(First Draft)

The effect of the Chinese renminbi on the Korean exports to Japan

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This research aims to determine the effect of the value of the Chinese yuan on the export volume from Korea to Japan. For this purpose, the quarterly export data of Korea from 1986 to 2003 are examined. Specifically, this study examines the long-run relationship between the Korean exports to Japan and other economic factors including the real exchange rate of the Chinese yuan by performing cointegration tests。 In addition, the short run impacts of the real exchange rate of the Chinese yuan on the Korean exports to Japan are examined by estimating error-correction models. Along with the real exchange rate of the Chinese yuan, other economic variables such as the Japanese industrial production indices, the real exchange rate of the Korean won, and the exchange rate volatility of the Korean won are also employed as explanatory variables. The test results indicate a negative long-run relationship between the Korean exports to Japan and the real exchange rate of the Chinese yuan against the Japanese yen. However, the estimation of the error correction models reveals that short-run impacts of the variables are not clearly detected from the data examined.

JEL Classification: C2, F1, F3
Keywords: Korean exports to Japan, Chinese yuan, Cointegration, Error correction model

1. Introduction

Different from most East Asian countries, the Chinese government has maintained a fixed exchange rate regime. Specifically, the value of the Chinese yuan has been fixed to the U.S. dollar. Because the currency values of other East Asian countries against the U.S. dollar are fluctuating, the Chinese yuan is frequently noted to be over- or under-valued compared with other East Asian currencies. Especially, the under-valued Chinese yuan is regarded as a threat to the exports of East Asain countries, because China is their major competitor in the international market.

However, the effect of the value of the Chinese yuan on the exports of other East Asian countries has been rarely explored. Against this background, this research aims to determine the effect of the value of the Chinese yuan on the export volume from Korea to Japan. Even though it targets the exports of one country, the research results should shed light on the understanding of other cases.

For this purpose, the quarterly export data of Korea from 1986 to 2003 are examined. Specifically, following the work of Arize, Osang and Slottje (2000), Chowdhury (1993) and Hassan and Tufte (1998) among others, this study examines the long-run relationship between the Korean exports to Japan and other economic factors including the real exchange rate of the Chinese yuan by performing cointegration tests。 In addition, the short run impacts of the real exchange rate of the Chinese yuan on the Korean exports to Japan are examined by estimating error-correction models. Along with the real exchange rate of the Chinese yuan, other economic variables such as the Japanese industrial production indices, the real exchange rate of the Korean won, and the exchange rate volatility of the Korean won are also employed as explanatory variables of the Korean exports to Japan. Exchange rate volatility is measured by computing the quarterly standard deviations of monthly real bilateral exchange rates.

The test results indicate a negative long-run relationship between the Korean exports to Japan and the real exchange rate of the Chinese yuan against the Japanese yen. That is, depreciation of the value of the Chinese yuan has a negative impact on the volume of the Korean exports to Japan. More specifically, one percent increase of the exchange rate of the Chinese yuan (that is, one percent decrease of the value of the Chinese yuan) turns out to decrease the Korean exports by about one percent.

On the other hand, one percent increase of the exchange rate of the Korean won (that is, one percent decrease of the value of the Korean won) turns out to decrease the Korean exports by about two percent. It implies the impact of the Chinese yuan on the Korean exports is half of the impact of the Korean won.

Manufacturing production indices of Japan and the volatility of the Korean exchange rates turn out to have expected impacts on the Korean exports in the long run. The former has positive impacts, while the latter has negative impacts.

However, the estimation of the error correction models reveals that short-run impacts of the variables are not clearly detected from the data examined.

2. Description of the models and data

2.1. The cointegration equation

This paper investigates the long-run export function by performing cointegration tests and the short run dynamics of the export function by estimating error-correction models, as in the studies of Arize, Osang and Slottje (1999, 2000), Chowdhury (1993) and Hassan and Tufte (1998).

Following the typical specification of other papers, the long-run equilibrium relation between exports and other economic variables is examined in this paper by the following equation:

$$X_t = \xi_0 + \xi_1 . g_t + \xi_2 p_t + \xi_3 \sigma_t + \xi_4 p_t^C + \varepsilon_t \qquad \text{------ (1)}$$

where X_t denotes real exports from Korea to Japan; g_t the manufacturing production index of Japan; p_t the real bilateral exchange rate of the Korean won against the Japanese yen, reflecting the price competitiveness; σ_t the volatility of the bilateral exchange rates of the Korean won against the Japanese yen; p_t^c the real bilateral exchange rate of the Chinese yuan against the Japanese yen and ε_t a disturbance term. All variables are in natural logarithm and the subscript *t* symbolizes the time.

In this equation, g_t is used as a proxy for the level of economic activity in the importing country. It is expected that the higher the economic activity in the importing country, the higher the demand for exports. Therefore, the value for ξ_1 is expected to be positive. Since a higher real exchange rate implies a lower relative price, the value for ξ_2 is also expected to be positive.

Exchange rate volatility is measured by computing the quarterly standard deviations of monthly real bilateral exchange rates.

2.2. The error-correction model

After observing the results of cointegration tests, the following dynamic error correction (EC) model is constructed and estimated to see the short-run impacts of the explanatory variables on the Korean exports:

$$\Delta X_t = \alpha + \lambda EC_{t-1} + \sum_{h=0}^{nx} \beta_h \Delta X_{t-h-1} + \sum_{h=o}^{np} \gamma_h \Delta p_{t-h} + \sum_{h=0}^{ng} \delta_h \Delta g_{t-h} + \sum_{h=0}^{ns} \eta_h \Delta \sigma_{t-h} + \sum_{h=o}^{np} \pi_h \Delta p^c_{t-h} + u_t \quad \text{--(2)}$$

If the variables in equation (1) are not cointegrated, the error correction term, EC_{t-1}, is eliminated from equation (2). In addition, lots of estimation experiments are performed to find a parsimonious structure of equation (2). In other words, variables which are insignificant and do not generate, even though omitted, any noticeable difference in the estimation results are eliminated from equation (2).

2.3. The variables and data[1]

Real exports (X_t)

The real export from Korea to Japan is defined as follows:

$$X_{ijt} = \ln\left(\frac{EX_{ijt}}{EXUV_{it}} \times 100\right),$$

where X_{ijt} denotes the log value of the real exports of country *i* to country *j;* EX_{ijt} is the monthly nominal exports of country *i* to country *j;* $EXUV_{it}$ denotes the export unit value index of country *i*. Hereafter, *i* represent Korean and *j* represent Japan.

Industrial production index (g_{jt})

Industrial production indices are commonly used as a proxy for income in literature, for example in Baum, Calagyan and Ozkan (2002). The variable g_{jt} is the natural logarithm of the industrial production index of an importing country *j* in time *t*.

Real bilateral exchange rate (p_{ijt})

[1] In order to ensure consistency in data, variables, which were not seasonally pre-adjusted, were adjusted for seasonality prior to taking logarithm by applying the method Census X12 available in the software package E-views 4.

The bilateral trade between two countries depends upon, among other factors, exchange rates and the relative price level of the two trading partners. Hence, the real exchange rates are included in the export equations of this paper and are computed as follows:

$$p_{ijt} = \ln\left(E_{ijt} \times \frac{CPI_{jt}}{CPI_{it}} \right)$$

where p_{ijt} symbolizes the real monthly exchange rate in natural logarithm scale; E_{ijt} is the nominal monthly exchange rate; CPI_{it} and CPI_{jt} denote the monthly consumer price index of an exporting country *i* and an importing country *j*, respectively.

<u>Real exchange rate volatility</u> (σ_{ijt})

This present study applies the standard deviation of exchange rates as the measure of the exchange rate volatility.[2] Specifically, the real exchange rate volatility σ_{ijt} is defined as the natural logarithm of the quarterly standard deviation of monthly real exchange rates:

$$\sigma_{ijt} = \ln\left(\sqrt{\frac{1}{n-1} \sum_{k=1}^{n} \left(RER_{ijk} - \overline{RER_{ij}} \right)^2} \right),$$

[2] See Akhtar and Hilton (1984), Cote (1994) and Baum et al. (2002).

where RER_{ijk} is the monthly real exchange rate, $\overline{RER}_{ij}$ the quarterly average of monthly real exchange rates, and *k* the index of the months in a quarter.

<u>Data Sources</u>

The data starts from the first quarter of 1990 and ends at the fourth quarter of 2003. Consumer Price Indices (CPI) have been collected from the *International Financial Statistics (IFS)* of the International Monetary Fund (IMF).

The data for exports from Korea to Japan have been obtained from the *Direction of Trade Statistics (DOTS)* of the IMF. The data for the industrial production index of Japan have been collected from the Ministry of Economy, Trade and Industry (METI) of Japan.

3. Empirical test results

3.1. Unit Root tests

As preparation for cointegration tests, the presence of unit roots in the variables included in equation (1) were examined using the augmented Dickey-Fuller (ADF) tests. Based on the visual examination of the time series, we allowed for a trend and an intercept in the auto-regression for the levels of exports and industrial production indices, and only an intercept for the levels of other variables and the first differences of all variables. The lengths of the lags included in the tests were determined by the Akaike infomation criterion.

The ADF statistics for the levels of all the series except for the volatility of the Korean exchange rates are below the 5 percent critical values, and the ADF statistic for the level of the volatility of the Korean exchange rates is below the 1 percent critical values, implying the presence of unit roots. On the other hand, the statistics obtained from the first differences of the variables reject the null hypothesis of a unit root at the 5 percent significance level. Tables 1-1 and 1-2 present the ADF test statistics for all the five variables in equation (1).

<Insert Table 1-1 and Table 1-2>

3.2. Cointegration tests

Johansen (1988,1991) cointegration tests were applied to test for the presence of a long-run equilibrium relationship in the variables in equation (1). We included an intercept and a trend in the cointegration equation in view of reasonable test results. Considering we are dealing with quarterly data, the length of lags was determined to be 4. However, slight changes in the length of lags do not generate noticeable changes in the results.

<Insert Table 2>

The results of the cointegration tests are presented in Table 2, where r denotes the number of cointegrating vectors. Both the trace statistics and the maximum eigenvalue statistics strongly imply the presence of one cointegrating relationship for the five variables. The estimated coefficients for the long-run relationship are presented in Tables 3.

<Insert Table 3>

The test results indicate a negative long-run relationship between the Korean exports to Japan and the real exchange rate of the Chinese yuan against the Japanese yen. That is, depreciation of the value of the Chinese yuan has a negative impact on the volume of the Korean exports to Japan. More specifically, one percent increase of the exchange rate of the Chinese yuan (that is, one percent decrease of the value of the Chinese yuan) turns out to decrease the Korean exports by about one percent.

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Manufacturing production indices of Japan and the volatility of the Korean exchange rates turn out to have expected impacts on the Korean exports in the long run. The former has positive impacts, while the latter has negative impacts.

3.3. Error Correction models

Since the cointegration tests in the previous section detected one long-run equilibrium relationship for each of the export equations, An error correction model is estimated to see the short-run dynamics of the export equation. The error correction term is computed by the cointegration equation reported in Tables 3.

<Insert Table 4>

The estimated coefficients for the error-correction model, presented in Table 4-1 for the exports to Japan and in Table 4-2 for the exports to the U.S., do not show the impacts of the explanatory variables as clearly as in the long-run relationship.

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<Table 1-1> ADF Unit Root Test for the levels

Variable	Included Observations after Adjustments	Lags	ADF Test Statistic
X_t	69	2	-3.117
g_t	68	3	-3.147
p_t	68	3	-2.488
σ_t	64	7	-3.498
p_t^c	71	0	-2.560

Notes: 1) “Lags” denotes the included augmentation lags in unit root test. 2) ADF is the augmented Dickey-Fuller test. 3) The Mckinnon critical values for rejection of hypothesis of a unit root at 1, 5 and 10 percent level are approximately –4.097, –3.476 and –3.166, respectively. 4) The number of lags was determined based on Akaike criterion.

<Table 1-2> ADF Unit Root Test for the first differences

Variable	Included Observations after Adjustments	Lags	ADF Test Statistic
ΔX_t	69	1	-3.788
Δg_t	68	2	-4.363
Δp_t	67	3	-4.350
$\Delta \sigma_t$	62	8	-4.383
Δp_t^c	70	0	-8.227

Notes: 1) The Mckinnon critical values for rejection of hypothesis of a unit root at 1, 5 and 10 percent level are approximately –3.529, –2.904 and –2.590, respectively.
Also refer to the notes under <Table 1-1>

<TABLE 2> JOHANSEN CO-INTEGRATION TESTS

Statistic	H_0:	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
	H_A:	$r \geq 1$	$r \geq 2$	$r \geq 3$	$r = 4$	$r = 5$
Trace Statistics		124.69*	62.06	35.17	17.83	5.45
(5 % critical value)		88.80	63.88	42.92	25.87	12.52
Max-Eigen Statistics		62.63*	26.90	17.34	12.38	5.45
(5 % critical value)		38.33	32.12	25.82	19.39	12.52

Notes: 1) r denotes the number of co-integrating vectors. 2) The asterisk (*) indicates the rejection of the null hypothesis at the 5% significance level.

<Table 3-1> Estimates of the contegrating vectors for exports to Japan

	g_t	p_t	σ_t	p_t^c	Trend
Coefficient	2.512*	2.130*	-0.328*	-0.950*	0.011*
Standard Error	0.413	0.279	0.042	0.091	0.001

Notes: The asterisk (*) indicates the rejection of the null hypothesis of zero coefficient at the 5% significance level.

<Table 4> Estimation Results for the Error-Correction Model

Variables	Coefficient	Standard Error
C	-0.841	0.484
EC_{t-1}	-0.072	0.041
ΔY_{t-1}	0.174	0.114
ΔY_{t-2}	0.420	0.093
ΔY_{t-8}	-0.288	0.087
Δg_{t-1}	1.382	0.298
Δg_{t-2}	0.772	0.378
Δg_{t-3}	-2.747	0.410
Δg_{t-5}	1.802	0.416
Δg_{t-7}	-1.078	0.408
Δi_{t-8}	0.862	0.386
Δp_t	0.129	0.086
Δp_{t-1}	-0.459	0.093
Δp_{t-5}	0.262	0.082
Δp_{t-7}	0.344	0.085
Δp_{t-8}	0.185	0.069
$\Delta \sigma_t$	-0.015	0.008
$\Delta \sigma_{t-1}$	0.045	0.010
$\Delta \sigma_{t-2}$	0.025	0.008
$\Delta \sigma_{t-7}$	-0.014	0.005
$\Delta \sigma_{t-8}$	-0.016	0.006
$\Delta \sigma_{t-10}$	-0.017	0.005
Δp_t^c	0.271	0.068
Δp_{t-3}^c	0.143	0.070
Δp_{t-4}^c	-0.159	0.057
Δp_{t-7}^c	-0.152	0.068
R^2	0.883	
Adjusted R^2	0.799	