

The empirical analysis of Sino-US trade deficit and RMB appreciation

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Abstract: Based on VAR model, this paper uses time series data from 1985-2013 to study the impact of RMB's appreciation on narrowing down Sino-US trade deficit. Empirical result shows that RMB appreciation has very limited impact on narrowing down Sino-US trade deficit and it has a J curve effect. In fact the huge Sino-US trade deficit is an inevitable result of international division of labor, US economic development pattern and protectionist trade policies. To effectively solve the huge Sino-US trade deficit, US should revive real economy, encourage savings and rational consumption, and relax trade control policy to expand export to China.

Keywords: trade deficit, appreciation, impulse response analysis, variance decomposition, Johansen cointegration test.

INTRODUCTION

Sino-US trade deficit is a big part of US trade deficit. From Fig-1, Sino-US trade deficit has been increased rapidly during the past decade except in 2009 with the effect of financial crisis. In 2013, the Sino-US trade deficit peaked to 268.03 billion dollar. With the expansion of the Sino-US trade deficit, US accuses China of manipulating RMB exchange rate to obtain trade competitive advantage and push China to appreciate RMB. In fact, Rapid appreciation of RMB is not a good solution to Sino-US trade deficit. Since the reform of RMB exchange rate in 2005, RMB against US dollar has appreciated by 20%, at the same time, the Sino-US trade deficit did not decrease, actually it increased by 32.5%. In 2008, when the financial crisis came, RMB-dollar exchange rate stay stable, the Sino-

US trade deficit decreased by 42.1 billion dollar [1]. The same data also shows that the Sino-US trade deficit increases with the prosperity of US economy and decreases with the depression of US economy [2]. Moreover, RMB under valuation could not explain that the US has trade deficit with so many countries around the world. So the Sino-US trade deficit must have deep-seated reasons [3].

Based on VAR model, this paper uses time series data from 1985-2013 to analyze whether RMB appreciation can effectively narrow down the huge Sino-US trade deficit. At last, this paper also put forward effective measures to solve Sino-US trade deficit.

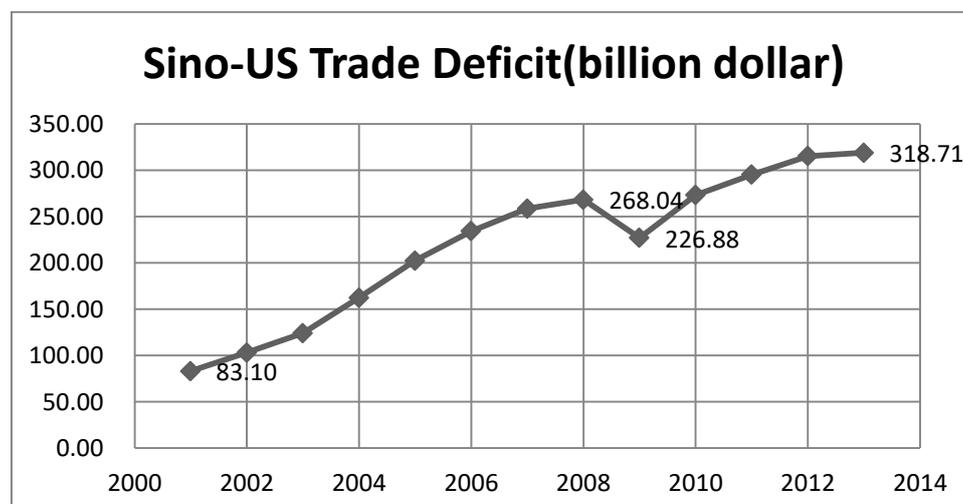


Fig-1: Sino-US trade deficit from 2000-2014

EXPERIMENTAL SECTION

VAR Model

The vector autoregression (VAR) is an econometric model used to capture the linear interdependencies among multiple time series. VAR model generalizes the univariate autoregressive model by allowing for more than one evolving variable. All variables in a VAR are treated symmetrically in a structural sense; each variable has an equation explaining its evolution based on its own lags and the lags of the other model variables. The modeling process of VAR includes the following steps.

a. Variables selection and sample interval

According to macroeconomic theory, trade balance amount is affected by real exchange rate, domestic disposable income, foreign disposable income, trade structure, price elasticity of commodity, trade policy

and etc [4]. Among them, real exchange rate, domestic disposable income and foreign disposable income have greater impact. So this article choose real exchange rate (RMB-dollar real exchange rate), domestic disposable income (replaced by China real GDP), foreign disposable income (replaced by US real GDP) and Sino-US trade deficit to construct a VAR model. The sample interval is from 1985-2013.

b. Unit root test

In statistics, a unit root test tests whether a time series variable is non-stationary using an autoregressive model. A well-known test that is valid in large samples is the augmented Dickey–Fuller test. Before ADF test, use logarithmic Sequences for RMB-dollar exchange rate, China real GDP, US real GDP and Sino-US trade deficit to reduce volatility and eliminate sequences of heteroscedasticity. ADF test shown in Table 1.

Table-1: ADF test

Sequence	(C,T,K)	ADF-statistic	P values	Test result
LnTD	(C,T,0)	-16.55*	0.0000	stationary
LnY _{ch}	(C,T,6)	-4.52*	0.0084	stationary
LnY _{us}	(C,T,1)	-1.32	0.8607	non-stationary
Lne	(C,0,0)	-1.92	0.3177	non-stationary
ΔLnTD	(C,T,0)	-41.77*	0.0000	stationary
ΔLnY _{ch}	(C,0,1)	-3.96*	0.0056	stationary
ΔLnY _{us}	(C,0,0)	-2.76***	0.0772	stationary
ΔLne	(C,0,0)	-5.34*	0.0002	stationary

(Annotation: *, **, *** successively indicate pass 1%, 5%, 10% significance level test;

C: Intercept; T: Trend items; K: Lag; Δ: difference)

From Table 1, LnY_{ch} represents logarithm of China real GDP, LnY_{us} represents logarithm of US real GDP, Lne represents logarithm of RMB-dollar exchange rate, LnTD represents logarithm of Sino-US trade deficit. All the sequences are I(1) series and it is suitable to construct a VAR model.

c. Lag order

Refer to LR, FPE, AIC, SC and HQ criterion to choose the best lag order of VAR model. Lag order test shown in Table 2.

Table-2: Lag order test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	63.44	NA	0.00	-4.76	-4.56	-4.70
1	216.86	245.46	0.00	-15.75	-14.77	-15.48
2	249.73	42.08*	5.1*10 ⁻¹³ *	-17.10	-15.34*	-16.61
3	263.55	13.26	0.00	-16.92	-14.39	-16.22
4	289.14	16.38	0.00	-17.69	-14.38	-16.77*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error AIC: Akaike information criterion;

SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

As shown from table 2 that, lag 2 has 3 minimum criterion, including LR, FPE and SC criterion, So 2 is the best lag order and VAR model is below:

$$\begin{bmatrix} Lntd \\ LnYch \\ LnYus \\ Lne \end{bmatrix}_t = \begin{bmatrix} -6.25 \\ -0.32 \\ 1.053 \\ -0.448 \end{bmatrix} + \begin{bmatrix} 0.839 & -0.699 & 0.792 & -0.287 \\ 0.015 & 1.641 & -0.262 & 0.107 \\ -0.03 & -0.26 & 1.396 & 0.089 \\ 0.322 & -0.671 & -0.722 & 0.038 \end{bmatrix} \begin{bmatrix} Lntd \\ LnYch \\ LnYus \\ Lne \end{bmatrix}_{t-1} + \begin{bmatrix} -0.007 & 0.476 & 0.065 & 0.332 \\ -0.006 & -0.685 & 0.328 & -0.098 \\ 0.005 & 0.375 & -0.595 & 0.081 \\ -0.047 & -0.092 & 1.442 & -0.085 \end{bmatrix} \begin{bmatrix} Lntd \\ LnYch \\ LnYus \\ Lne \end{bmatrix}_{t-2} + \begin{bmatrix} \varepsilon_0 \\ \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix}_t$$

Through test, the VAR model is stable and is possible to make impulse response analysis and variance decomposition.

Impulse Response analysis

An impulse response function measures the time profile of the effect of shocks at a given point in time on the expected future values of variables in a dynamical

system[5].This paper uses impulse response functions to describe the reaction of Sino-US trade deficit at the time of the exogenous impulses and over subsequent points in time. The exogenous impulses include Sino-US trade deficit itself, US real GDP, China real GDP and RMB-dollar real exchange rate. Impulse Response Periods: 20 years, result shown in Fig-2.

Response of LNTD to Cholesky One S.D. Innovations

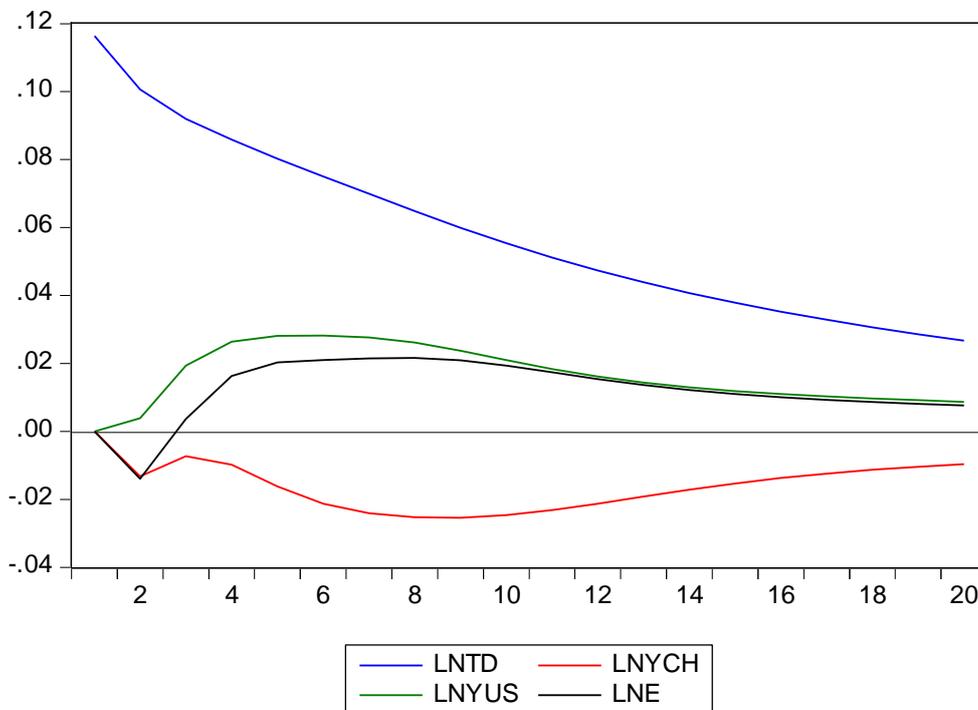


Fig-2: Impulse Response analysis

Fig. 2shows that, Sino-US trade deficit has an immediate response from a standard deviation impulse of itself. In period 1,the response of Sino-US trade deficit is 11 and it is positive. After that this shock’s impact on Sino-US trade deficit decreases gradually and about in period 20 its impact tends to be stable.

Sino-US trade deficit does not have an immediate response from a standard deviation impulse of US real GDP. In period 1, the response of Sino-US trade deficit is 0. After that, Sino-US trade deficit’s response toward

a standard deviation impulse of US real GDP increases rapidly, about in period 6,it reaches a peak of 2.8 and it is positive. Then its impact on Sino-US trade deficit decreases.

Sino-US trade deficit does not have an immediate response from a standard deviation impulse of China real GDP. In period 1, the response of Sino-US trade deficit is 0. In period 9, it reaches to a peak of 2.5 and it is negative. After that, its impact on Sino-US trade deficit decreases and become stable in period 20.

The response of Sino-US trade deficit from a standard deviation impulse of RMB-dollar real exchange rate can be divided into two stages. Stage 1, from period 1 to period 3, is negative. Sino-US trade deficit does not have an immediate response from a standard deviation impulse of RMB-dollar real exchange rate at this stage. In period 1, the response of Sino-US trade deficit is 0. Stage 2, from period 4 to period 20, is positive. In period 8, Sino-US trade deficit has the strongest response from a standard deviation impulse of RMB-dollar real exchange rate and in period 20 its impact on Sino-US trade deficit become stable. Logically, RMB appreciation can reduce Sino-US trade deficit. But why Sino-US trade deficit has a negative response from a standard deviation impulse of RMB-dollar real exchange rate? The reason is J curve effect, because immediately following the depreciation or devaluation of the RMB, the volume of imports and exports between US and China may remain largely

unchanged due in part to pre-existing trade contracts that have to be honoured. Moreover, in the short run, demand for the more expensive imports remain price inelastic. This is due to time lags in the consumer's search for acceptable, cheaper alternatives, which means RMB appreciation need adjustment time to narrow down Sino-US trade deficit.

Variance decomposition

The variance decomposition indicates the amount of information each variable contributes to the other variables in the autoregression [6]. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. This paper uses variance decomposition to analyze how much of the forecast error variance of Sino-US trade deficit can be explained by exogenous shocks of US real GDP, China real GDP, RMB-dollar real exchange rate and Sino-US trade deficit itself. Decomposition periods:20 years, shown in Fig-3.

Variance Decomposition of LNTD

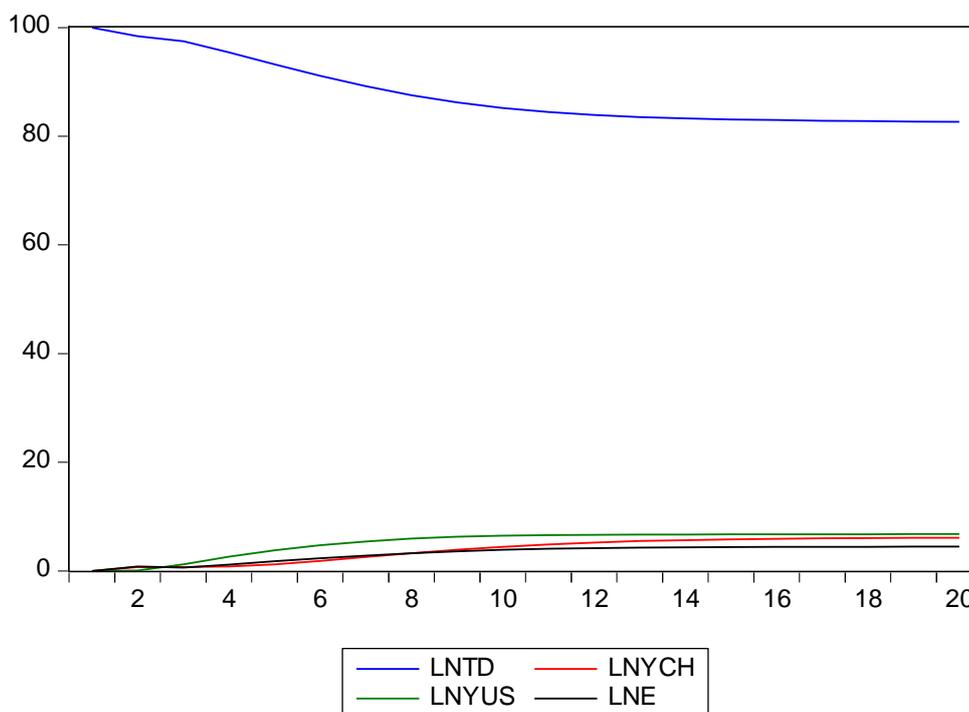


Fig-3: Variance decomposition

Fig. 3 shows that, in period 1, forecast standard deviation of the Sino-US trade deficit is caused by perturbation of Sino-US trade deficit itself totally. In period 4, 0.78% of forecast standard deviation of the Sino-US trade deficit is caused by perturbation of China real GDP; 2.63% of forecast standard deviation of the Sino-US trade deficit is caused by perturbation of US real GDP; 1.14% of forecast standard deviation of the Sino-US trade deficit is caused by perturbation of

RMB-dollar real exchange rate and 95.45% of forecast standard deviation of the Sino-US trade deficit is caused by perturbation of Sino-US trade deficit itself.

With the passage of forecast period, the percentage of forecast standard deviation of the Sino-US trade deficit caused by perturbation of China real GDP, US real GDP and RMB-dollar real exchange rate increases gradually. By comparison, the percentage of forecast

standard deviation of the Sino-US trade deficit caused by perturbation of Sino-US trade deficit itself decreases but still occupy an important position. In period 20, the decomposition result of Sino-US trade deficit become stable. In period 20, about 6.12% of forecast standard deviation of the Sino-US trade deficit is caused by perturbation of China real GDP, 6.77% caused by perturbation of US real GDP, 4.49% caused by perturbation of RMB-dollar real exchange rate, 82.62% caused by perturbation of Sino-US trade deficit itself.

Johansen cointegration test

In statistics, the Johansen test, based on VAR, is a procedure for testing cointegration of several time series. This paper uses Johansen cointegration test to test whether there are long-term equilibrium relationship among Sino-US trade deficit, China real GDP, US real GDP and RMB-dollar real exchange rate. Cointegration test shown in Table 3.

Table- 3: Johansen cointegration test

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical	Prob.**
None *	95.59	47.86	0.00
At most 1 *	35.65	29.80	0.01
At most 2	11.90	15.49	0.16
At most 3	2.63	3.84	0.10

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

According to Table 3, there is a long-term equilibrium linear relationship among Sino-US trade deficit, China real GDP, US real GDP and RMB-dollar real exchange rate. The cointegration equation is:

$$\text{LnTD} = -0.49 * \text{LnYch} + 4.24 * \text{LnYus} + 0.39 * \text{Ln(E)} + \hat{u}_t$$

Standard error =(0.43477) (0.99634) (0.43221)

Cointegration equation is a long-term equilibrium equation, \hat{u}_t is Error correction term. From cointegration equation, US real GDP and RMB-dollar real exchange rate have positive impact on Sino-US trade deficit, but US real GDP has a greater role in expanding Sino-US trade deficit. Specifically, logarithm of US real GDP increase by 1%, logarithm of Sino-US trade deficit will increase by 4.24% correspondingly. Logarithm of RMB-dollar real exchange rate increase by 1%,

logarithm of Sino-US trade deficit will increase by 0.39% correspondingly. By comparison, China real GDP has negative impact on Sino-US trade deficit. Specifically, logarithm of China real GDP increase by 1%, logarithm of Sino-US trade deficit will decrease by 0.49% correspondingly.

Granger causality

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. This paper use Granger causality test to make further exploration of whether there are causality among Sino-US trade deficit, US real GDP, China real GDP and RMB-dollar real exchange rate. Based on this case, the corresponding hypotheses can be examined by Granger causality test, shown in table-4.

Table-4: Granger causality test

Null hypothesis	Lags=3 ,Obs=26		Lags=4,Obs=25		Lags=5,Obs=24	
	F-statistic	Prob	F-statistic	Prob	F-statistic	Prob
LnE does not Granger Cause LnTD	0.32347	0.8083	0.06530	0.9914	0.39627	0.8428
LnY _{ch} does not Granger Cause LnTD	0.91010	0.4547	0.32253	0.8587	1.75875	0.1908
LnY _{US} does not Granger Cause LnTD	1.48811	0.2497	0.55707	0.6970	0.57938	0.7154

We can see from table 4 that, F statistical probability values of all lag order cannot pass the test standard of 1% level, cannot reject the null hypothesis. So US real GDP, China real GDP and RMB-dollar real exchange rate are not the Granger cause of Sino-US trade deficit.

RESULTS AND DISCUSSION

Based on VAR model, Impulse response analysis shows Sino-US trade deficit has the maximal response from a standard deviation impulse of trade deficit itself, followed by US real GDP, China real GDP and RMB-dollar real exchange rate. Because of J curve effect,

RMB appreciation need adjustment time to narrow down Sino-US trade deficit.

Variance decomposition shows the variance deviation of the Sino-US trade deficit is mainly caused by perturbation of Sino-US trade deficit itself. By comparison, US real GDP, China real GDP and RMB-dollar real exchange rate make very limited contribution to the variance deviation of the Sino-US trade deficit. Johansen Cointegration test shows US real GDP has the biggest effect on narrowing down Sino-US trade deficit, followed by China real GDP and RMB-dollar real exchange rate. Granger causality shows RMB-dollar real exchange rate is not the Granger cause of Sino-US trade deficit.

CONCLUSION

Based on VAR model, this paper uses time series data from 1985-2013 to study the impact of RMB's appreciation on narrowing down Sino-US trade deficit. Impulse response analysis, variance decomposition, Johansen cointegration test and Granger causality show that RMB appreciation has very limited impact on narrowing down Sino-US trade deficit and RMB appreciation need adjustment time to narrow down Sino-US trade deficit. In fact, the huge Sino-US trade deficit is an inevitable result of international division of labor, US economic development pattern and protectionist trade policies. To effectively solve the huge Sino-US trade deficit, US should revive real economy, encourage savings and rational consumption and relax trade control policy to expand export to China, especially high-tech products.

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