-country PPP and the deviation of nominal exchange rates from exchange rates which satisfy multi-country PPP. In the third section, I will construct a long-term won-dollar exchange rate model using the cointegration test. I will consider both current account and capital account imbalances for the cause of the deviation from exchange rates which maintain multi-country PPP. I will also perform a cointegration test to consider structural changes such as the transition of the exchange rate system. If there is no cointegrating relationship with or without considering structural changes, then one can interpret this result as meaning that there is no long-term relationship among these variables. However, if there is no cointegrating relation without structural changes but there is one when considering structural changes, then one can say that the cointegrating relationship has changed according to the structural break.

In the last section, brief conclusions will be drawn.

II. Price Competitiveness and Multi-Country PPP

If there is only one trade partner for a country, then price competitiveness can be maintained by fixing the real exchange rate constant between the two countries. When there are many trade partners, however, price competitiveness is affected by all the other exchange rates, so the price competitiveness of one country's goods will vary as the exchange rates between its trade partners change. Therefore, to keep price competitiveness constant, one has to maintain the real effective exchange rate constant.

Now, I will undertake the calculation of how the won-dollar exchange rate should move in order to maintain the real effective exchange rate

constant. In other words, I will derive won-dollar exchange rates which maintain international price competitiveness and which hold multi-country PPP. The real effective exchange rate is defined as the geometric weighted means of real exchange rates vis-a-vis trade partners. It is shown in equation (1)

$$R = \prod \left(\frac{E_i P_i}{P_0} \right)^{w_i}, \quad \sum_{i=1}^{n} w_i = 1, \tag{1}$$

where, R = real effective exchange rate

E_i = nominal exchange rate to ith country

P_i = price level of ith country

P_0 = domestic price level

w_i = trade weight to ith country.

If it is assumed that $i = 1$ represents the United States, then E_1 is the won-dollar exchange rate. Keeping R constant and differentiating equation (1) with respect to time, then we can derive the rate of change of the won-dollar exchange rate which keeps the real effective exchange rate constant. It is shown in equation(2).[2]

$$\frac{\dot{E}_1}{E_1} = (\pi_0 - \pi_1) + \sum_{i=2}^{n} w_i(\pi_1 - \pi_i) + \sum_{i=2}^{n} w_i \left(\frac{\dot{E}_{i1}}{E_{i1}} \right), \tag{2}$$

where π = inflation rate

E_{i1} = exchange rate of ith country's currency to the dollar.

Here $\dot{E}$ means dE/dt. In a strict sense, there needs to be a distinction between tradable and non-tradable goods. Price competitiveness can be maintained when the real effective exchange rate of tradable goods stays constant. Since price competitiveness means the constant real effective exchange rate of tradable goods, I derive in equation (3) the rate of change of the won-dollar exchange rate which maintains the price competitiveness of Korean products in a world market.

$$\frac{\dot{E}_1}{E_1} = (\pi_0^T - \pi_1^T) + \sum_{i=2}^{n} w_i(\pi_1^T - \pi_i^T) + \sum_{i=2}^{n} w_i \left(\frac{\dot{E}_{i1}}{E_{i1}} \right), \tag{3}$$

where, superscript T means tradable goods.

Equation (3) is shown as a rate of change in the exchange rate. In

[2]See I.J. Kim (1992) for further reference.

order to change this to variables in level, we need a base level. I selected the exchange rate of January 1985 as a base level since the current account balance was near equilibrium in that year. If the current account was in equilibrium in 1985, then the nominal won-dollar exchange rate and competitive won-dollar exchange rate can be thought to be the same on average throughout the year (from now on, I will call the derived exchange rate with equation (3) the competitive won-dollar exchange rate). The competitive exchange rate of the base level can be obtained from equations (4) and (5) by letting the average of monthly competitive exchange rates of 1985 equal the average of nominal exchange rates. For a more precise explanation, let the average competitive exchange rate in 1985 $=E_1^{1985}$, the competitive exchange rate in January 1985 = $\overline{E}_1^J$, the rate of change in January = x^J, the competitive exchange rate in February = $\overline{E}_1^F$ and the rate of change in February = x^F, and so on. Then, equation (4) shows how each monthly competitive exchange rate is related to the previous monthly competitive exchange rate.

$$\begin{aligned}
&\overline{E}_1^F = \overline{E}_1^J (1+ x^J) \\
&\overline{E}_1^M = \overline{E}_1^F (1+ x^F) = \overline{E}_1^J (1+ x^J) (1+ x^F) \\
&\qquad\qquad \vdots \\
&\overline{E}_1^D = \overline{E}_1^N (1+ x^N) = \overline{E}_1^J (1+ x^J) \cdots (1+ x^N).
\end{aligned} \tag{4}$$

The average of competitive exchange rates in 1985 is as follows:

$$\overline{E}_1^{1985} = \frac{(\overline{E}_1^J + \cdots\cdots + \overline{E}_1^D)}{12}. \tag{5}$$

$\overline{E}_1^J$ can be derived by equalizing the equation (5) and E_1^{1985}. Therefore, the time series data of monthly competitive exchange rates can be derived by applying the rate of change in exchange rates from equation (3) to $\overline{E}_1^J$.

Now, I will define multi-country PPP and the deviation from multi-country PPP. As shown above, price competitiveness is maintained if nominal exchange rate is equal to the competitive exchange rate. In other words, multi-country PPP is satisfied at $E_1 = \overline{E}_1$. This means that there is no change in the real effective exchange rate of tradable goods. The deviation from multi-country PPP is the difference between nominal and competitive exchange rates, $E_1 - \overline{E}_1$. Figure 1 shows the deviation from PPP of the monthly exchange rate data from January 1980 to December 1993. It is clearly shown in the Figure 1 that the deviation from PPP is persistent and in a strict sense the nominal won-dollar

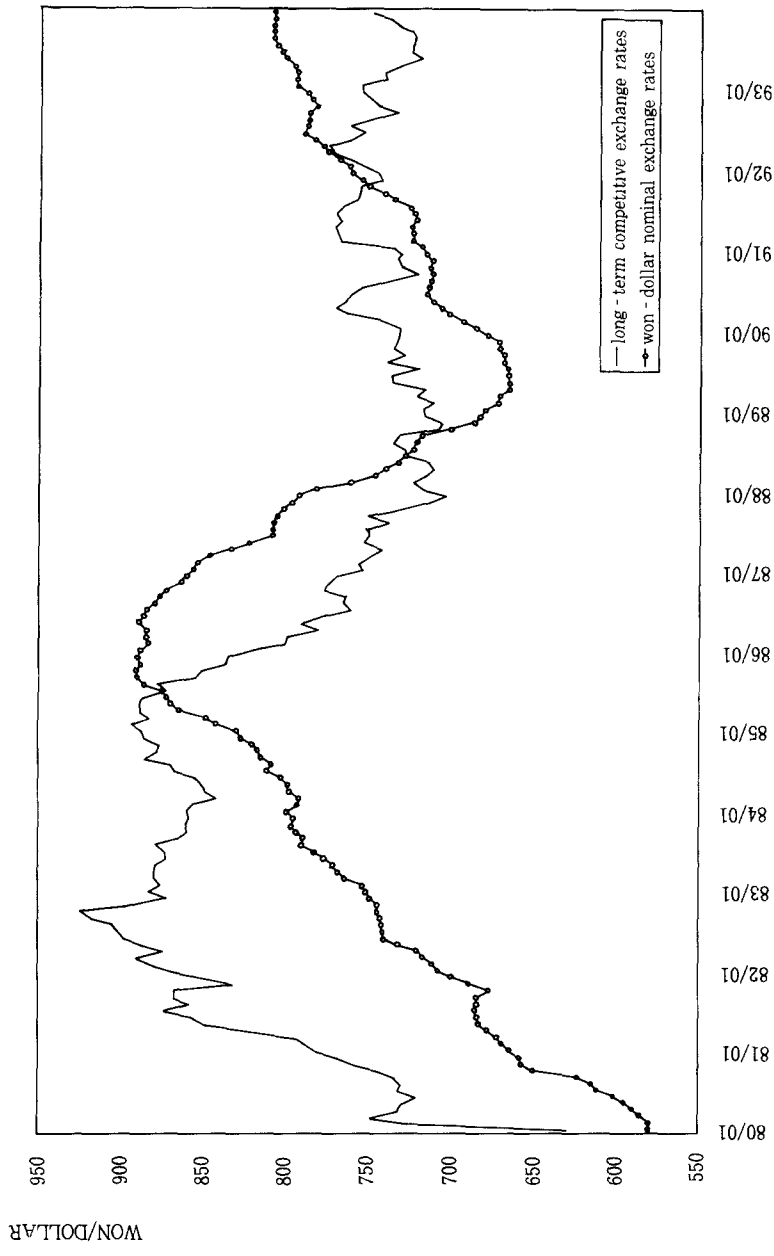

FIGURE 1

LOGN-TERM COMPETITIVE EXCHANGE RATES AND NOMINAL EXCHANGE RATES

exchange rate does not satisfy multi-country PPP in the long run.

III. Long-Term Exchange Rate Model

In the previous section, I defined the deviation of the present won-dollar exchange rate from the competitive exchange rate which satisfies multi-country PPP , and found that such a deviation lasts for a long time. Institutional factors responsible for the deviation of exchange rates from competitive exchange rates are the differences among countries in the composition of price indexes, changes in productivity, transactions costs, trade barriers, existence of non-tradable goods, imperfect information, etc. I will skip the details of these factors since many previous studies have been done.[3] Here, however, I will focus on the fact that the deviation can be mainly explained by investigating the time series behavior of factors composing the balance of payments since the changes in exchange rate are caused fundamentally by the changes in equilibrium conditions of the balance of payments.

A. Model Specification

The model is set up to explain the deviation of nominal exchange rates from competitive exchange rates with the accumulated current account balance and interest differentials between the U.S. and Korea. Figure 2 shows the close relationship between nominal exchange rates and the accumulated current account balance. It is quite clear from Figure 2 that the accumulated current account balance has a direct effect on the nominal exchange rates. The size of the accumulated current account imbalance might be thought as an indicator signaling the direction of exchange rate policies of Bank of Korea. With the accumulated current account deficits, the Bank of Korea might intervene in foreign exchange market to improve the balance of payments situation.

There is no doubt that continuous disequilibrium in the capital account has direct impacts on the short and medium-term exchange rates. The effect of capital movements on the change in exchange rate is a natural concern since both the importance of the capital account in the balance of payments and its effect on the exchange rate are increasing. As well-known, capital movements among countries depend

[3]Refer to Caves, Frankel and Jones(1990), pp.448-53.

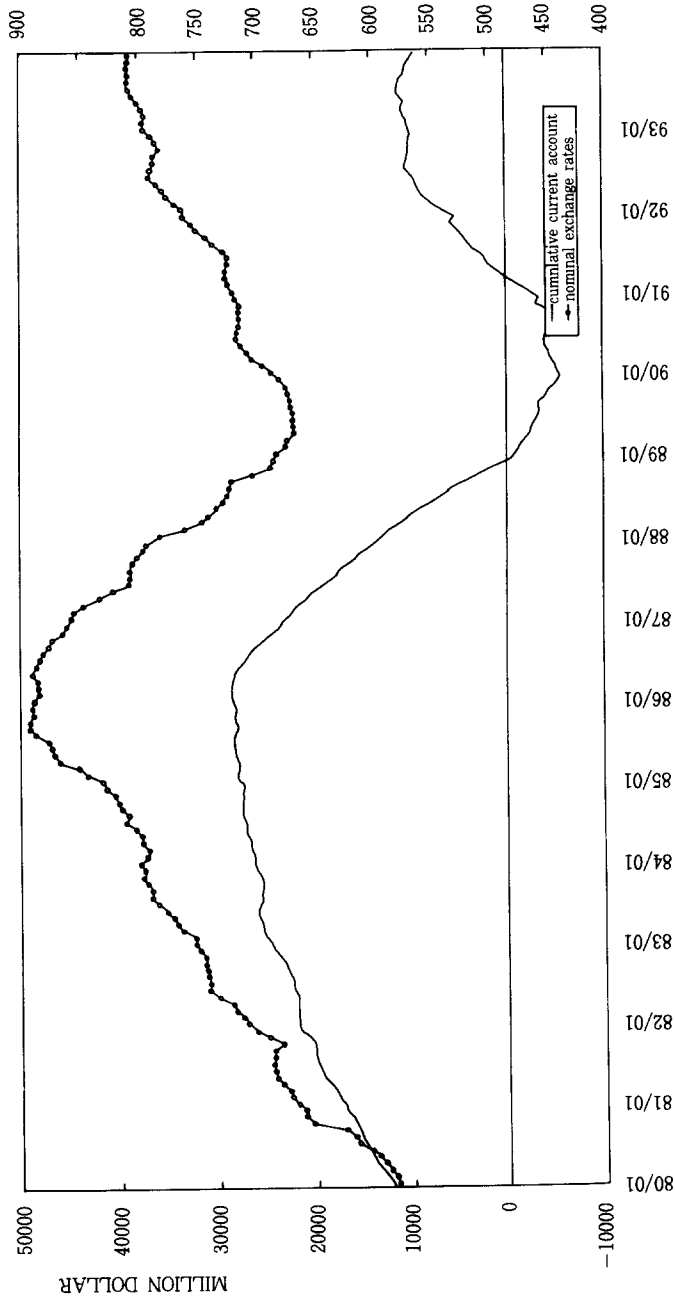

FIGURE 2

CUMULATIVE CURRENT ACCOUNT DEFICITS AND NOMINAL EXCHANGE RATES

on differences in interest rates which represent differences in earnings. In this model, interest rate differentials are used as variables explaining the capital account imbalance which contributes to the deviation of the nominal exchange rate from the competitive exchange rate.

The model I used in this paper to explain the deviation of nominal exchange rate from competitive exchange rates is as follows:

$$E_1 - \overline{E}_1 = \beta_0 + \beta_1 t + \beta_2 (\gamma^* - \gamma) + \beta_3 B + (\beta_4 - 1)\overline{E}_1 + \varepsilon. \quad (6)$$

The left hand side of equation (6) shows the deviation of the nominal won-dollar exchange rate from the competitive exchange rate. The t on the right hand side is the time trend, and reflects the difference between the defined concept in Section II and the data used in empirical analysis.[4] $\gamma^* - \gamma$ is the difference between U.S. and Korean interest rates, and reflects the capital account disequilibrium. B is the accumulated deficit of the current account since 1970, and reflects the disequilibrium of the current account. The last term is to consider the sensitivity of the reaction of the deviation of the nominal exchange rate from the competitive exchange rate. A negative coefficient ($\beta_4 < 1$) means that the movement of the nominal exchange rate is not sensitive enough to maintain competitiveness. For example, when a depreciation is needed, the exchange rate does not depreciate enough so that it weakens competitiveness. A positive coefficient ($\beta_4 > 1$) suggests that the present exchange rate overshoots the level for maintaining competitiveness. That is, when a depreciation is needed, it depreciates more than it should, leaving competitiveness overstrengthened as a result, and when the rate overappreciates, it weakens competitiveness.

In this model, if there is a cointegrating relation among time series variables $\{E_{1t}\}$, $\{\gamma_t^* - \gamma_t\}$, $\{CB_t\}$ and $\{\overline{E}_{1t}\}$, then it means that the equation (6) holds in the long run even though not in the short run because of temporary shocks. If the cointegrating vectors of these time series are $(1, -\beta_2, -\beta_3, -1)$, then it means that multi-country PPP holds in a broad sense, though, not in a narrow sense. Multi-PPP in a narrow sense means that the real effective exchange rate is constant, that is, $E_1 = \overline{E}_1$ in this paper. If this relationship holds even after controlling other factors affecting exchange rates, then we can say that PPP holds

[4]The definition in Section II considered only tradable goods, but in estimation I used the producer price index instead since the data for tradable and non-tradable goods' prices are not available. Therefore, the t in equation (6) partly reflects the difference in productivity between the tradable and non-tradable sectors. For further reference, see I.J. Kim(1992).

in a broad sense.[5]

B. Cointegration Test and Model Estimation

In this paper, I used the J-test developed by Park(1990) for the cointegration test. The J-test is based on the variable adding approach, which tests the significance of additional variables. It is easy to apply and can be used to analyze time series data containing deterministic and stochastic time trends more efficiently. Moreover, while other tests have a null hypothesis of no cointegration, this test takes "there is a cointegrating relation" as its null hypothesis, which is conceptionally more appropriate.

To estimate the cointegrating vector which is necessary to analyze the long run relationship among time series data and the validity of multi-country PPP, I used the canonical cointegrating regression(CCR) developed by Park(1992).

C. Empirical Results

Monthly data from January 1980 to December 1993 were used for the empirical analysis. All data were taken from the IMF data base and Bank of Korea monthly data. The nominal won-dollar exchange rate was used for the exchange rate and the purchaser price index was used for the price data of the tradable goods sector in all the countries. For the U.S. interest rate, 3-year Treasury bill rate was used, and the 3-year corporate bond yield was used for the Korean interest rate. In deriving the effective exchange rate, I used different monthly weights according to the trade volumes with Japan, U.S., U.K., and Germany. The accumulated current account balance means the accumulated current account deficit since January 1970. All the data are seasonally adjusted using ARIMA X-11 filter.

A) Cointegration Test

Before doing the cointegration test, I conduct a unit root test to analyze whether or not the variables are nonstationary. The results are given in Table 1 and show that most of the variables in equation (6) are nonstationary.

I tested for a cointegrating relationship among the variables in equa-

[5]Johansen and Juselius(1992) and Sul(1993) interpreted the results in the same way including interest rates as well as the price level.

TABLE 1
TESTS FOR UNIT ROOT

	ADF	$Z(t(\alpha))$	$Z(\alpha)$
$E - \overline{E}$	-1.728	-1.027	-2.171
$\gamma^* - \gamma$	-1.426	-1.398	-2.286
CB	-1.023	-0.422	-0.209
critical value(5%)	-3.402	-3.402	-21.617
(1%)	-3.943	-3.943	-28.758

Notes: 1. *ADF*, $Z(t(\alpha))$, and $Z(\alpha)$, respectively, signify Augmented Dickey-Fuller test, Phillips-Perron *t*-test, and Phillips-Perron α-test.
2. Critical values refer to Fuller(1976).

tion (6) and they are proved to be nonstationary. The result of the *J*-test conducted without considering structural changes is shown in Table 2. The null hypothesis of cointegration is rejected in all the cases at 1% and 5% critical values. This suggests that the exchange rate since 1980 does not have any stable long run relationship with interest rate differentials, the accumulated current account balance, or the competitive exchange rate. This means that it is difficult to specify a long-term exchange rate model using these variables.

However, as already mentioned, several major events since the 1980s caused structural changes in the time series behavior of the exchange rate. In this paper, I have considered two major events as structural changes: the transition of the exchange rate system in early 1990 and the opening of the capital market in January 1992. Before the cointegration test with structural breaks, I performed a Wald test to see whether these events caused structural changes.[6] The results show

[6]In the test, the unrestricted model is as follows:

$$\begin{bmatrix} E^I \\ E^{II} \end{bmatrix} = \begin{bmatrix} (\gamma - \gamma^*)^I & B^I & \overline{E}^I & 0 & 0 & 0 \\ 0 & 0 & 0 & (\gamma - \gamma^*)^{II} & B^{II} & \overline{E}^{II} \end{bmatrix} \begin{bmatrix} \beta_1^I \\ \beta_2^I \\ \beta_3^I \\ \beta_1^{II} \\ \beta_2^{II} \\ \beta_3^{II} \end{bmatrix} + \begin{bmatrix} \varepsilon^I \\ \varepsilon^{II} \end{bmatrix}$$

With the restriction of $\beta_1^I = \beta_1^{II}$, $\beta_2^I = \beta_2^{II}$, $\beta_3^I = \beta_3^{II}$, then the restricted model is as follows:

TABLE 2
TESTS FOR COINTEGRATION

	J-test statistic
No Structural Change	
Whole Period:	13.281
Structural Changes	
Exchange Rate Regime Change:	8.873
Capital Market Opening:	5.889

Note: 5% and 1% critical values are, respectively, 9.488 and 13.277.

that both events did indeed cause structural changes.[7] The results of a cointegration test considering these structural changes are shown at the bottom of Table 2 and they are very interesting.

In both cases, when considering the structural changes caused by the transition of the exchange rate system and the opening of capital market, the null hypothesis of cointegration is not rejected. Without considering structural changes, the deviation from competitive exchange rates does not seem to have any relationship with interest rate differentials and the current account. However, after considering the structural changes caused by the transition of the exchange rate system or the opening of capital market, the deviation from competitive exchange rates has a long run stable relationship with interest rate differentials and the current account within the same structure. This result differs from the results reported in the previous papers on the validity of the PPP hypothesis. It shows that the existence of a cointegrating relationship for the won-dollar exchange rate depends on structural changes. That is, the long run stable relationship among these variables does not break down in the face of structural changes, but changes to another cointegrating relationship.

$E = \beta_1 (\gamma - \gamma^*) + \beta_2 B + \beta_3 \overline{E} + \varepsilon$

[7]For the Wald Test, I used long run variance derived from CCR transformation instead of the initial sample variance, so this is a kind of transformed Wald test. To estimate the long run variance, I selected the quadratic spectral kernel as used by Andrew and Monahan. For the lag truncation, I used Andrew's automatic lag selection method.

I selected August 1990 for the exact time of the transition of exchange rate system, which is 5 months later than the original date, in order to consider the lagged effect. I assumed that the capital market was opened in January 1992, which has the limitation of a lack of sample periods.

B) Model Estimation

Equation (6) is estimated to examine the validity of multi-country PPP in a broad sense. The results using CCR are as follows:

· whole period[8]

$$E_1 = \beta_0 + \beta_1 t + \underset{(3.5537)}{0.0065}(\gamma^* - \gamma) + \underset{(12.5274)}{0.1405}B - \underset{(-1.0812)}{0.1314}\,\overline{E}_1 \tag{7}$$

· before the transition of the exchange rate system

$$E_1 = \beta_0 + \beta_1 t + \underset{(2.9417)}{0.0047}(\gamma^* - \gamma) + \underset{(19.4897)}{0.1567}B - \underset{(-1.3955)}{0.1179}\,\overline{E}_1 \tag{8}$$

· after the transition of the exchange rate system

$$E_1 = \beta_0 + \beta_1 t + \underset{(3.0727)}{0.0106}(\gamma^* - \gamma) + \underset{(3.9198)}{0.0647}B + \underset{(3.4482)}{0.9732}\,\overline{E}_1 \tag{9}$$

· before the opening of the capital market

$$E_1 = \beta_0 + \beta_1 t + \underset{(3.1601)}{0.0050}(\gamma^* - \gamma) + \underset{(12.5274)}{0.1537}B + \underset{(-1.0812)}{0.1274}\,\overline{E}_1 \tag{10}$$

· after the opening of the capital market

$$E_1 = \beta_0 + \beta_1 t + \underset{(0.2452)}{0.0020}(\gamma^* - \gamma) + \underset{(1.3060)}{0.1261}B + \underset{(2.1222)}{0.8858}\,\overline{E}_1 \tag{11}$$

The results of estimation in equations (8) and (9) show how interest differentials, accumulated current account balance, and competitive exchange rates impact on the nominal exchange rate before and after change in exchange rate system. According to these results, the exchange rate in Korea was affected strongly by interest rate differentials and the accumulated current account balance both before and after the transition of the exchange rate system. The exchange rate depreciates when Korean interest rates are lower than U.S. interest rates and when there is an accumulated current account deficit. In the opposite cases, the exchange rate tends to appreciate. After the transition of the exchange rate system, the sensitivity of the exchange rate to interest rate differentials increased while its sensitivity to the current account balance decreased. This can be interpreted as meaning that with the adoption of the market average exchange rate system, capital movements have a more significant impact on the exchange rate than

[8]Using whole period data, there is no cointegrating relation. The values in parentheses are *t* values.

before.

The effect of the competitive exchange rate on the nominal exchange rate is also different before and after the change of the exchange rate regime. In equation (8), the coefficient of the competitive exchange rate is negative (–0.1179), which tells us that the nominal exchange rate depreciates when appreciation is needed and appreciates when depreciation is needed for maintaining competitiveness. According to equation (3), the won-dollar nominal exchange rate should decrease when the Japanese yen strengthens against the dollar in order to maintain competitiveness, and should increase when the yen weakens against the dollar. However, observation of the behavior of the won-dollar exchange rate in the 1980s shows that it depreciated around 1985 when appreciation was needed and appreciated around 1988-89 when depreciation was needed, resulting in the negative coefficient. This suggests that before the transition, under the multiple currency basket system, intervention of the central bank in the foreign exchange market worked against maintaining price competitiveness.[9] In equation (9), the coefficient of the competitive exchange rate is positive and near unity, which indicates that the nominal won-dollar exchange rate moves in a way that maintains price competitiveness. Therefore, unlike the results of previous papers, after the change in the exchange rate system, the cointegrating vector of $\{E_{1t}\}$, $\{\gamma_t^* - \gamma_t\}$, $\{CB_t\}$ and $\{E_{1t}\}$ meet the conditions of long run multi-country PPP in a broad sense.

The results of estimation in equations (10) and (11) show the long run relationship among time series variables before and after the opening of the capital market. They indicate that the relationship between the exchange rate and other variables has changed with the opening of the capital market. The effects of interest rate differentials and the current account are significant before the opening of the capital market but after the opening they are not quite significant. The decreased effect of the current account suggests that the importance of the current account balance for the exchange rate decreases with the opening of the capital market, but the decreased effect of interest rate differentials is a somewhat unexpected outcome. There could be two different explanations for the result. One is the lack of available data after the opening of the capital market. The other explanation is that the interest rate used in the regression is not the rate of return on stocks, but the bond yield. Since it was the stock market and not the bond market

[9]See I.J. Kim(1992) for further discussion.

that opened in 1992, the interest rate used in this study does not correctly reflect the impacts of opening of the capital market. As in the case of the transition of the exchange rate system, the effect of the competitive exchange rate on the nominal won-dollar exchange rate before and after the opening of the capital market is not the same. In equation (10), the coefficient of $\overline{E}_1$ is negative as shown in equation (8). In equation (11), the coefficient of $\overline{E}_1$ is close to unity, suggesting that the won-dollar exchange rate satisfies multi-country PPP in a broad sense after the opening of the capital market.

IV. Conclusions

In this paper, I analyzed whether the hypothesis of multi-country PPP holds with the won-dollar exchange rate and with what kind of variables the deviation from multi-country PPP has a stable long-term relationship through cointegration tests. I also estimated the long-term won-dollar exchange rate model. The results of the empirical analysis and the implications on the long-term model for Korean exchange rates are summarized below.

First, without structural breaks, the nominal won-dollar exchange rate has not moved to maintain the competitiveness of Korean products in world markets.

Second, the deviation from multi-country PPP has a stable long-term relationship with interest rate differentials, the current account, and the competitive won-dollar exchange rate.

Third, since the stable relationship among these variables reacts sensitively to structural changes, such as the transition of the exchange rate system or the opening of the capital market, it was not possible to obtain a stable long-term relationship in cointegration tests without taking into account such structural changes. However, where structural changes were considered, it was found that the variables maintain a stable long-term relationship within an established structure. When the structure changes, they maintain another relationship within that changed structure.

Fourth, the estimation results show that the interest rate differentials and current account balance have effects on the exchange rate in expected directions.

Fifth, before the structural changes (under the multi-currency basket system or before the opening of capital market), the nominal exchange rate moved irrespective of, or counter to, the direction of competitive-

ness. Since the structural changes (under the market average exchange rate system or after the opening of capital market), the nominal exchange rate has moved appropriately to maintain competitiveness. Therefore, the won-dollar exchange rate after the structural changes satisfies multi-country PPP in a broad sense.

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