Analysis of the Relationship Between Korea's Export to China and Exchange Rate

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Abstract: Background/Objectives: The purpose of this study is to analyze the relationship between Korea's exports to China and won/dollar, won/100yen, won/yuan, and suggest directions for the future. Methods/Statistical analysis: Monthly data used in the analysis period were analyzed by using Excel, e-views and SPSS. In addition, I will examine trends and correlations between Korea's exports and imports and exchange rates of major countries over the last 213 months through descriptive statistics, correlation, regression analysis, normal distribution, Scatter, Quantile-Quantile and Box-Plot analysis. Findings: Korea's exports, imports, trade balance data to China used in this study were collected from Trade Statistics of the Korea Customs Service. Won/Dollar, Won/100Yen and Won/Yuan was obtained from the Economic Statistics System in the Bank of Korea. The analysis period was from January 2000 to September 2017 for a total of 213 months (17 years 9 months). The correlation between Korea's exports to China and exchange rate was Won/Dollar -0.491, Won/100Yen -0.386, Won/Yuan -0.406. In the regression analysis, Won/Dollar and Won/Yuan were statistically significant. However, the Won/100Yen was statistically insignificant. In the parallax analysis between two variables, exchange rate fluctuations affects exports with a time lag of 4 or 5 months.

Improvements/Applications: In order for Korea's exports to China to continue to increase in the future, Won/dollar and won/yuan should move favorably. And I will try to predict the future direction.

Keywords: Export, Exchange Rate, Won/Dollar, Won/100Yen, Won/Yuan

I. INTRODUCTION

China is Korea's first export nations. By 2016, Korea has exported about 25% of its total exports to China. Korea's exports to China have a huge impact on the Korean economy. Korea's exports to China are heavily influenced by China's exports to the world. In general, factors affecting exports include income levels, prices, and exchange rates in each country. It is analyzed that exports are affected by exchange rate, which is one of several factors. The exchange rate mainly considers the real exchange rate.

Before examining the variables affecting China's exports to the world, we will first examine the factors that affect Korea's exports to China. The purpose of this study is to examine the trends of Korea's exports to China and to analyze the linkages with exchange rate fluctuations to suggest future directions. We will try to find out the causal relationship between Korea's export to China and the exchange rate in various ways. For this purpose, we selected Won/dollar, Won/100Yen, Won/Yuan which has a great impact on Korean exports. The analysis period was from Jan. 2000 to Sep. 2017 and total 213

month data was used. We will use Excel, e-views, SPSS etc. for numerical analysis, indicator analysis and model analysis.

II. PRECEDENT RESEARCH

2.1. *Exports and Dollars*

Various studies have been conducted on the effect of Won/Dollar exchange rate on exports. Han and Jung (2016) analyzed. the effect of exchange rate on exports and suggested that the Yen/Dollar exchange rate was the largest and strongest level of total exports and exports to Japan. On the impact of exchange rate fluctuations on Korea's exports to China[1], Lim(2015) showed that the correlation between Korea's exports to China and the Won/Dollar was +0.390 and analyzed the root of unit in root test of Chinese exports and dollar[2]. Kim and Kim(2017) have studied the effect of Won/Dollar on exports, and analyzed that the Won/Dollar had a predictive power on exports[3].

2.2. *Exports and Yen*

Kim (2015) predicted that the exchange rate volatility will increase and the exchange rate risk of exporting companies will increase significantly due to the strengthening dollar and weak yen due to the recent monetary easing policy of Japan and Europe and the US interest rate hike on the impact of the won's fluctuations on exports[4]. Shin(2014) showed that Won/Yen had a negative effect on Korean exports as a whole, but the influence was found to be different by item and country[5]. Lee (2015) suggested that Korea exports are declining rapidly due to the fall in Won/Yen and the inability to adapt to changes in China's economy[6]. Kim (2014) pointed out that the export-driven Korean economy is dangerous as the Won/Yen decline[7]. Kwak(2014) analyzed the effect of Won/Yen fluctuations on Korean exports[8].

2.3. *Exports and Yuan*

In the analysis of the impact of the yuan change on Chinese exports, Phil etc.2 (2014) investigated the existence of a long-term balance between exchange rates and exports. Demand elasticity is 3.09, which is larger than 1, and that imports rather than exports respond more sensitively to exchange rate fluctuations[9]. Park (2013) said that if the value of the Chinese yuan increases by 1% from the trading partner, exports fall by about 0.768% on the study on the Real Exchange Rate and Export Resilience of the Chinese Yuan.

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He analyzed that exports fluctuate gradually with time as the yuan fluctuates. According to the analysis of the effects of appreciation of Chinese yuan appreciation on Korea exports[10], Kang and Park (2012) suggested that exports to Korea's major trading partners decreased by 10.1% ~ 16.4% due to appreciation of the Chinese yuan[11].Kim and Choi (2010) suggested that the appreciation of the yuan would have a negative impact on Korea's exports to China as a result of analyzing the effect of changes in the Chinese yuan on Korea's exports to China. The reason is that the price competitiveness of Chinese exports in the world market has weakened and China's exports & GDP have declined, resulting in a decrease in Korea's exports to China[12]. Lim (2015) analyzed that if the Won/Yuan falls by 5%, Korea's total exports decrease by 3% on the impact of devaluation of the Yuan on exports to Korea. If the depreciation of the yuan continues, Korea's major industries are concerned that exports will decline[13,14]. On the other hand, the devaluation of the yuan has been suggested to be an increase in exports of China and a goal of internationalization of the yuan[15,16].

III. DATA COLLECTION AND INDICATOR ANALYSIS

3.1. *Data Collection*

Korea's exports, imports, trade balance data to China used in this study were collected from Trade Statistics of the Korea Customs Service. Won/Dollar, Won/100Yen and Won/Yuan was obtained from the Economic Statistics System (EXOS) in the Bank of Korea. The analysis period was from January 2000 to September 2017 for a total of 213 months (17 years 9 months). For the sake of convenience, we want to mark EXPO for Korea's exports to China, IMPO for exports to China, EXUS for Won/Dollar, EXJP for Won/100Yen, EXCN for Won/Yuan. Monthly data used in the analysis period were analyzed by using Excel, e-views and SPSS. In addition, we will examine trends and correlations between Korea's exports and imports and exchange rates of major countries over the last 213 months through descriptive statistics, correlation, regression analysis, normal distribution, Scatter, Quantile-Quantile and Box-Plot analysis. And I will try to predict the future direction.

3.2. *Indicator Analysis*

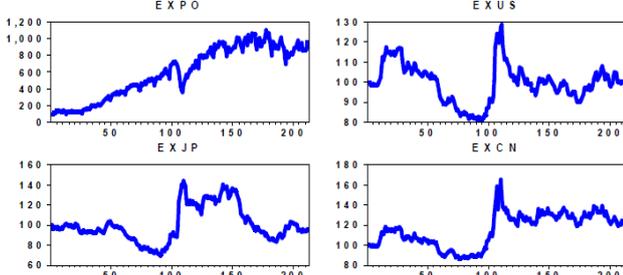(period : 2000.1-2017.9, unit : %)

Figure 1. Trend of Monthly Growth Rate

For the past 213 months, trends by each indicator is in [Figure 1]. Since 2000, the growth rate in exports to China has been the most noticeable, exceeding 963%. On the other hand, Won/Dollar and Won/100Yen are moving around 70~130%. In the case of Won/Yuan, it showed a fluctuation of between 90~150%. After 2010, it has fluctuated between 120~130%.

The harmonization phenomenon between EXUS, EXJP and EXCN seems to looks strong.
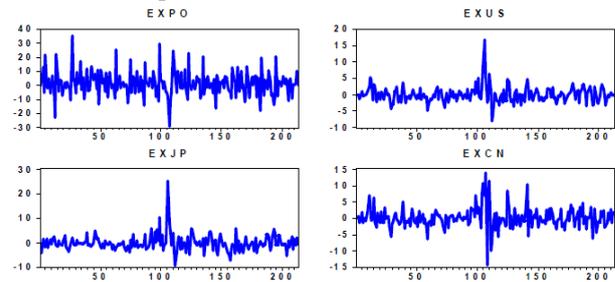
(period : 2000.1-2017.9, unit : %)

Figure 2. MoM Change Rate

MoM change rates for each indicator expressed in [Figure 2]. Overall, the change rate in exports to China is the largest, showing a variation of between -30% and 40%. In addition, the change rate is similar to Won/100Yen, Won/USD, Won/Yuan and we can see a significant ups and downs before and after the global financial crisis in 2008.
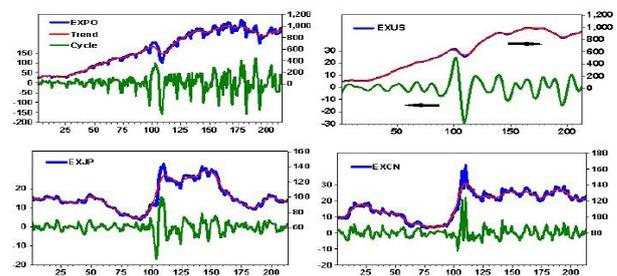

Figure 3. Hodrick-Prescott Filter (lambda=100)

Hodrick-Prescott Filter of EXPO, EXUS, EXJP and EXCN is expressed in [Figure 3]. The difference between each indicator and Trend is indicated by Cycle. As shown in the figure, since EXPO has been expanding its export volume since 2009, the vibration width of the cycle has increased slightly since 2016. However, EXUS, EXJP and EXCN are continuing small fluctuations without much change.

IV. EMPIRICAL ANALYSIS

4.1. Numerical Analysis
Table 1 : Descriptive Statistics

	EXPO	EXUS	EXJP	EXCN
Mean	1.436	0.028	0.026	0.161
Median	1.205	-0.089	-0.502	-0.137
Maximum	35.128	16.734	25.127	13.880
Minimum	-29.072	-8.055	-9.324	-14.155
Std. Dev.	8.702	2.404	3.232	3.188
Skewness	0.468	1.751	2.557	0.524
Kurtosis	4.882	14.012	19.863	7.519
Jarque-Bera	39.26	1185.19	2755.91	191.04
Probability	0	0	0	0
N	213	213	213	213

For the past 213 months, descriptive statistics for each indicator have been classified as EXPO, EXUS, EXJP, EXCN in <Table 1>.

The average is 1.436% in EXPO, 0.028% in EXUS, 0.026% in EXJP and 0.161% in EXCN. The standard deviation is 8.702 in EXPO, 2.404 in EXUS, 3.232 in EXJP, 3.188 in EXCN. The skewness is all positive(+) value and it is tilted to the right axis with the left tail and it is concentrated at the upper part. Kurtosis is positive(+) value, meaning that it is well concentrated around the mean.

Table 2 : Correlation Analysis

	EXPO	EXUS	EXJP	EXCN
EXPO	1			
EXUS	-0.491**	1		
EXJP	-0.386**	0.707**	1	
EXCN	-0.406**	0.921**	0.661**	1

**: Correlation coefficient is significant at 0.05level.

<Table 2> shows the correlation analysis of each index as EXPO, EXUS, EXJP, EXCN. In the case of exports to China, EXUS -0.491, EXJP -0.386, and EXCN -0.406 are shown, indicating a negative(-) correlation. On the other hand, EXUS, EXJP, EXCN show a positive(+) correlation with each other, indicating a high harmonization phenomenon.

Table 3 : Regression Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.360	0.188	7.233	0
EXUS	-1.604	0.367	-4.371	0
EXJP	-0.139	0.138	-1.010	0.313
EXCN	0.636	0.319	1.992	0.047
R-squared	0.258	Mean dependent var	1.403	
Adjusted R-squared	0.248	S.D. dependent var	3.066	
S.E. of regression	2.658	Akaike info criterion	4.812	
Sum squared resid	1449.1	Schwarz criterion	4.876	
Log likelihood	-498.9	Hannan-Quinn criter	4.838	
F-statistic	23.876	Durbin-Watson stat	0.878	
Prob(F-statistic)		0		

<Table 3> shows Least Squares regression analysis of EXUS, EXJP, EXCN with EXPO as a dependent variable. In the simple regression model, Least Squares defines the mean by the distribution score that the sum of the squared deviations becomes minimum. For EPXO, the coefficient shows EXUS -1.604, EXJP -0.139, EXCN 0.636, showing the same directionality as EXCN. The adjusted R-squared was calculated as 0.248, and the change of the dependent variable EXPO in the regression model shows the explanatory power of 24.8%. EXUS was statistically significant at t-statistic and p-value(≤ 0.001), and EXCN was statistically significant at t-statistic and p-value(≤ 0.05). On the other hand, EXJP was not statistically significant.

4.2. Model Analysis
(Period: 2000-2017.9)
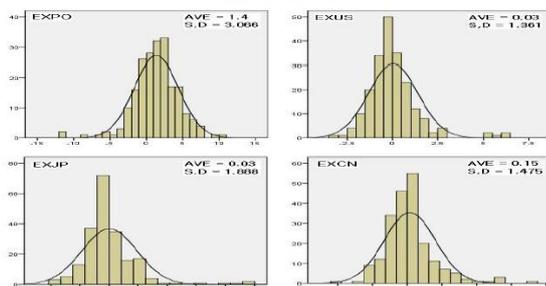

(Period: 2000-2017.9)

Figure 4.Normal Distribution

Since January 2000, the monthly growth rate normal distribution for each indicator is shown in [Figure 4]. The monthly average for the rate of increase is 0.03% for EXUS, 0.03% for EXJP, 0.15% for EXCN and the standard deviation is EXUS 1.361, EXJP 1.888 and EXCN 1.476. For EXPO, the standard deviation of EXCN is similar, but the average is higher, which is considered to have a relatively more stable impact.
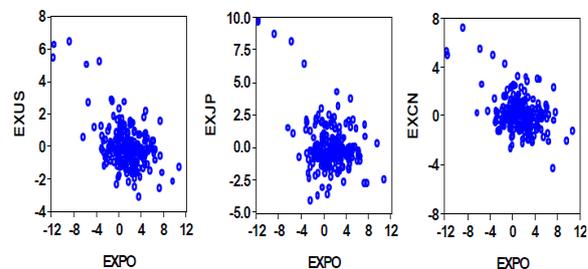

Figure 5. Scatter Charts

Monthly Scatter Charts for the last 210 months of exchange rate against exports to China is shown in [Figure 5]. The X axis is the EXPO variation rate, and the Y axis shows the variation rates of EXUS, EXJP, EXCN. Compared with EXPO, the distributions of EXUS, EXJP, EXCN are

finely decreasing to the right, showing a weak inverse relationship.
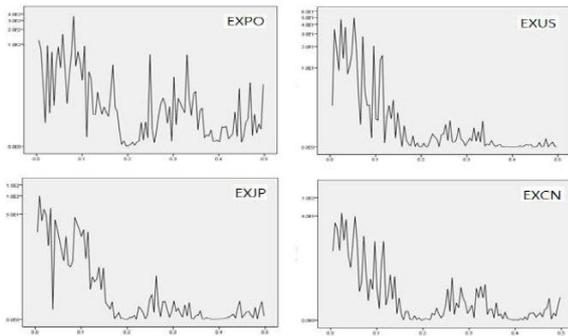
(Period: 2000-2017.9)

Figure 6. Periodicity according to Frequency

The periodicity of EXPO, EXUS, ECJP, EXCN according to the frequency is shown in [Figure 6]. In the figure, the X axis represents the frequency from 0.0 to 0.5, and the Y axis represents the periodicity. As the frequency increases, the periodicity becomes smaller. However, in the case of EXPO according to the frequency, the periodicity is relatively large. The periodicity of EXUS, ECJP, EXCN is rapidly decreased at a frequency of 0.2 or more.
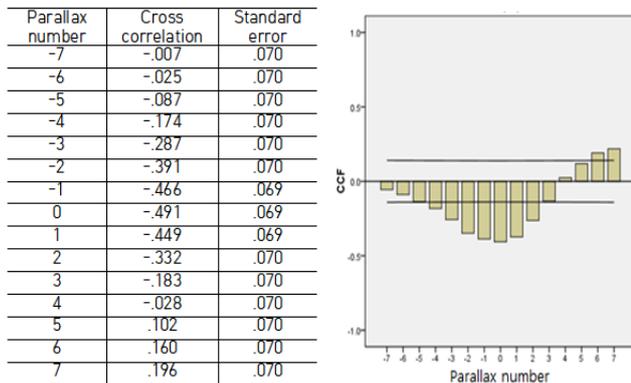
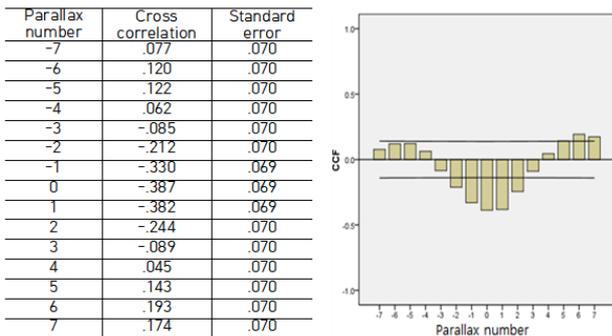| Parallax number	Cross correlation	Standard error
-7	-.007	.070
-6	-.025	.070
-5	-.087	.070
-4	-.174	.070
-3	-.287	.070
-2	-.391	.070
-1	-.466	.069
0	-.491	.069
1	-.449	.069
2	-.332	.070
3	-.183	.070
4	-.028	.070
5	.102	.070
6	.160	.070
7	.196	.070

Figure 7. EXPO included with EXUS

Parallax number	Cross correlation	Standard error
-7	.077	.070
-6	.120	.070
-5	.122	.070
-4	.062	.070
-3	-.085	.070
-2	-.212	.070
-1	-.330	.069
0	-.387	.069
1	-.382	.069
2	-.244	.070
3	-.089	.070
4	.045	.070
5	.143	.070
6	.193	.070
7	.174	.070

Figure 8. EXPO included with EXJP

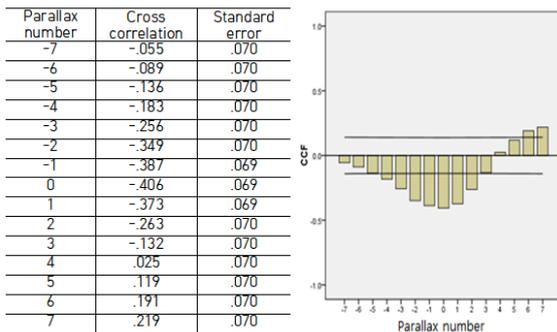| Parallax number	Cross correlation	Standard error
-7	-.055	.070
-6	-.089	.070
-5	-.136	.070
-4	-.183	.070
-3	-.256	.070
-2	-.349	.070
-1	-.387	.069
0	-.406	.069
1	-.373	.069
2	-.263	.070
3	-.132	.070
4	.025	.070
5	.119	.070
6	.191	.070
7	.219	.070

Figure 9. EXPO included with EXCN

[Figure 7, 8, 9] represent EXPO including with EXUS,

ECJP, EXCN respectively. In the figure, the X axis indicates the Parallax number, the Y axis indicates the CCF(Cross Correlation Function), the bar graph indicates the coefficient, the upper line indicates the confidence limit and the lower line indicates the confidence interval lower limit. This figure shows the correlation between two variables according to time difference. CCF is changed from negative(-) to positive(+) at time difference 4 and 5 in case of EXUS, ECJP, EXCN. The impact of exchange rate fluctuations on exports is interpreted as a time lag of approximately 4 or 5 months.
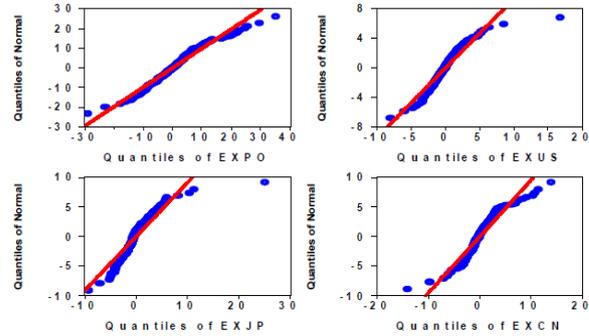

Figure 10. Quantile-Quantile Plot

Monthly Quantile-Quantile Plot over the last 210 months for each indicator is shown in [Figure 10]. The figure shows EXPO, EXUS, EXJP, and EXCN output data centered on 1: 1 line (red line). In all figures, it is moving close to the 1: 1 line and shows a generally stable flow. However, it can be seen that the temporary ups and downs appear at the top and bottom.
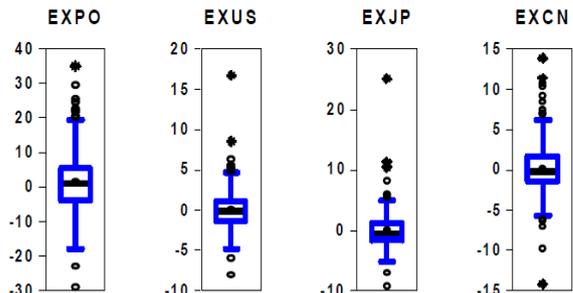

Figure 11. Box-Box Plot

Monthly Box-Box Plots for the last 210 months for each indicator shoes in [Figure 11]. In the picture, EXPO has a long body and a long tail on the top and bottom. However, it can be seen that EXUS, EXJP, EXCN have a relatively small body and a small tail on the upper and lower sides, so that the variation rate is small. On the other hand, it can be seen that there is a lot of abnormality(*) in the top and bottom in all figures.

V. CONCLUSION

The purpose of this study is to examine the trends of Korea's exports to China and to analyze the linkages with exchange rate fluctuations to suggest future directions. To this end, the exchange rate was used in Won/Dollar, Won/100Yen, Won/Yuan. The analysis period was a total of 213 months from January 2000 to September 2017. We used Excel, e-views and SPSS for numerical analysis, indicator analysis and model analysis. As a result of the analysis, the correlation between Korea's exports to China and

exchange rate was -0.491 for Won/Dollar, -0.386 for Won/100Yen, -0.406 for Won/Yuan.

Therefore, the Won value depreciation was thought to be helpful for Korea's exports. Regression analysis showed that the coefficient of Korea's exports to China was -1.604 for Won/Dollar, -0.139 for Won/100Yen and 0.636 for Won/Yuan respectively. The Won/Dollar and Won/Yuan were statistically significant in the t-statistic and the p-value.

Until recently since January 2000, Korea's exports to China have increased by 963%. But the Won/Dolllar and Won/100Yen showed about 70~130% and the Won/Yuan was 90~150%. The monthly rate of change shows that Korea's exports to China are between -30 and 40%, while the exchange rates of Won/100Yen, Won/Yuan, Won/Dollar are comparatively smaller. Comparing monthly average and standard deviation in monthly growth rate normal distribution, it was analyzed that Won/Yuan had a more stable impact on Korea's exports to China relative to Won/Dollar and Won/100Yen. Scatter analysis showed that the distribution of Won/Dollar, Won/100Yen and Won/Yuan was weakly lowered to the right compared to Korea's exports to China, indicating a weak negative(-) correlation.

In relation to periodicity with frequency as the frequency increases, the periodicity becomes smaller. The periodicity of Won/Dollar, Won/100Yen and Won/Yuan is rapidly decreasing at a frequency of 0.2 or more, but the periodicity of export is relatively large. In the function representing the degree of correlation between two variables according to time lag, CCF is shifting from negative(-) to positive(+) at time difference 4, 5 in Won/Dollar, Won/100Yen and Won/Yuan. Therefore, it is interpreted that the effect of exchange rate fluctuations on exports appears at a time lag of approximately 4 or 5 months. In order for Korea's exports to China to continue to increase in the future, Won/dollar and won/yuan should move favorably.

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