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THE EFFECT OF EXCHANGE RATE ON SINO-EU AND SINO-US TRADE

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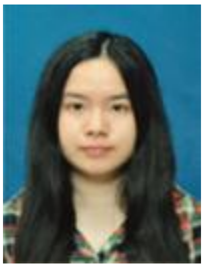

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ABSTRACT

The EU and the United States are China's first and second largest trade partners respectively. This paper selects monthly data between January 2002 and December 2016 including real exchange rate and import & export volume. Cointegration equations and vector error correction models are built for capturing long-term relationships among variables. Besides, impulse response function and variance decomposition are applied to analyze short-run dynamic characteristics of impacts of exchange rate on trade. Results show there are long-term steady relationships between imports & exports and real exchange rate. It is also found that the RMB devaluation can harm to Sino-EU import but benefit for Sino-EU export and Sino-US trades, while Marshall-Lerner condition only establishes in Sino-EU trade. However, the strength China needs to improve trade with the Euro Zone is not as much as with the US. In a short run, the shock from exchange rate has more durable impact on Sino-EU import, but exchange rate is a most important factor only for Sino-EU export. Therefore, current depreciation of RMB have little impact on Sino-EU and Sino-US trades.

Contribution/ Originality: This study contributes in the existing literature by attempting to compare relationships between exchange rate and import & export trade of Sino-EU and Sino-US, for which this study uses multiple methods including VECM, impulse response and variance decomposition.

1. INTRODUCTION

RMB exchange rate has been playing an important role in trade market since China entered WTO in 2001, when China's international trade volume has been rapidly increasing. After the exchange rate reform in 2005, China began to implement a managed floating exchange rate system based on market supply & demand, referring to a basket of currencies. The result of the exchange rate reform is that flexibility of exchange rate of RMB has increased since then. In 2016, RMB was formally included in SDR basket which s indicates RMB is also playing more important role in the international currency market. According to World trade Statistical Review of WTO in 2016, China has become the first largest export country in the world, the EU and the US are respectively China's first and second largest trade partners, so it is significant to analyze the relationships between exchange rate and import & export of Sino-EU and Sino-US.

Based on Marshall-Lerner condition, the devaluation of exchange rate can improve trade balance. But physical truth is complex and many researches had adverse conclusions on the influence of exchange rate on international trade situation. Himarios (1985) applied the least square method to estimate the influence of exchange rate on international trade in both industrial countries and developing countries. The result showed that coefficients of exchange rate in the current period and two-lagged period are all significantly greater than zero in the nine of 10 countries. His conclusion is that depreciation of currency can stimulate trade. Chowdhury (1993) studied the impact of nominal and real exchange rate on export of the G-7 countries by selecting data from 1976 to 1990. He found that the fluctuation of nominal exchange rate had a significant negative impact on export. Another researchers focused on the relationships between exchange rate and trade in a long term. Rose (1991) built trade balance model to study trades of five major OECD countries by data of 1974-1986. He found that there was no co-integrating relationship among real exchange rate, imports & exports and outputs of these five countries, which means Marshall-Lerner condition didn't exist in trades of those countries. Singh (2004) established a similar trade model as Rose's to estimate the influence of exchange rate on the balance of trade in India. He didn't find relationship between exchange rate and trade balance of India.

In empirical researches, different results of correlation between exchange rate and trade balance can be gotten by different methods of measurement. Boyd *et al.* (2001) established structural co-integrating vector auto-regressive distributed lag (VARDL) models to analyze the effect of exchange rate on the balance of payments. They found that the 5 of 8 researching countries had Marshall-Lerner condition. Onafowora (2003) tested the short-term and long-term effects of exchange rate on the trade balance of ASEAN countries by a co-integrating vector error correction model (VECM) and generalized impulse response functions. Results of VECM showed there existed a long-run steady relationship among real trade balance, real exchange rate, real domestic and foreign income in each country. But Wilson (2001) used two-country imperfect substituted model built by Rose and Yellen (1989) on Singapore, Korea and Malaysia, and he didn't find Marshall Lerner conditions and effect of J-curve in these countries. Moura and Silva (2005) found a Marshall-Lerner condition in trade balance of Brazil by using impulse response functions including Markov-switching and vector error correction models.

After the reform of RMB exchange rate in China, researches about the impact of RMB exchange rate on trade have been heated recently. Some focused on total trade volume of China to researrch on the relationship between exchange and the balance of trade. Zuxiang (1997) established a model by data of 1981-1995 of China and found the price elasticity of import and export was significantly greater than 1, thus Marshall-Lerner condition exists in China. Xiangqian and Guoqiang (2005) applied the co-integration vector auto-regression to empirically analyze a long-term relationship between import&export and real exchange rate weighed by major currencies in world from 1994 to 2003. It was concluded that real exchange rate of RMB had significant influence on trade balance, which suggested that Marshall-Lerner condition was tenable in China.

Another researchers tested the impact of RMB exchange rate on trade between China and its main trade partners. Gao *et al.* (2011) established VAR model to analyze the influence of exchange rate on relative Sino-EU trade balance, which suggested that depreciation of RMB against Euro would cause Sino-EU trade deficit in a short run, but the two-side relationship would keep steady for a long time. Youwei (2011) identified the relationship between trade balance and exchange rate by panel data of China and its 13 main Asian-Pacific traders, and he concluded that the appreciation of RMB could improve those partners' trade condition partially. Liu and Han (2012) used method of co-integration to estimate the relationship among trade balance, RMB real efficient exchange rate, GDP of China and foreign GDP of 5 ASEAN countries. They found there was a long-term equilibrium of these 4 factors, so trade balance of China and these 5 ASEAN countries can be adjusted by RMB real efficient exchange rate.

Reports of the Ministry of Commerce of China shows that China has been the largest trade nation in world since 2013, and international trade has been the pillar industry in China's economy. What's more, European Union and the US are respectively the first and the second largest trading partners of China, so it is necessary to analyze Sino-EU and Sino-US trading characteristics from the perspectives of exchange rate. The previous studies have concentrated on the relationship between exchange rate and trade of China with either the Euro Zone or the US, but we have interests in the different characteristics between Sino-EU and Sino-US trade. So we attempt here to compare relationships between exchange rate and import&export trade of Sino-EU and Sino-US. We apply multivariate co-integration model, vector error correction model(VECM), impulse response and variance decomposition by using monthly data from January 2002 to December 2016 to comprehensively analyze the short-term and long-term dynamic relationships among exchange rate, import&export volume and other main macroeconomic variables.

The structure is as follows: Part2 establishes the basic model and introduces variables of the model; Part3 does an empirical analysis by applying co-integration, impulse response and variance decomposition; Part4 gives conclusions of empirical analysis.

2. MODEL AND DATA

There are many incomplete substitution models for measuring the impact of exchange rate on trade. The most classic one is Bickerdike-Robinson-Metzler model (BRMM), under which exporting goods can't replace goods of importing country entirely even though exports have advantages of prices when devaluation occurs in exporting country. International trade is affected not only by total domestic income of importing countries and prices of import goods, but also by prices of similar domestic commodities in importer countries and some other factors.

This paper uses a simplified trade model established by Rose and Yellen (1989), whose model has the same implication as BRMM. It is a model for two countries, which is based on theory of incomplete substitution theory. In this theory, imports can't replace domestic goods entirely in one country, and exports also have their own features as well. Under this theoretical model, exports of one country have correlation with exchange rate, foreign total income, domestic and foreign price level. But imports have relation with exchange rate, domestic total income and price levels of two-side countries.

Many of the studies in the literature that examine Marshall-Lerner Condition by Distributed Lag model (DL), the Vector Auto-Regressive model (VAR), the Error correction model (VECM), or the Auto-Regressive Distributed Lag model (ARDL), in which different types of variables are included. All these models have their strengths and weakness. This paper attempts to examine the long-term equilibrium relationship between the exchange rate and trade. We also look at the short-term effects of exchange rate fluctuations on the import & export in China, the Euro Zone and the US. So we choose the method of VECM to establish a general equation developed by Rose and Yellen (1989).

2.1. Equation and Variables

The following is the equation based on which our analyses are conducted.

$$IM = f(Y, Pm, Pm^*, ER)$$

$$EX = f(Y^*, Px, Px^*, ER)$$

Where IM is imports volume, EX is exports volume, Y and Y^* are domestic and foreign total income respectively, Pm and Pm^* are domestic and foreign market price of imports, Px and Px^* are domestic and foreign market price of exports, ER is the bilateral exchange rate under direct quotation. Real exchange rate can be calculated according to the equation then we take logarithm on both sides of models above, we get following models: $RER = ER \times \frac{P^*}{P}$, so import and export models above can be converted into models below.

$$IM = f(Y, RER)$$

$$EX = f(Y^*, RER)$$

We add supply factors in the import and export model, namely adding foreign total income in import model and adding domestic total income in export model. Advanced import and export model are as follows.

$$IM = f(Y, Y^*, RER)$$

$$EX = f(Y^*, Y, RER)$$

Then we take logarithm on both sides of models above, we get following models.

$$InIM = InY + InY^* + InRER$$

$$InEX = InY^* + InY + InRER$$

2.2. Variables Introduction, Selection and Processing

This paper uses Eviews6.0 to process monthly data covering the period from January 2002 to December 2016 with 180 observations in total. The selection of 2002 as the start of the period is due to the fact that Euros circulated in Euro Zone formally in that year. The use of monthly data would allow us to capture the short-run fluctuations of exchange rates in relation to the other variables in the model.

(1) *RER* — The key variable in our model is the real exchange rate, RER, which are measured in terms of the real bilateral exchange rate of RMB against Euros and dollars. Nominal bilateral exchange rate is a variable including influence of price factors, which can be collected by IFS database of IMF. Exchange rate of RMB against Euros data can be gotten by processing exchange rate of RMB against dollars and the exchange rate of Euros against dollars. Real bilateral exchange rate is nominal bilateral exchange rate without the price factor. It can measure a country's realistic competitiveness in trade, so this paper chooses to use real bilateral exchange rate in all models. According to $RER = ER \times \frac{P^*}{P}$, real bilateral exchange rate can be calculated, and here price index is measured by CPI consumer price index. In this paper, exchange rate uses direct quotations for RMB, namely RMB will devalue when exchange rate increases.

(2) *IM* and *EX* — (b)The dependent variable in our model is import and export, IM and EX, in the home country. Dollar-denominated data of imports and exports of China with the Euro area and the US can be obtained from IFS database of IMF, which can be converted into data denominated by RMB from raw data with exchange rate of RMB against dollars in the same period.

(3) Y and Y^* — (c)The variables which measures demand and supply for trading goods in models is domestic and foreign total income, Y and Y* . GDP monthly data is not published in those three research countries. Most scholars' method is to use monthly industrial production index to measure monthly trend of the domestic production change. However, China doesn't publish monthly industrial production index neither. Referring to the practice of Chinese scholars, this paper uses industrial added value index IVA as a proxy variable instead of GDP for China while industrial production index IPI is still used by Euro area and the US. Accounting scopes of IVA and IPI are consistent which represent industrial production, and the both reflect production of industrial enterprise. Besides, IVA is calculate based on IPI and it is a difference between the value of industrial production and industrial intermediate input. The fundamental difference between IVA and IPI is that the former one is a final result of

industrial production, in which raw materials don't involve but the latter one reflects a total result of industrial production, whose value includes raw materials. The difference between these two measures can be negligible here and we assume it would not affect the results of our analysis.

All data above except IVA is from IFS database on IMF official website[1]. Bilateral exchange rate and import and export data denominated by dollars can be used directly, while the others are obtained by calculating into data based on January 1999 as benchmark. All of our data have been adjusted by the X12 method to eliminate seasonal effects. In addition to get around heteroscedasticity problems, all equations have be converted into logarithmic forms.

2.3. Variables Abbreviated Forms and Definitions

In order to identificate of the variables in models easier, Table1 contains all the variables' abbreviated symbols and a brief definition for each. Generally, the letters LN stand for natural log, DLN indicates logarithmic difference, and letters C, E, and US represent China, the Euro Zone, and the United States, respectively.

Table-1. Variables and Definitions

	bbreviation	Definition
Sino-EU Variables	LNCEIM	Logarithmic Form of Sino-EU import
	DLNCEIM	Logarithmic Difference Form of Sino-EU import
	LNCEEX	Logarithmic Form of Sino-EU export
	DLNCEEX	Logarithmic Difference Form of Sino-EU export
	LNCERER	Logarithmic Form of Sino-EU real bilateral exchange rate
	DLNCERER	Logarithmic Difference Form of Sino-EU real bilateral exchange rate
	LNEIPI	Logarithmic Form of Euro Zone Industrial Production Index
	DLNEIPI	Logarithmic Difference Form of Euro Zone Industrial Production Index
	LNIVA	Logarithmic Form of Industrial Value Added
	DLNIVA	Logarithmic Difference Form of Industrial Value Added
Sino-US Variables	LNCUIM	Logarithmic Form of Sino-US import
	DLNCUIM	Logarithmic Difference Form of Sino-US import
	LNCUEX	Logarithmic Form of Sino-US export
	DLNCUEX	Logarithmic Difference Form of Sino-US export
	LNCURER	Logarithmic Form of Sino-US real bilateral exchange rate
	DLNCURER	Logarithmic Difference Form of Sino-US real bilateral exchange rate
	LNUIPI	Logarithmic Form of the US Industrial Production Index
	DLNUIPI	Logarithmic Difference Form of the US Industrial Production Index
	LNIVA	Logarithmic Form of Industrial Value Added
	DLNIVA	Logarithmic Difference Form of Industrial Value Added

Source: The table is made originally by the author.

3. EMPIRICAL ANALYSIS

3.1. Stationarity Test

To avoid the statistic probems normally associated with time series data, the first test we conduct on our date is the stationarity test. We use the Phillips - Perron test method to test our logarithmic raw data and their first difference.

[1] Link: http://www.imf.org/en/data

Table-2. PP test for Sino-EU import model

variables	T-stat	critical value (1%)	critical value (5%)	critical value (10%)	P-value	stationarity
LNCEIM	1.7252	-2.5779	-1.9426	-1.6155	0.9796	non-stationary
DLNCEIM	-20.3817	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNCERER	-0.0086	-2.5779	-1.9426	-1.6155	0.6786	non-stationary
DLNCERER	-11.7450	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNEIPI	0.3209	-2.5779	-1.9426	-1.6155	0.7772	non-stationary
DLNEIPI	-13.6209	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNIVA	10.5201	-2.5779	-1.9426	-1.6155	1.0000	non-stationary
DLNIVA	-8.5831	-2.5780	-1.9426	-1.6155	0.0000	stationary

Source: Data is calculated by using Eviews.

Table- 3. PP test for Sino-EU export model

variables	T-stat	critical value (1%)	critical value (5%)	critical value (10%)	P-value	stationarity
LNCEEX	1.6696	-2.5779	-1.9426	-1.6155	0.9769	non-stationary
DLNCEEX	-18.3478	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNCERER	-0.0086	-2.5779	-1.9426	-1.6155	0.6786	non-stationary
DLNCERER	-11.7451	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNEIPI	0.3403	-2.5779	-1.9426	-1.6155	0.7824	non-stationary
DLNEIPI	-14.0837	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNIVA	0.5201	-4.0039	-3.4321	-3.1398	1.0000	non-stationary
DLNIVA	-8.5831	-2.5780	-1.9426	-1.6155	0.0000	stationary

Source: Data is calculated by using Eviews.

Table-4. PP test for Sino-US import model

variables	T-stat	critical value (1%)	critical value (5%)	critical value (10%)	P-value	stationarity
LNCUIM	2.6710	-2.5779	-1.9426	-1.6155	0.9982	non-stationary
DLNCUIM	-25.5455	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNCURER	-0.3848	-2.5779	-1.9426	-1.6155	0.5444	non-stationary
DLNCURER	-11.2168	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNUIPI	0.8060	-2.5779	-1.9426	-1.6155	0.8855	non-stationary
DLNUIPI	-12.1566	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNIVA	10.5201	-2.5779	-1.9426	-1.6155	1.0000	non-stationary
DLNIVA	-8.5831	-2.5780	-1.9426	-1.6155	0.0000	stationary

Source: Data is calculated by using Eviews.

Table-5. PP test for Sino-US export model

variables	T-stat	critical value (1%)	critical value (5%)	critical value (10%)	P-value	stationarity
LNCUEX	2.9802	-2.5779	-1.9426	-1.6155	0.9993	non-stationary
DLNCUEX	-21.3046	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNCURER	-0.3848	-2.5779	-1.9426	-1.6155	0.5444	non-stationary
DLNCURER	-11.2168	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNUIPI	0.8060	-2.5779	-1.9426	-1.6155	0.8855	non-stationary
DLNUIPI	-12.1566	-2.5780	-1.9426	-1.6155	0.0000	stationary
LNIVA	10.5201	-2.5779	-1.9426	-1.6155	1.0000	non-stationary
DLNIVA	-8.5831	-2.5780	-1.9426	-1.6155	0.0000	stationary

Source: Data is calculated by using Eviews.

The results of the PP test as shown in the tables above indicate that under the confidence level of 1%, the logarithmic raw data of China, the Euro Zone and the US agree with the null hypothesis that each of them has a unit root, that suggests that they are all non-stationary time series variables. Under the 1% confidence level, base on the results of these tests of the first difference data, the null hypothesis is rejected, that means the time series data are stationary. Thus, all logarithmic variables are integrated of order one namely they are I(1) sequences.

3.2. Lag Determining for VAR Models

Optimal lags of VAR models are necessary for the whole modeling process. So before building the models, using the Akaike info criterion, as shown in Table 6.

Table-6. Lags of VAR model

model	Lag	LR	FPE	AIC	SC	HQ
Sino-EU Import	5	35.59324*	7.41e-14*	-18.88712*	-17.34998	-18.26346
Sino-EU Export	4	40.82233	5.42e-14*	-19.19785*	-17.95349	-18.69298
Sino-US Import	5	40.47066	1.02e-14*	-20.87148*	-19.33433	-20.24782
Sino-US Export	5	37.60197	4.67e-15*	-21.65078*	-20.11363	-21.02711

Source: Data is calculated by using Eviews.

According to Akaike info criterion, this paper selects lag 4 for VAR models of Sino-EU export and the left models are all 5 lagged.

3.3. Co-Integration Test

The co-integration test is used to determine whether or not there is a long-run equilibrium condition among variables that are non-stationary themselves but their linear combination may be stationary. The stationarity tests show that all logarithmic variables are integrated of order 1. To make sure that these variables are not co-integrated we use Johansen co-integration test, applying the lag of VAR model minus one. The same procedure is used for China, the Euro Zone and the United States. This paper chooses lag 3 for Sino-EU export model and others are 4.

Table-7. Johansen cointegration test of Sino-EU import

Null hypothesis	Eigenvalue	Trace statistic	5% Critical Value	Prob.
None*	0.3400	104.3855	40.1749	0.0000
At most 1*	0.1116	31.6733	24.2760	0.0049
At most 2	0.0449	10.9596	12.3209	0.0836
At most 3	0.0165	2.9154	4.1299	0.1038

Source: Data is calculated by using Eviews.

Johansen test shows that under the confidence level of 5%, trace statistic for the null hypothesis that there is no cointegration relationship is 104.3855 greater than 5% critical value of 40.1749. Also trace statistic for the null hypothesis that there is one cointegration relationship is 31.6733 greater than 5% critical value of 24.2760. Therefore, these two null hypothesis are refused, which indicates there is two cointegration relationships among all the variables. The parameters of standardized co-integration equation are shown in table 8.

Table-8. Parameters of standardized co-integration equation of Sino-EU import

LNCEIM	LNCERER	LNIVA	LNEIPI
1.000000	7.923449	-0.267258	-2.963077

Source: Data is calculated by using Eviews.

So the standardized co-integration equation of Sino-EU import is:

$$LNCEIM = -7.923449 LNCERER + 0.267258 LNIVA + 2.963077 LNEIPI$$

Table-9. Johansen cointegration test of Sino-EU export

Null hypothesis	Eigenvalue	Trace statistic	5% Critical Value	Prob.
None *	0.3234	106.6564	40.1749	0.0000
At most 1 *	0.1015	37.8875	24.2760	0.0005
At most 2*	0.0840	19.0494	12.3209	0.0032
At most 3	0.0203	3.6058	4.1299	0.0683

Source: Data is calculated by using Eviews.

Johansen test shows that under the confidence level of 5%, trace statistic for the null hypothesis that there is no cointegration relationship is 106.6564 greater than 5% critical value of 40.1749. Also trace statistic for the null hypothesis that there is one cointegration relationship is 37.8875 greater than 5% critical value of 24.2760 and the null hypothesis that there is two cointegration relationships is 19.0494 greater than 5% critical value of 12.3209. Therefore, these three null hypothesis are refused, which indicates there are three cointegration relationships among all the variables. The parameters of standardized co-integration equation are shown in table 10.

Table-10. Parameters of standardized co-integration equation of Sino-EU export

LNCEEX	LNCERER	LNIVA	LNEIPI
1.000000	-12.13537	1.310494	1.409696

Source: Data is calculated by using Eviews.

So the standardized co-integration equation of export data for Sino-EU is:

$$LNCEEX = 12.13537 LNCERER - 1.310494 LNIVA - 1.409696 LNEIPI$$

Table-11. Johansen cointegration test of Sino-US import

Null hypothesis	Eigenvalue	Trace statistic	5% Critical Value	Prob.
None*	0.3191	109.1506	40.1749	0.0000
At most 1*	0.1118	41.9019	24.2760	0.0001
At most 2*	0.1064	21.1559	12.3209	0.0013
At most 3	0.0083	1.4671	4.1299	0.2646

Source: Data is calculated by using Eviews.

Johansen test shows that under the confidence level of 5%, trace statistic for the null hypothesis that there is no cointegration relationship is 109.1506 greater than 5% critical value of 40.1749. Also trace statistic for the null hypothesis that there is one cointegration relationship is 41.9019 greater than 5% critical value of 24.2760 and the null hypothesis that there is two cointegration relationships is 21.1559 greater than 5% critical value of 12.3209. Therefore, these three null hypothesis are refused, which indicates there are three cointegration relationships among all the variables. The parameters of standardized co-integration equation are shown in table 12.

Table-12. Parameters of standardized co-integration equation of Sino-US import

LNCUIM	LNCURER	LNUIPI	LNIVA
1.000000	-1.924027	3.753931	-2.934980

Source: Data is calculated by using Eviews.

So the standardized co-integration equation of import data for Sino-US is:

$$LNCUIM = 1.924027 LNCURER - 3.753931 LNUIPI + 2.934980 LNIVA$$

Table-13. Johansen cointegration test of Sino-US export

Null hypothesis	Eigenvalue	Trace statistic	5% Critical Value	Prob.
None*	0.3523	122.4640	63.8761	0.0000
At most 1*	0.1464	46.4653	35.1928	0.0021
At most 2	0.0702	18.7674	20.2618	0.0792
At most 3	0.0339	6.0323	9.1645	0.1882

Source: Data is calculated by using Eviews.

Johansen test shows that under the confidence level of 5%, trace statistic for the null hypothesis that there is no cointegration relationship is 122.4640 greater than 5% critical value of 63.8761. Also trace statistic for the null hypothesis that there is one cointegration relationship is 46.4653 greater than 5% critical value of 35.1928. It indicates there are two cointegration relationships among all the variables. The parameters of standardized co-integration equation are shown in table 14.

Table-14. Parameters of standardized co-integration equation of Sino-US export

LNCUEX	LNCURER	LNUIPI	LNIVA	C
1.000000	-0.534507	-3.351994	-1.680381	20.59296

Source: Data is calculated by using Eviews.

So the standardized co-integration equation of export data for Sino-US is:

$$LNCUEX = 0.534507 LNCURER + 3.351994 LNUIPI + 1.680381 LNIVA - 20.59296$$

From the equation of Sino-EU and Sino-US standardized co-integration, a steady long-term relationship can be found among import & export, real bilateral exchange rate, IVA of China or IPI of the Euro Zone and the US. In equations above, coefficients of industrial production index are all positive in import model. These results suggests that domestic total income can promote import volumes. This is because the increasing domestic income of importing countries could stimulate local consumption so as to expand the scale of import.

Coefficients of real exchange rate in Sino-US models are all positive, which indicates its rise can promote the growth of Sino-US imports and exports. The depreciation of RMB exchange rate benefits for Sino-EU export while the same variable in Sino-EU import model has a negative coefficient oppositely. In particular, real exchange rate of RMB rises by 1%, namely RMB depreciates by 1%, Sino-EU imports will decrease by about 7.92% but exports will adversely go up by about 12.14%. By contrast, Sino-US imports will rise by about 1.92% and exports will also increase by about 0.53%. In the traditional trade theory, currency devaluation can lead to a decline of imports but a increase of exports so generally it can improve trade condition for one country. But this theory can only be applied in Sino-EU trade. Depreciation of RMB leads to the growth of Sino-US imports, which suggests that exchange rate of RMB against Dollars is not a significant factor for Sino-US trade in a long run. In terms of international trade, the most important investigating object is the difference between imports and exports, which is called trade balance. What's more, a common method can judge whether or not devaluation is beneficial for trade and it is Marshall-Lerner condition.

The most important investigating point of international trade is trade balance, especially the results of devaluation whether be beneficial for domestic trade, which can be judged by Marshall-Lerner condition. Marshall-Lerner condition conducts that devaluation can benefit for trade when the demand elasticity of import price Em plus the demand elasticity of export price Ex excess 1, means: When $Em + Ex > 1$, then devaluation of local currency can improve the trade situation.

There are 3 main methods measuring Marshall-Lerner condition in previous researches. The first, estimating exchange rate elasticity of import and export respectively, Marshall-Lerner condition exists if the sum of absolute values of them is greater than 1. The second one is that Marshall-Lerner condition exists when elasticity of import is smaller than 0 and elasticity of export is greater than 0 meanwhile. The last one is to build a model with the difference of elasticity of import and export to confirm whether Marshall-Lerner condition exists.

The paper uses 4 standardized co-integration models combined with the last 2 methods to analyze Marshall-Lerner condition in Sino-EU and Sino-US trade. The model below can be gotten through the model that $LNCEEX$ minus $LNCEIM$:

$$LN\frac{CEEX}{CEIM} = 20.058819LNCERER - 1.577752LNIVA - 4.372773LNEIPI$$

The model of Sino-US can be got as the similar way:

$$LN\frac{CUEX}{CUIM} = -1.38952LNCURER + 7.105925LNUIPI - 1.254599LNIVA - 20.59296$$

The ratio of EX and IM is trade balance. The coefficient of LNCERER is 20.058819, which is greater than 0, which means Marshall-Lerner condition exists in Sino-EU trade, while LNCURER in model has a negative coefficient, which is -1.38952, means there is no Marshall-Lerner condition between the trade of China and the US. In other words, devaluation of RMB can increase Sino-EU trade but decrease Sino-US trade.

3.4. VEC Model Building

Co-integration analysis only explains long-run equilibrium relationships among variables, but in the short run, economic variables usually exhibit unstable relationships. Therefore, it is necessary to construct an Error Correction Model to explain how the dynamic process of disequilibrium leads to a long-term equilibrium.

First, we apply the Granger Causality test to the VEC models. The Granger Causality Test here is an exogenous variables judgment test.

Table-15. Granger causality test for variables in Sino-EU import model

Dependent variable is D(LNCEIM)			
variables	**chi-squared stat.**	**degree of freedom**	**Prob.**
D(LNCERER)	21.01790	4	0.0003
D(LNEIPI)	2.448629	4	0.6539
D(LNIVA)	15.73084	4	0.0034
All	40.11526	12	0.0001

Source: Data is calculated by using Eviews.

Table15 shows under the 95% confidence level, only D(LNEIPI) accepts the null hypothesis as exogenous variables, so establishing VEC model with it as a exogenous variable.

Table-16. Granger causality test for variables in Sino-EU export model

Dependent variable is D(LNCEEX)			
variables	**chi-squared stat.**	**degree of freedom**	**Prob.**
D(LNCERER)	21.49466	3	0.0001
D(LNEIPI)	13.39859	3	0.0038
D(LNIVA)	2.081718	3	0.5556
All	37.47783	9	0.0000

Source: Data is calculated by using Eviews.

Table16 shows under the 95% confidence level, D(LNCERER) and D(LNEIPI) refuse the null hypothesis as exogenous variables, so establishing VEC model with D(LNIVA) as a exogenous variable.

Table-17. Granger causality test for variables in Sino-US import model

Dependent variable is D(LNCUIM)			
variables	**chi-squared stat.**	**Degree of freedom**	**Prob.**
D(LNCURER)	5.56768	4	0.2338
D(LNUIPI)	10.48828	4	0.0330
D(LNIVA)	16.03783	4	0.0030
All	33.66637	12	0.0008

Source: Data is calculated by using Eviews.

Table17 shows under the 95% confidence level, only D(LNCURER) does not refuse the null hypothesis as a exogenous variable, so establishing VEC model with it as exogenous variable.

Table-18. granger causality test for variables in Sino-US export model

Dependent variable is D(LNCUEX)			
variables	**chi-squared stat.**	**degree of freedom**	**Prob.**
D(LNCURER)	2.618346	4	0.6236
D(LNUIPI)	17.47076	4	0.0016
D(LNIVA)	13.18144	4	0.0104
All	36.79319	12	0.0002

Source: Data is calculated by using Eviews.

Table18 shows under the 95% confidence level, D(LNUIPI) and D(LNIVA) refuse the null hypothesis as exogenous variables, so establishing VEC model with D(LNCURER) as exogenous variables.

Table-19. Error coefficients of VECM

Error Correction	D(LNCEIM)	D(LNCEEX)	D(LNCUIM)	D(LNCUEX)
Error coefficient	-2.312596	-1.932087	-2.577770	-2.312287

Source: Data is calculated by using Eviews.

The results of table15 shows that, the coefficients of the error terms for all three models are negative, which indicates that in the short run, the price indices are affected by random influences and deviate from the long-run equilibrium. However, the short-run deviations are temporary, the fluctuations caused by random influences would bring the variables to a long-run equilibrium finally. For example, if the RMB exchange rate fluctuations in a given period result in a 1% change in the Sino-EU import, then the exchange rate will be adjusted by a factor of 2.312596% as a result of the weakening of the random influences, pushing it toward a long-run equilibrium. The adjustment factors of Sino-EU export and Sino-US import&export are 1.932087%, 2.577770% and 2.312287%, respectively; the greater the coefficient of the error term is, the stronger adjustment factor is needed to bring the system back to equilibrium.

In other words, there exist reverse self-correcting mechanisms in the economy that bring the exchange rate to a long-run equilibrium. Based on these results, the strength of the adjustment factor needed for Sino-US import and export is greater than that for Sino-EU. Also the strength that import department needs is much more than export department. So China should distribute different degrees of adjustment strength to import and export with different countries, Sino-US import should be paid more attention.

3.5. Impulse Response Analysis under VAR

In this section, using the impulse response function, we have examined the dynamic characteristics of the variables. In a VAR model the impulse response function requires that all variables be integrated of order one, or all be I(1) sequence. Otherwise there will be an error term preventing the convergence the function and thus affecting the consistency of the estimates. We have already demonstrated that all of the variables in the model are integrated of degree one. Before conducting an impulse function analysis we need to test the stability of the variables of the VAR models.

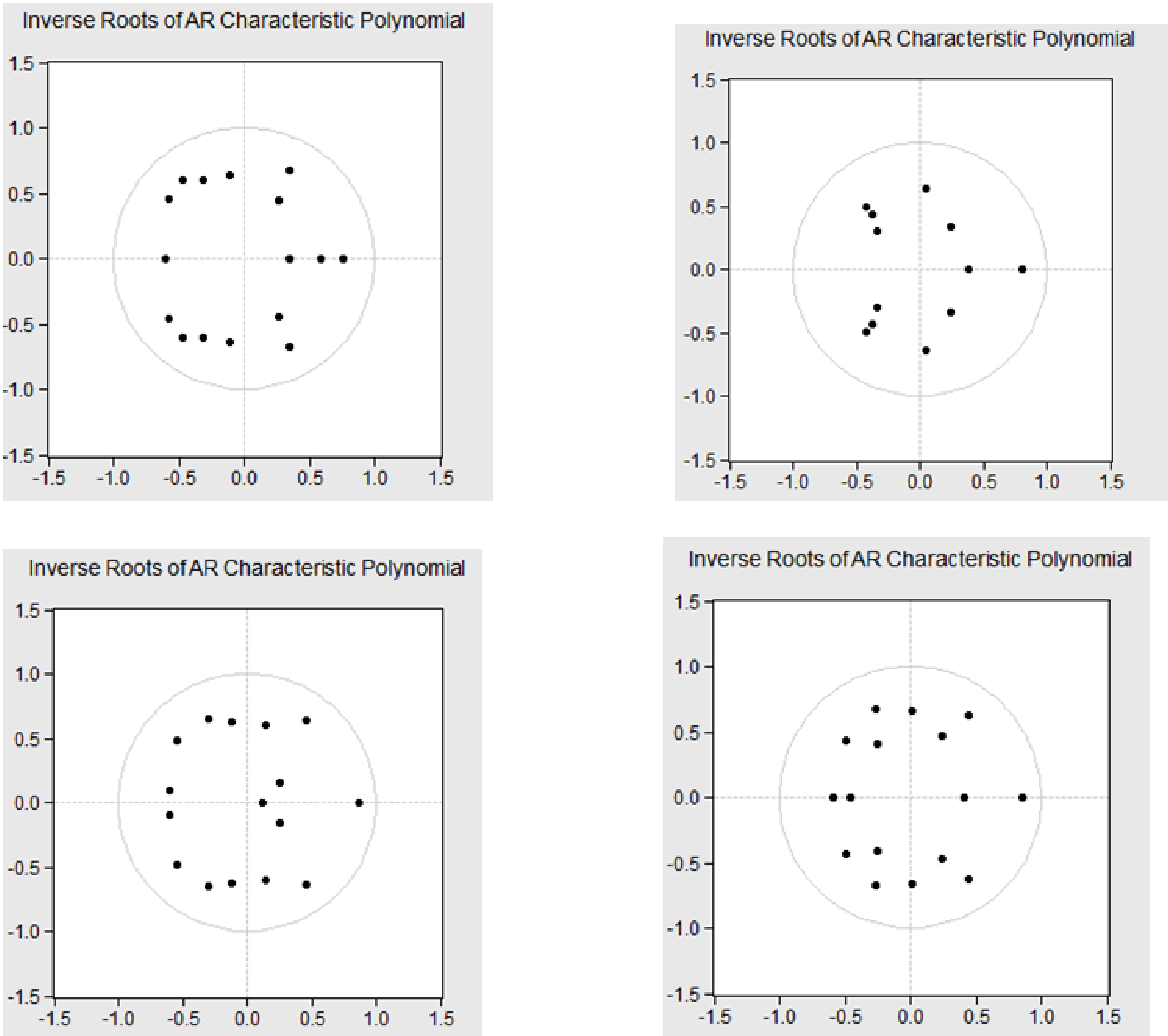

Fig-1. Inverse roots of AR characteristic polynomial

Source: Figures are made by using Eviews.

It is shown in Figure 1 that all characteristic roots of VAR models for Sino-EU and Sino-US are in the unit circle, which means first-lagged VAR models are stable. So we can continue to do Impulse Response analysis for VAR.

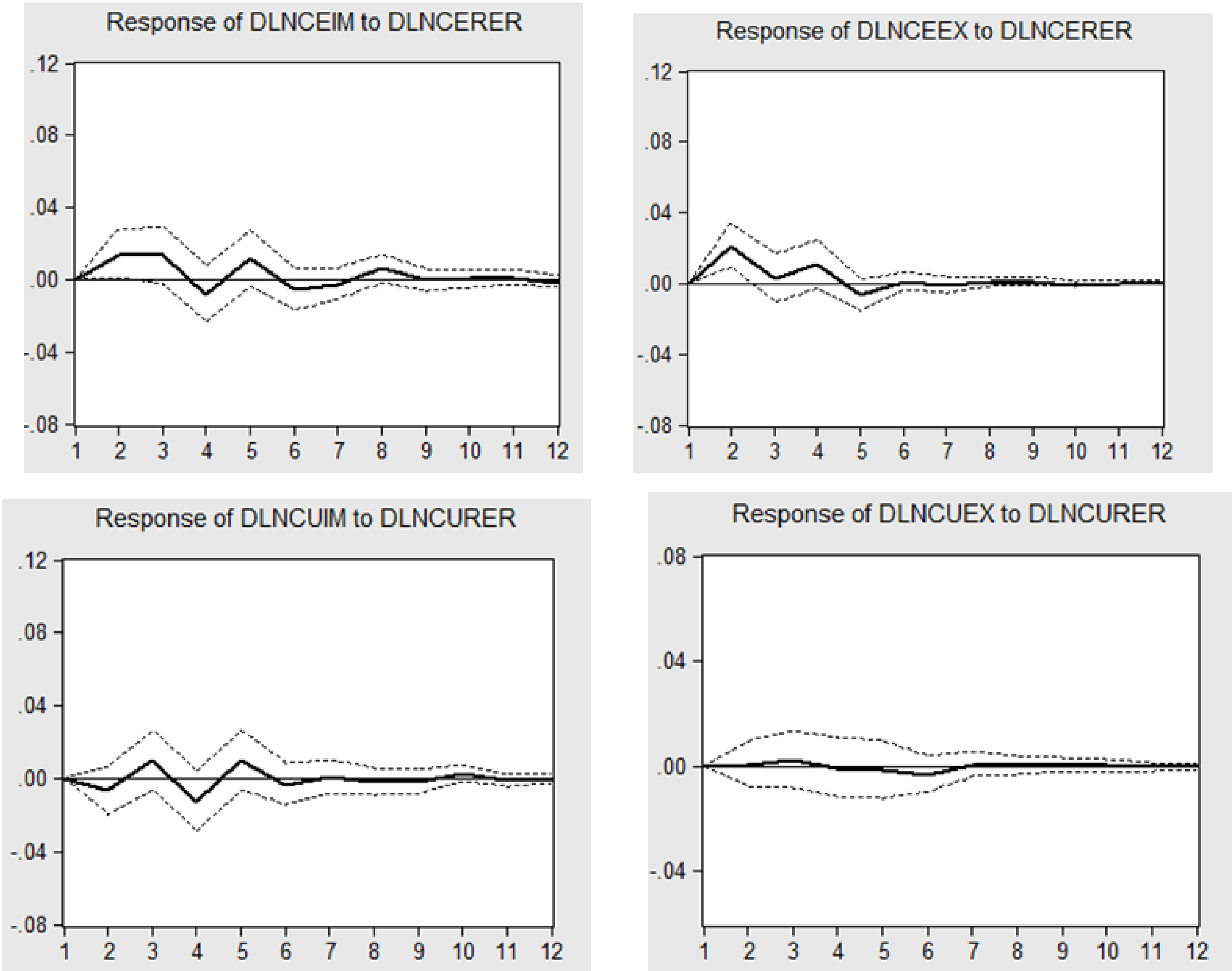

Fig-2. Impulse response of imports or exports to exchange rate

Source: Figures are made by using Eviews.

The four charts of Figure 2 are the response of import or export of Sino-EU or Sino-US to changes in real bilateral exchange rate. As these figures indicate, there is no response by the import or export to changes in real bilateral exchange rate initially. Relative to the standard deviation of the real bilateral exchange rate, no observable change is detected in the import or export at the first stage, means that the exchange rate pass-through effect on the import or export is subject to a time lag. However, the response of import or export to the exchange rate at the second stage is quite notable, which suggests that the effect of exchange rate on trade volume has a time lag. Meanwhile, Sino-EU imports and exports in second stage are all affected the most by exchange rate, but the impacts of exchange rate on Sino-US trades are the most in stage 3. These results show that influence of the real bilateral exchange rate on the current trade is stronger relatively in incipient lags. The effects of the exchange shocks on the import and export over time seem to weaken and approach zero. It reaches zero at stage 9 in Sino-EU import, at stage 6 in the Sino-EU export, at stage 7 in Sino-US import & export.

Generally, we can find that the effect of exchange rate on Sino-EU import is more durable than that of Sino-US import. Besides, the shock of exchange rate fluctuation to Sino-EU import lasts longer than its own export. The influence of Sino-US export affected by exchange rate is insignificant compared with Sino-EU trade and Sino-US import.

3.6. Variance Decomposition

The impulse response analysis above examined the effect of a change in the exchange rate on the import or export over time and showed that the response level weakens and eventually fades away. In this section, we employ variance decomposition analysis to forecast the variances of all variables and decompose them to measure the degree of contribution of each to the process of adjustment in the import and export following on the exchange rate shock.

We first rank the variables in each VAR model according to their impact on the import and export. In VAR of import, the second variable and the last variable are respectively industrial added value index and industrial production index. But in VAR of export, industrial production index and industrial added value index are ranked in the second and the third position respectively.

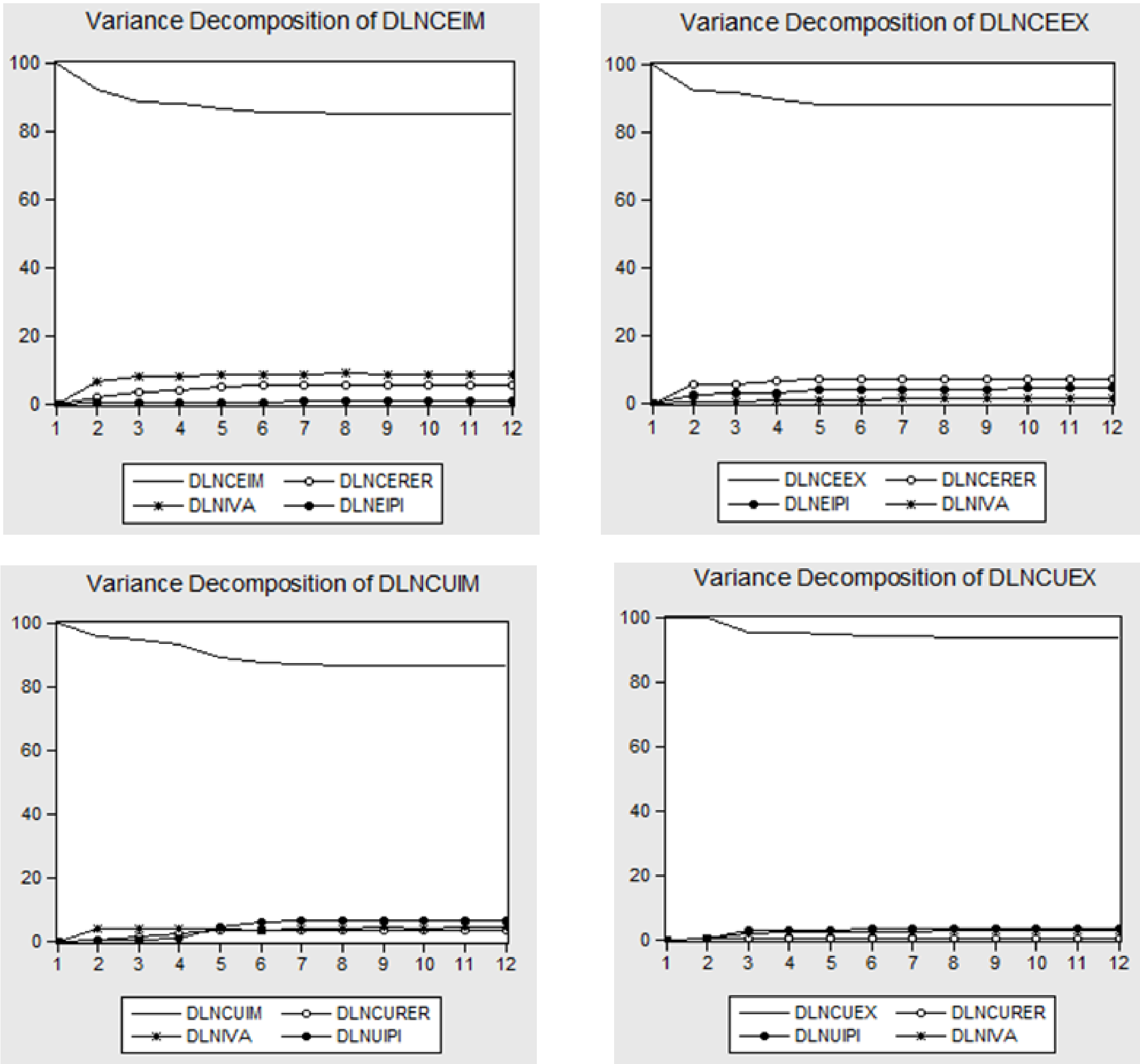

Fig-3. Variance decomposition

Source: Figures are made by using Eviews.

Figure 3 is the results of variance decomposition analysis, just as the figure, at the first stage, the impact of imports and exports of Sino-EU and Sino-US can explain their own fluctuations completely, the contribution of imports and exports for their own fluctuation is falling after then. The influence of exchange rate plays the most important role on export fluctuations of Sino-EU, but does not on imports of Sino-EU and trades of Sino-US. Specifically, for imports of Sino-EU, the contribution of exchange rate is not as much as IVA; for imports of Sino-US, the contribution of exchange rate is less than industrial production index of US and industrial add value index of China; and for exports of Sino-US, the exchange rate is still not as important as industrial production index of US and industrial add value index of China.

Generally, RMB exchange rate against Euros is the obvious factor of Sino-EU export, however, domestic and foreign prices are the crucial factors in the trade of Sino-US. So the exchange rate play the most important role in Sino-EU export but not in Sino-EU import and Sino-US trade, which indicates the effect of exchange rate on maintaining stability of Sino-EU exports is stronger than its own imports and Sino-US trades.

4. CONCLUSIONS

For grasping the long-term and short-term influences of bilateral exchange rate on imports and exports of Sino-EU and Sino-US, this paper uses methods of co-integration analysis, establishing VEC, impulse response analysis and variance decomposition based on monthly data from January 2002 to December 2016. By comparison, we obtain the following research conclusions:

a. Under traditional trade theory, devaluation can promote export rather than import. However, in this study, the empirical results of Sino-US trade have conflicts with the theory while it can be applied to explain about Sino-EU trade. Not only there is a long-term equilibrium relationship among all influenced factors of Sino-EU and Sino-US trades, but also the coefficients of real exchange rate in co-integration equations of Sino-US imports & exports and Sino-EU import are all positive but the coefficient in Sino-EU import is negative, which suggests in the long term that the increase of real exchange rate namely depreciation of RMB will increase Sino-EU export and Sino-US imports & exports but contrarily undermine Sino-EU import.

b. In a long run, if exchange rates of RMB against Euros or Dollars depreciate 1%, then Sino-EU and Sino-US will be affected adversely, while they will get a long-term equilibrium finally. For pulling volume of trade back to a normal level, Sino-US import needs the most strength to return a long-term equilibrium. Besides, Sino-EU export needs the least strength. However, all import departments need more strength to recover than export departments. Therefore, import department in trade need more attention especially Sino-US import.

c. Responses of import and exports to short-run shocks from real exchange rate is slow, so the effects of exchange rate pass-through on imports and exports have time lags. The influence of exchange rate on Sino-EU import is more durable than Sino-US import. And also the shock of exchange rate change to Sino-EU imports lasts longer than its own exports. The influence of Sino-US export affected by exchange rate is not apparent compared with Sino-EU trade and Sino-US imports. Shocks of exchange rate of RMB against Euros should be controlled promptly in Sino-EU import otherwise its influence will last longer.

d. When Sino-EU export temporarily fluctuates, exchange rate plays the most important role. But in Sino-EU import and Sino-US import & export, the influence of exchange rate is not the most important factor. In particular, in Sino-EU, exchange rate is not as important as industrial add value index of China. In Sino-US import and export, the contribution of exchange rate is less than industrial production index of US and industrial add value index of China. These results mean that the effect of exchange rate on maintaining a short-term stability of Sino-Euro import is stronger than its export and Sino-US trade.

e. When RMB is devalued, Sino-US export and import increase at the same time. Depreciation of RMB also causes the decrease of Sino-US import and the increase of its own export. Only under Marshall-Lerner condition, depreciation can improve trade deficit situation. Exchange rate elasticity of import in Sino-US trade is greater than exchange rate elasticity of export, so devaluation is not conducive to Sino-US trade condition, namely Marshall-Lerner condition can't be verified in Sino-US trade. However, coefficient of exchange rate is negative in Sino-EU import cointegration equation but positive in export equation, which accords with the hypothesis in traditional international trade theory, so currency devaluation can improve Sino-EU trade condition, in other words, Marshall-Lerner condition exists between China and the Euro Zone.

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