Rough Draft

February 2007

The Exchange Rate Adjustment in the Course of Global Rebalancing: The Case of Korean Won

Doo Yong Yang

KIEP

1. Introduction

There is an emerging consensus that reducing the global imbalances to a less dangerous level would require compression of the US current account deficit to about 3 per cent of GDP and a concomitant curtailment of surpluses of other cuntries including practically all East Asian economies Most analysts would agree that such a proposed global adjustment would entail a substantial depreciation of the US dollar. For example, Blanchard et al. (2005), Obstfeld & Rogoff (2004) and others all argue that a 50~60% depreciation of the US dollar would be needed. In East Asia, the dollar depreciation raises am important question of assessing a set of exchange rates of East Asian economies that might be consistent with the US adjustment. The impact of the fall of the dollar will differ from country to country and this asymmetry could provoke competitive devaluation in East Asia. For an orderly adjustment of the trade imbalance between the US and East Asia, what is needed therefore is exchange rate policy coordination among the countries on the two sides of the pacific.

Despite the growing literature on the adjustment of the global imbalances, there are few papers that examine the effects of changes in the exchange rates of Asian economies triggered by the fall of the dollar on growth and stability of East Asia. The purpose of this paper is to shed light on the level of the Korean won/U.S dollar exchange rate consistent with the US adjustment.

In order to estimate an equilibrium level of the won/dollar exchange rate needed to bring about the proposed global adjustment, this paper uses two different approaches that are complementary to each other. The first approach is to find an equilibrium exchange rate determined by long-term economic fundamentals. This approach is based on the assumption that exchange rates are mean reverting in the long run, but there can be quite significant and persist deviations from the equilibrium in the short run and medium terms. This framework can help estimate the degree of deviation from the equilibrium. The behavioral equilibrium exchange rate (BEER) approach provides such a framework. The BEER is a modified version of the fundamental equilibrium exchange rate approach (FEER) of Williamson (1994). Unlike the FEER, the BEER is less normative in a sense that the FEER approach requires subjective notions of sustainable external balance and internal balance.

The second approach for the estimation of the equilibrium exchange rate relies on a general equilibrium model that offers helpful insight into what the US and East Asian economies might experience, depending on the nature of the shocks that lead to the global adjustments. Obstfeld and Rogoff (2004, 2005) developed a three country model that examines the economic consequences in the US, Europe and Asia when the current account deficit in the three region returns to the balanced level. The three country model is adapted to analyze the effects of the proposed global adjustment on the won/dollar exchange rates.

This paper is organized as follows. Section 2 estimates the equilibrium exchange rate based on the behavioral equilibrium exchange rate approach. This allows measurement of deviations from the equilibrium won/dollar exchange rate and finding the level of won/dollar exchange rate consistent with the global imbalance.adjustment. Section 3 presents the general equilibrium approach to identify the level of the equilibrium won/dollar exchange rate from the simulation of the three country model developed by Obstfeld and Rogoff (2005). Section 4 concludes the paper.

2. A Behavioral Equilibrium Exchange Rate Approach

To analyze the deviation of the won/dollar exchange rate from equilibrium, this section utilizes the concept of the behavioral equilibrium exchange rate (BEER). The behavioral equilibrium exchange rate approach modifies the fundamental equilibrium exchange rate (FEER) approach. Williamson (1994) defines the FEER as a real effective exchange rate that simultaneously ensures internal and external balances. Internal balance is said to be reached when the economy is at full employment output level and operating in a low inflation environment. With regard to external balance the FEER approach abstracts from the short-run cyclical and speculative forces in the foreign exchange market and focuses on factors that are expected to persist over the medium-term horizon. In particular, external balance is characterized as a sustainable balance of payment position over the medium-term horizon, ensuring desired net inflows of resources and external debt sustainability. The FEER approach recognizes that the equilibrium real exchange rate could change over time as factors impacting sustainable internal and external balances evolves.

Estimation of the FEER takes two steps (Clark and MacDonald (1998)). First a sustainable current account (or capital account), which is exogenously determined, is identified. This balance is then used to solve the fundamental equilibrium exchange rate. Unlike the FEER, the BEER approach focuses on the actual and not necessarily the medium-term equilibrium values of the fundamental determinants of the real exchange rate. The underlying theoretical underpinnings of the BEER approach rest on the basic concept of the uncovered real interest rate parity. The uncovered real interest rate parity is given in equation (2-1)

$$E_t(q_{t+1}) - q_t = r_t - r_t^* \qquad (2\text{-}1)$$

where q_t is real exchange rate at time *t*, and E_t denotes conditional expectation based on time *t* information, r_t and r_t^* denote domestic and foreign real interest rate respectively. By rearranging equation (2-1), the observed real exchange rate q_t can be represented as a function of the expected value of exchange rate $E_t(q_{t+1})$ and the current real interest rate differential.

$$q_t = E_t(q_{t+1}) - (r_t - r_t^*) \qquad (2\text{-}2)$$

Under the BEER approach, the unobservable expectation of the real exchange rate $E_t(q_{t+1})$ is assumed to be determined by a vector of long-run economic fundamentals Z_t, that is,

$$E_t(q_{t+1}) = f(Z_t).$$

The BEER approach produces estimates of an equilibrium real exchange rate $\overline{q_t}$ which incorporates both the long-run economic fundamentals $f(Z_t)$ and the short-run interest rate differentials.

$$\overline{q_t} = f\left(Z_t, \left(r_t - r_t^*\right)\right) \tag{2-3}$$

Frenkel and Mussa (1985), Clark and MacDonald (1998) assume that long-run determinants of economic fundamentals Z_t can be expressed as in equation (2-4)

$$E_t\left(q_{t+1}\right) = f\left(Z_t\right) = f\left(\overset{-}{tot_t}\ ,\ \overset{-}{tnt_t},\ \overset{-}{nfa_t}\right) \tag{2-4}$$

The term of trade is *tot* and *tnt* is defined as the relative price of tradable to nontradable goods, which can explain the Balassa-Samuelson effect, and *nfa* denotes the value of net foreign assets at time t. The signs above the right hand side variables are those of partial derivatives.

Since the equilibrium exchange rate is unobservable variable, a common empirical approach to estimate the BEER involves two steps. The first step is finding a long-run relationship between the prevailing real exchange rate and a set of long-run economic fundamentals in equation (2-4) on the assumption that most variables are non-stationary. If a set of long-term equilibrium relationship is found in the relevant variables, then a vector error correction model can be used to estimate the relevant coefficients. .

A unit root test finds that the foreign exchange rate, the terms of trade and the level offoreign exchange reserves, which is a proxy of the net foreign assets, have non-stationary times series characteristics. In order to find the long-term stable relationship among the three variables, the cointegration test is conducted. There exists at least one cointegrated relationship among the three variables (see Table 1). The following equation is then estimated by the VECM (Vector Autoregressive Error Correction Model) to derive the behavioral equilibrium exchange rate.

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \mu + \varepsilon_t \qquad (2\text{-}5)$$

where y_t represents the vector of the non-stationary variables, q_t, tot, tnt, and nfa, μ is a constant term and ε_t is a Gaussian white noise. The number of cointegration relationships corresponds to the rank of the matrix Π. Since there is only one cointegration relationship and a stationary exogenous real interest rate differential, a VECM with the following structure is estimated:

$$\begin{bmatrix} \Delta q_t \\ \Delta nfa_t \\ \Delta tnt_t \\ \Delta tot_t \end{bmatrix} = \Gamma_1 \begin{bmatrix} \Delta q_{t-1} \\ \Delta nfa_{t-1} \\ \Delta tnf_{t-1} \\ \Delta tot_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} \begin{bmatrix} 1 & \beta_1 & \beta_2 & \beta_3 & \beta_4 & \beta_5 \end{bmatrix} \begin{bmatrix} q_{t-1} \\ t \\ nfa_{t-1} \\ tnt_{t-1} \\ tot_{t-1} \end{bmatrix} + \mathrm{P} \begin{bmatrix} rid_t \\ rid_{t-1} \\ rid_{t-1} \end{bmatrix} + \mu + \varepsilon_t \qquad (2\text{-}6)$$

where t represents the time trend. The long-term relationship of the system is obtained from the second part of right hand side of equation (2-5) and the estimated coefficient.

The second step uses the coefficient parameters of the fundamental variables, $\left(\hat{\beta}_1, \hat{\beta}_2\, \hat{\beta}_3, \hat{\beta}_4, \hat{\beta}_5\right)$, to generate the long-run fundamental equilibrium rate.

$$q_t^{BEER} = \hat{\beta}_1 + \hat{\beta}_2\, t + \hat{\beta}_3\, nfa_t + \hat{\beta}_4\, tnt_t + \hat{\beta}_5\, tot_t \qquad (2\text{-}7)$$

In the estimation of equation (2-6) and (2-7), the long-term trends of net foreign assets and terms of trade, which are estimated by the Hodrick-Prescott filtering, are used. Table 2 reports the estimation result of equation (2-7). This estimated equation is then used to simulate both the real effective and the bilateral won/dollar exchange rates. As expected, the coefficients of *nfa* and *tot* are negative which implies that the deterioration of the terms of trade and decrease in the value of net foreign asset induce a depreciation of both the real and nominal bilateral exchange rates. The coefficient of *tot* has a positive value but is not statistically significant.

<Figures 2 and 3> show the simulated q_t^{LFER} based on equation (2-7). The simulation results show the deviation from the equilibrium exchange rate, that is, an overvaluation or undervaluation of the real effective exchange and the won/dollar bilateral exchange rates. Judging from the simulation, the real effective won/dollar exchange rate is 3.8% overvalued as of February 2006 whereas the won/dollar bilateral exchange rate is 8% overvalued from the equilibrium exchange rate. These simulation

results suggest that Korea has made exchange rate adjustments to reduce its current account surplus, which is expected to disappear altogether in 2007 (see <figure 1>).

3. A General Equilibrium Approach

This section develops a three-country general equilibrium model along the line of Obstfeld and Rogoff (2005) to conduct a quantitative analysis of the effects of changes in the exchange rates of some of the East Asian economies on their current account balances. To be more specific, the three country model is used to analyze the effects of changes in real exchange rates of the US, Japan, China, and Korea on the global imbalances and to examine several scenarios to rebalance the current accounts across the trans-pacific countries, i.e. the US, China, Japan and Korea[1]are examined.

Inclusion of Korea in this analysis helps highlight the adjustment process of the small open emerging economies in East Asia to significant external shocks they will be exposed to during the process of global rebalancing. In estimating and calibrating the potential exchange rate changes in response to the global rebalancing, most previous analyses have focused on large economies or a group of major global players such as the US, Europe, China and Japan. Since trade and financial flows of these large economies are mostly responsible for global current account imbalances, it is appropriate to analyze the economic consequences based on the adjustments and policy changes of those economies (Obstfeld and Rogoff (2004, 2005) and Blanchard, Giavazzi and Sa (2005)).

However, in the course of the global readjustment, the small open economies in

East Asia such as Korea may experience an undershooting of the domestic currency against major international currencies such as the US dollar, the euro, and the yen. For example, a fall of the U.S. dollar against the yen is likely to create the pressure on the Korea won to appreciate against the U.S dollar and the yen at the same time. As a result, the won/yen bilateral exchange rate will appreciate more than otherwise. Expectations of the U.S dollar against the yen and the euro will induce shifting out of the U.S dollar denominated assets, causing the won/dollar exchange rate to appreciate more than otherwise.

As shown in the previous section, even though the won/dollar exchange rate has already approached the equilibrium level, the market may expect a further appreciation of the won/dollar exchange rate. This will induce foreign capital inflows, reinforce the appreciation pressure, and in the end could create bubbles in the domestic financial markets. Therefore, as long as global imbalances exist and rebalancing is expected, the currencies of small open economies in East Asia would face continuous pressure of appreciation against the major global currencies. In this sense, the adjustments of Japan and China to global imbalances are critical to the currency movements of small open economies. However, the current picture of rebalancing process is likely to impose greater burden on small open economies in East Asia. The yuan is almost fixed to the U.S. dollar, and the yen has depreciated against the U.S dollar despite the growing volume of Japan's trade surplus.

Against this background, using the three country model, this paper simulates exchange rate changes of the won in two scenarios. The first scenario calculates the

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[1] More detailed description of the three country model provided in the appendix.

required exchange rates to remove all the current account imbalances of all three countries. In this scenario two cases of adjustments are considered. In case1, the three-country model includes the United States, Japan and Korea, and in case 2, the United States, China and Korea. First, the exchange rates required to remove current account imbalances in all three countries are calculated. In case 1, the adjustment of the imbalances requires that the U.S dollar depreciate against the yen by 13.3%, the won against the yen then depreciates by 14%, and the won against the U.S. dollar depreciates by 3% in nominal terms. This adjustment corresponds to an equilibrium nominal exchange rate of the won/dollar of 1054 (see Table 6) [2]. This simulation result makes it clear that Korea has to take into account its chronic current deficit vis-a-vis Japan when it calculates the equilibrium exchange rate. In case 2, the U.S. dollar against the yuan should appreciate by 102.8%, and the yuan against the won by 27.1%. However, the won against the U.S dollar appreciates by 47.9% in nominal terms, and the expected nominal won/dollar rate is 703.

The second scenario assumes that each country reduces trilateral current account balances by 30%. In case 1, the U.S dollar against the yen should appreciate by 3.9%, the yen against the won depreciates by 4.7%, but the won against the U.S dollar should depreciate by only 1%. The equilibrium won/dollar exchange rate for case 1 turns out to be 1023 (see table 7). In case 2, the U.S dollar against the yen should appreciate by 29%, and the yuan against the won depreciates by 11%, but the won against the U.S appreciates by 13.7%. The equilibrium exchange rate of the won/dollar for case 2 is 874.

Finally, this paper calibrates the case when only Korea and the U.S. reduce the

[2] Since the data of the simulation based on the end of 2005, the baseline nominal won/dollar exchange rate is 1013.

bilateral current account balance by 30% and neither Japan nor China does adjust their current account positions. In case 1, the U.S. dollar against the yen should depreciate by 1.3%, but the yen against the won appreciates by 17.8%, and the won against the U.S dollar should appreciate by 16.2%, which ends up with the equilibrium won/dollar rate of 858 (see Table 8). In case 2, the U.S dollar against the yuan should appreciate by 3%, but the yuan against the won appreciate by 77.6%, and the won against the U.S. dollar should appreciate by 82.9% with an equilibrium rate of 560 of the won/dollar exchange rate.

The implications of the simulations based on the two scenarios show that the adjustments of the yuan to the global imbalances have much greater impacts on the won/dollar exchange rates than those of the Japan yen. If the current account surplus of China is reduced significantly, this would reduce the China's demand for imports and hence the demand for Korea's exports to both China and the United States will decrease.. As a consequence, the real exchange rate of the Korean won would appreciate due to the decrease in the global demand for Korea's exports. On the other hand, the decrease in Japan's demand for imports has relatively less impacts on the won/dollar exchange rates.

Second, if Japan and China do not adjust and the U.S. current account gap is reduced, Korea would bear greater burden than otherwise, ending up with a current account deficit more or less and more than expected won/dollar appreciation.

4. Conclusion

Most analysts agree that the global imbalance should be rebalanced to a sustainable level. In the course of rebalancing the U.S dollar depreciation is inevitable.

The effects of the weaker U.S. dollar on the U.S. economy have been much discussed and the prediction is varying from an optimistic to a very pessimistic outcomes. There is also widespread consensus that the consequences of the dollar depreciation in East Asia would be a severe recession for the regional economy. In this regard, this paper tries to shed light on the effects on the Korean won/dollar exchange rate of the adjustment of the global current account imbalances.

The main findings of this paper can be summarized as follows. First, after a sustained appreciation for more than a year, the Korean won/U.S dollar reached the equilibrium level in 2006. Both the BEER and the general equilibrium model simulations show that the won/dollar rate in 2006 appreciated enough to balance the current account in 2007. Second, even though Korea is going to balance its current account, the country is likely to face with the pressure of further appreciation on its currency largely due to the growing pressure of appreciation on other Asian currencies. In conclusion, Korea and other small open economies in East Asia will benefit from regional and global cooperation in the adjustment of the global imbalances.

<Appendix>

In this appendix, the general structure and assumption of the three county model of Obstfeld and Rogoff (2005) are presented. Several assumptions are made for analytical simplicity. First, it is assumed that the endowments are exogenously given for, implying that capital and labor are not mobile in the short-run. In addition, the composition of tradables and non-tradables are invariable. Next, price is assumed to be flexible, and the inter-temporal allocation consumption is not considered. It is also assumed that initial pattern of international indebtedness, and world-wide interest rate is exogenously given. Then the relative prices are solved with the equilibrium conditions in all goods markets. Finally, this model considers changes in the international pattern of external imbalances, either due to relative demand shifts or due to relative shifts in productivity to obtain a new set of equilibrium prices.

3-1 A Three country model

Consumers in three countries (the US, Japan and Korea or the US, China and Korea) allocate their endowed income among consumption bundles which consist of home and foreign tradables as well as home nontradables. For each country, consumption index can be expressed in the nested form

$$C^i = [\gamma_i^{\frac{1}{\theta}} (C_T^i)^{\frac{\theta-1}{\theta}} + (1-\gamma_i)^{\frac{1}{\theta}} (C_N^i)^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} \quad , 0<\theta<1, \text{ for each country} \qquad (1)$$

where C_N^i represents nontradables consumption of country *i* and γ_i is the share of tradables in the aggregate consumption of country *i*. The parameter θ is the (constant) elasticity of substitution between tradable and nontradable goods. C_T^i, tradables of country *i* is an index given by

$$C_T^i = [\alpha_i^{\frac{1}{\eta}} (C_i^i)^{\frac{\eta-1}{\eta}} + (\beta_i - \alpha_i)^{\frac{1}{\eta}} (C_j^i)^{\frac{\eta-1}{\eta}} + (1 - \beta_i)^{\frac{1}{\eta}} (C_k^i)^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}} \quad , 0 < a_i < 1 \qquad (2)$$

Here C_i^i is the country *i*'s home consumption of home-produced tradable goods, C_j^i is country *i*'s home consumption of foreign (country *j*)-produced tradable goods, and C_k^i is country *i*'s home consumption of foreign (country *k*)-produced tradable products. α_i is country *i*'s weight on its own tradables, and β_i is country *i*'s weight on country *j*'s tradables. The parameter η is the (constant) elasticity of substitution between domestically-produced and imported tradables.

The home consumer price index (CPI) corresponding to the preceding consumption index C, measured in units of home currency, is given by

$$P_C^i = \left[\gamma \left(P_T^i\right)^{1-\theta} + (1-\gamma)\left(P_N^i\right)^{1-\theta}\right]^{\frac{1}{1-\theta}} \qquad (3)$$

with the price of tradable good for county *i* can be expressed as:

$$P_T^i = \left[\alpha_i P_i^{1-\eta} + (\beta_i - \alpha_i) P_j^{1-\eta} + (1-\beta_i) P_k^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{4}$$

If we assume that the law of one price for tradable holds, then the price of a country's tradable good is same in all countries. However, if we assume that each country has a relative preference for tradables that it produces and exports abroad, the tradables price index can differ across countries even when the law of one price holds. Therefore changes in terms of trade affect real exchange rates.

From equation (3) and (4), are derived three bilateral terms of trade, three bilateral real exchange rates. The terms of trade can be expressed as:

$$\tau_{i,j} = \frac{P_j}{P_i}, \quad \tau_{j,k} = \frac{P_k}{P_j}, \text{ and } \quad \tau_{i,k} = \frac{P_k}{P_i} = \frac{\tau_{i,k}}{\tau_{i,i}} \tag{5}$$

While the real exchange rate is defined as

$$q_{i,j} = \frac{S_{i,j} P_C^j}{P_C^i}, \quad q_{j,k} = \frac{S_{i,k} P_C^k}{P_C^j}, \quad q_{i,k} = \frac{S_{i,k} P_C^i}{P_C^k} = \frac{q_{i,k}}{q_{i,j}} \tag{6}$$

Note that because of the home bias in consumption of tradables, purchasing power parity does not hold for the differing preferred baskets of tradables in each country, even if the law of one price holds for individual tradable goods. From equation (6), (5) and (3) the bilateral real exchange rate for country i is given by

$$\begin{aligned} q_{i,j} &= \frac{P_T^i}{P_T^i} \times \frac{\left[\gamma + (1-\gamma)\left(\frac{P_N^j}{P_T^i}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}}{\left[\gamma + (1-\gamma)\left(\frac{P_N^i}{P_T^i}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}} \\ &= \frac{\left[\alpha_j \tau_{i,j}^{1-\eta} + (\beta_j - \alpha_j) + (1-\beta_j)\tau_{i,j}^{1-\eta}\right]^{\frac{1}{1-\eta}}}{\left[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}\right]^{\frac{1}{1-\eta}}} \times \frac{\left[\gamma + (1-\gamma)\left(\frac{P_N^j}{P_T^i}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}}{\left[\gamma + (1-\gamma)\left(\frac{P_N^i}{P_T^i}\right)^{1-\theta}\right]^{\frac{1}{1-\theta}}} \end{aligned} \tag{7}$$

The real exchange rates for country j and k are analogous.

3-1 Market Equilibrium

The market clearing condition for country i's produced good can be written as

$$Y_T^i = \gamma\alpha_i\left(\frac{P_i}{P_T^i}\right)^{-\eta}\left(\frac{P_T^i}{P_C^i}\right)^{-\theta}C^i + \gamma(\beta_i - \alpha_i)\left(\frac{P_i}{P_T^j}\right)^{-\eta}\left(\frac{P_T^j}{P_C^j}\right)^{-\theta}C^j + \gamma(1-\beta_i)\left(\frac{P_i}{P_T^k}\right)^{-\eta}\left(\frac{P_T^k}{P_C^k}\right)^{-\theta}$$

(8)

where Y_T^i is the country *i*'s endowment of its tradable goods, and it can be used for domestic consumption and foreign consumption in the good market. There is an analogous market-clearing condition for the country *j*'s and *k*'s tradables endowment, For country *i*'s nontradables, the equilibrium condition is given by

$$Y_N^i = (1-\gamma)\left(\frac{P_N^i}{P_C^i}\right)^{-\theta}C^i. \tag{9}$$

Abstracting from the underlying determinants of domestic and foreign saving and consumption, consumption and endowment for each country can be taken as given. Home resident's tradables consumption then depends negatively on its price:

$$C_T^i = \gamma\left(\frac{P_T^i}{P_C^i}\right)^{-\theta}C^i \tag{10}$$

Plugging (10) into (9), the equilibrium condition for country i's product market in nominal term is rewritten as

$$P_i Y_T^i = \alpha_i \left(\frac{P_i}{P_T^i} \right)^{1-\eta} P_T^i C_T^i + (\beta_i - \alpha_i) \left(\frac{P_i}{P_T^j} \right)^{1-\eta} P_T^j C_T^j + (1 - \alpha_i) \left(\frac{P_k}{P_T^k} \right)^{1-\eta} P_T^k C_T^k \qquad (11)$$

Equation (11) says that the country *i*'s output value measured in home currency equals the sum of country *i, j*, and *k*'s resident's demand for country *i*'s output. The country *i*'s current account surplus CA^i is defined as

$$CA^i = P_i Y_T^i + rF^i - P_T^i C_T^i \qquad (12)$$

where F^i denotes country *i*'s net Foreign assets and *r* (which is assumed to be given) denotes the nominal interest rate. Substituting for $P_T^i C_T^i$, $P_T^j C_T^j$, $P_T^k C_T^k$ in equation (11) and its foreign-tradable analog, we can have the following equilibrium conditions of two tradables and three nontradables for the three-country world.

$$P_iY_T^i = \alpha_i\left(\frac{P_i}{P_T^i}\right)^{1-\eta}\left(P_i\,Y_T^i + rF^i - CA^i\right) + \left(\beta_i - \alpha_i\right)\left(\frac{P_i}{P_T^j}\right)^{1-\eta}\left(P_j\,Y_T^i + rF^j - CA^j\right)$$
$$+\left(1-\beta_i\right)\left(\frac{P_i}{P_T^j}\right)^{1-\eta}\left(P_k\,Y_T^k + rF^k - CA^k\right) \qquad (13)$$

$$P_iY_T^j = \alpha_j\left(\frac{P_j}{P_T^i}\right)^{1-\eta}\left(P_jY_T^i + rF^j - CA^j\right) + \left(\beta_j - \alpha_j\right)\left(\frac{P_i}{P_T^j}\right)^{1-\eta}\left(P_i\,Y_T^{ii} + rF^i - CA^i\right)$$
$$+\left(1-\beta_i\right)\left(\frac{P_j}{P_T^j}\right)^{1-\eta}\left(P_k\,Y_T + rF^k - CA^k\right) \qquad (14)$$

$$P_N^iY_N^i = \frac{1-\gamma}{\gamma}\left(\frac{P_N^i}{P_T^i}\right)\left(P_i\,Y_T^i + rF^i - CA^i\right) \qquad (15)$$

$$P_N^jY_N^j = \frac{1-\gamma}{\gamma}\left(\frac{P_N^j}{P_T^j}\right)\left(P_j\,Y_T^j + rF^j - CA^j\right) \qquad (16)$$

$$P_N^kY_N^k = \frac{1-\gamma}{\gamma}\left(\frac{P_N^k}{P_T^k}\right)\left(P_k\,Y_T^k + rF^k - CA^k\right) \qquad (17)$$

Goods market equilibrium conditions consist of each country's tradables and home and foreign nontradables equilibrium conditions, in which only five conditions are independent. Hence, we only need to solve for the bilateral terms of trade for each country from the equilibrium conditions. Then the real exchange rates, q can be derived from the definition, equation (7).

Since this paper is interested in the changes in won/dollar exchange rate stemming from the process of current account current rebalancing, the effects of real exchange rates due to the shocks that make the current account balance are solved.

3-2 Simulation Analysis

For a quantitative analysis, the equilibrium conditions are written in terms of the ratios to nominal tradable component of GDPs by dividing equation (13) and (17) with each country's nominal tradable GDPs. Let $ca^i = CA^i/\left(P_i Y_T^i\right)$, and $f^i = F^i/\left(P_i Y_T^i\right)$, and $\sigma_{N,i} = Y_N^i / Y_T^i$. In addition let the relative price indexes for traded and nontraded goods in each country be given as $x^i = P_N^i / P_T^i$. Country *j* and *k*'s normalization is analogous. Then the market equilibrium conditions can be derived as;

$$
\begin{aligned}
1 = {} & \alpha_i \frac{1}{[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}]}[1 + rf^i - \mathrm{c}a^i] \\
& + (\beta_j - \alpha_j)\frac{1}{[\alpha_j \tau_{i,,j}^{1-\eta} + (\beta_j - \alpha_j) + (1-\beta_j)\tau_{i,k}^{1-\eta}]}[\frac{\tau_{i,j}}{\sigma_{i,j}} + rf^j - ca^j] \\
& + (\beta_k - \alpha_k)\frac{1}{[\alpha_k \tau_{i,k}^{1-\eta} + (\beta_k - \alpha_k) + (1-\beta_k)\tau i_{i,j}^{1-\eta}]}[\frac{\tau_{i,k}}{\sigma_{i,k}} - r(f^k) + ca^k]
\end{aligned}
\tag{18}
$$

$$
\begin{aligned}
1 = {} & (\beta_i - \alpha_i)\frac{\tau_{i,j}^{1-\eta}}{[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,j}^{1-\eta}]}[\frac{\sigma_{i,j}}{\tau_{i,j}}(1 + rf^i - ca^i)] \\
& + \alpha_j \frac{\tau_{i,j}^{1-\eta}}{[\alpha_j \tau_{i,j}^{1-\eta} + (\beta_j - \alpha_j) + (1-\beta_j)\tau_{i,j}^{1-\eta}]}[1 + \frac{\sigma_{i,j}}{\tau_{i,j}}(rf^j - ca^j)] \\
& + (1-\beta_k)\frac{\tau_{i,k}^{1-\eta}}{[\alpha_k \tau_{i,k}^{1-\eta} + (\beta_k - \alpha_k) + (1-\beta_k)\tau_{i,j}^{1-\eta}]}[\frac{\sigma_{i,k}}{\tau_{i,k}}(\frac{\tau_{i,k}}{\sigma_{i,k}} + r(f^k) + ca^k)]
\end{aligned}
\tag{19}
$$

$$
\sigma_{n,1} = \frac{1-\gamma}{\gamma}(x^i)^{-\theta}[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}]^{\frac{1}{1-\eta}}(1 + rf^i - ca^i)
\tag{20}
$$

$$\sigma_{n,2} = \frac{1-\gamma}{\gamma}(x^j)^{-\theta}[\alpha_j + (\beta_j - \alpha_j)\tau_{i,j}^{(1-\eta)} + (1-\beta_j)\tau_{j,k}^{1-\eta}]^{\frac{1}{1-\eta}}[1+\frac{\sigma_{i,j}}{\tau_{i,j}}(rf^j - ca^j)] \tag{21}$$

$$\sigma_{n,3} = \frac{1-\gamma}{\gamma}(x^k)^{-\theta}[\alpha_k + (\beta_k - \alpha_k)\tau_{i,k}^{(1-\eta)} + (1-\beta_k)\tau_{j,k}^{(1-\eta)}]^{\frac{1}{1-\eta}}[1-\frac{\sigma_{i,k}}{\tau_{i,k}}[r(f^k) + ca^k] \tag{22}$$

Then, real exchange rates changes for each country using results of above equations from the current account rebalancing are obtained.

$$q_{i,j} = \frac{[\alpha_j\tau_{i,j}^{1-\eta} + (\beta_j - \alpha_j) + (1-\beta_j)\tau_{i,k}^{1-\eta}]^{\frac{1}{1-\eta}}}{[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}]^{\frac{1}{1-\eta}}} \times \frac{[\gamma + (1-\gamma)x^{j^{1-\theta}}]^{\frac{1}{1-\theta}}}{[\gamma + (1-\gamma_1)x^{i^{1-\theta}}]^{\frac{1}{1-\theta}}} \tag{29}$$

$$q_{i,k} = \frac{[\alpha_k\tau_{i,k}^{1-\eta} + (\beta_k - \alpha_k) + (1-\beta_k)\tau_{i.k}^{1-\eta}]^{\frac{1}{1-\eta}}}{[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}]^{\frac{1}{1-\eta}}} \times \frac{[\gamma + (1-\gamma)x^{k^{1-\theta}}]^{\frac{1}{1-\theta}}}{[\gamma + (1-\gamma)x^{i^{1-\theta}}]^{\frac{1}{1-\theta}}} \tag{30}$$

$$q_{j,k} = \frac{q_{i,k}}{q_{i,j}} \tag{31}$$

In order to derive the bilateral nominal exchange rate, it is assumed that central banks stabilize GDP deflator as Obstfeld and Rogoff assume in their paper (2005).[3] More

[3] This partially reflects the fact that inflation targeting is optimal when there is only goods market friction.

specifically, central banks are assumed to stabilize geometric averages of the prices of tradable and nontradable domestic output. Thus,

$$
\begin{aligned}
P_i^{\gamma}(P_N^i)^{1-\gamma} &= 1 \\
P_j^{\gamma}(P_N^j)^{1-\gamma} &= 1 \\
P_k^{\gamma}(P_N^k)^{1-\gamma} &= 1
\end{aligned}
$$

Using above equations, the following nominal exchange rate formulas are derived:

$$
S_{i,j} = q_{i,j} \times \frac{[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}]^{\frac{\gamma_1}{1-\eta}}}{[\alpha_j + (\beta_j - \alpha_j)\tau_{i,j}^{(1-\eta)} + (1-\beta_j)(\frac{\tau_{i,k}}{\tau_{i,j}})^{1-\eta}]^{\frac{\gamma_2}{1-\eta}}} \tag{32}
$$

$$
S_{i,k} = q_{i,k} \times \frac{[\alpha_i + (\beta_i - \alpha_i)\tau_{i,j}^{1-\eta} + (1-\beta_i)\tau_{i,k}^{1-\eta}]^{\frac{\gamma_1}{1-\eta}}}{[\alpha_k + (\beta_k - \alpha_k)\tau_{i,j}^{(1-\eta)} + (1-\beta_k)(\frac{\tau_{1i,k}}{\tau_{i,j}})^{(1-\eta)}]^{\frac{\gamma_3}{1-\eta}}} \tag{33}
$$

With the model specification and parameter assumptions, we can simulate the won/dollar exchange rate which shows what happens with various scenarios on each country's current account balance. The critical parameters in the simulation are θ, the elasticity of substitution in consumption between tradables and nontradabels, and η, the elasticity of substitution in consumption between the tradabels produced in three countries. In our simulations, we set θ to one.[4] For the choice of η, we set it 2.

---

[4] For the value of theta, Mendoza (1991) report estimate of 0.74, while Stockman and Tesar (1995) use

The parameters, a_1, $(\beta_1 - a_1)$, and $(1 - \beta_2)$ are set to be 0.86, 0.12, and 0.02 in the U.S. and other countries parameters are reported in <Table 3> and <Table 4>. These parameters are set to reflect the consumption weights of the relevant three countries' on tradables consumption baskets. The other parameter assumptions for the model simulation are reported in Table 5.

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estimate of 0.44.

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Obstfeld Maurice and Kenneth Rogoff, 2004, "The Unsustainable US Current Account Position Revisited" NBER Working Paper

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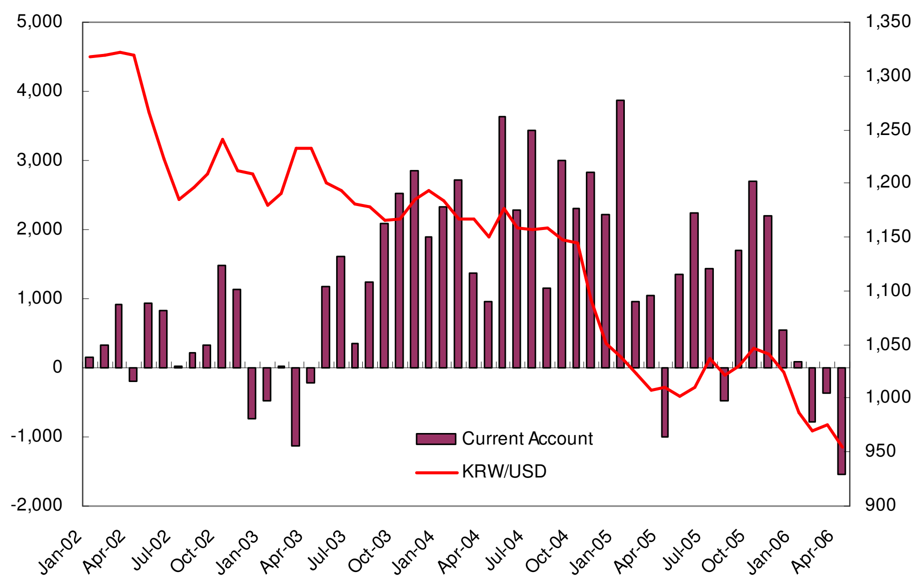
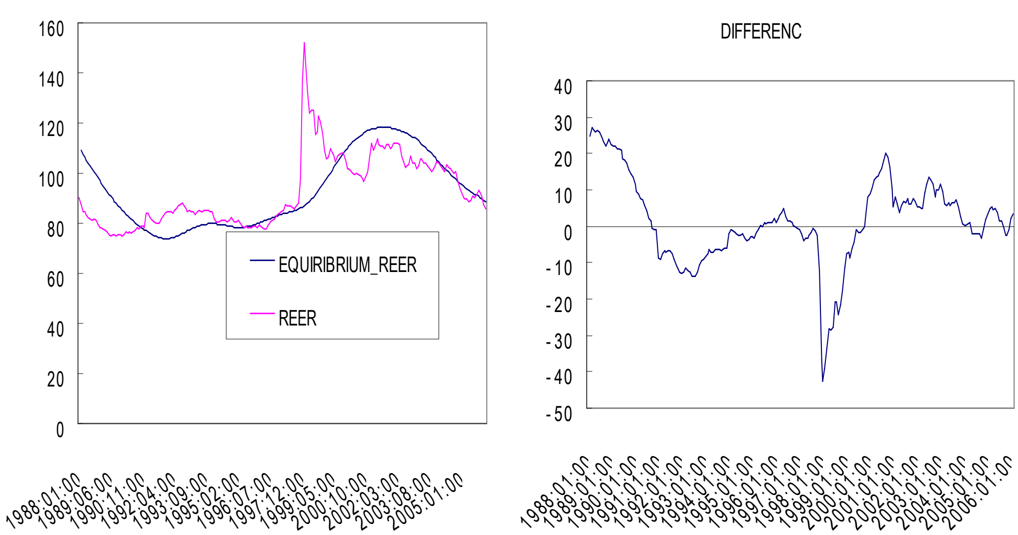
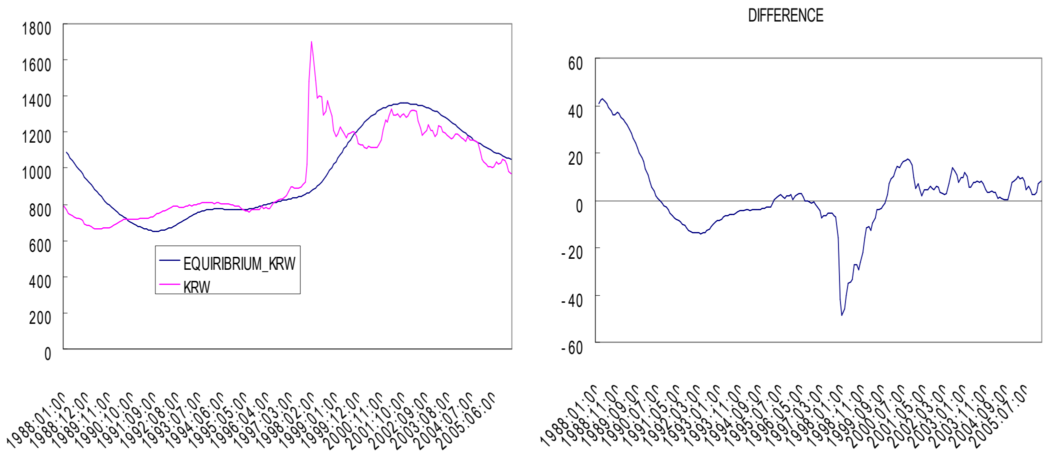
<Figure 1> Current Account and the Won/dollar Exchange Rates



<Figure 2> Real Effective Exchange Rates and Equilibrium Long-term Exchange Rates



<Figure 3> Won/dollar and Equilibrium Long-term Exchange Rates



<Table 1> Conintegration Test

	Trace Statistics	5%	1%
None	80.12*	77.74	85.78
At most 1	50.32	54.64	61.24
At most 2	23.21	24.55	40.47

<Table 2> Estimation Results of Equation (2-5)

	β_1	β_2	β_3	β_4	β_5
Won/dollar	-3101	4.22	-0.006* (0.002)	-22.1* (9.79)	2453 (2004)
Effective Real Exchange Rate	-293	0.406	-0.0005* (0.00018)	-1.95* (0.79)	196.7 (157.2)

Note: Parentheses are standard errors for the coefficients

<Table 3> Case 1 (United States, Japan and Korea)

	(α)	$(\beta - \alpha)$	$(1 - \beta)$
U.S.	0.845	0.135	0.02
Japan	0.15	0.84	0.01
Korea	0.13	0.5	0.82

<Table 4> Case 2 (United States, China and Korea)

	(α)	$(\beta - \alpha)$	$(1 - \beta)$
U.S.	0.93	0.05	0.02
China	0.14	0.85	0.01
Korea	0.13	0.02	0.85

<Table 5> Parameter Values

	Case 1	Case 2
γ_1	0.25	0.25
γ_2	0.5	0.5
γ_3	0.5	0.5

θ	1	1
η	2	2
ca^1	0.037	0.078
ca^2	0.04	0.063
ca^3	0.003	0.015
$\sigma_{1,2}$	1.27	1.27
$\sigma_{1,3}$	9.04	9.04
$\sigma_{n,1}$	3	3
$\sigma_{n,2}$	1	1
$\sigma_{n,3}$	1	1

<Table 6> the expected won/dollar exchange rates when all current account balances are squared

	Nominal Exchange Rate Change (%)			Real EX (%)	Expected Ex (won/$)
Case 1	U.S. – Japan	Japan - Korea	U.S. – Korea	U.S. – Korea	
	13.3	-14	-3	-2.8	1054

Case 2	U.S. – China	China - Korea	U.S. – Korea	U.S. – Korea	
	102.8	-27.1	47.9	45.6	703

<Table 7> the expected won/dollar exchange rates when all countries reduce CA position by 30%

	Nominal Exchange Rate Change (%)			Real EX (%)	Expected Ex (won/$)
Case 1	U.S. – Japan	Japan - Korea	U.S. – Korea	U.S. – Korea	
	3.9	-4.7	-1	-1.4	1023
Case 2	U.S. – China	China - Korea	U.S. – Korea	U.S. – Korea	
	29	-11	13.7	14.3	874

<Table 8> the expected won/dollar exchange rates when only Korea and the U.S reduce CA position by 30%

	Nominal Exchange Rate Change (%)			Real EX (%)	Expected Ex (won/$)
Case 1	U.S. – Japan	Japan - Korea	U.S. - Korea	U.S. – Korea	
	-1.3	17.8	16.2	17.2	858
Case 2	U.S. – China	China - Korea	U.S. - Korea	U.S. – Korea	
	3	77.6	82.9	83.2	560