The Impact of Exchange Rate on Trade Balance between China and Japan—An Empirical Study Based on SVAR Model

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Abstract. As one of China’s major trading partners, Competition and cooperation with Japan in international trade play an unignorable role in China's economic development. Based on previous studies and balance-of-payments theory, we collected data on the exchange rate as well as China-Japan import and export trade from 2013 to 2018. SVAR model was utilized to analyze the influence of the exchange rate on international trade between China and Japan. Results show that a stable mutual relationship between the exchange rate and China's export trade with Japan exists in long term, but there is no strong correlation between the exchange rate and China’s import trade with Japan; in short term, the fluctuation in the exchange rate restrains the progression of China-Japan trade.

Introduction

As the world's second and third-largest economies, the competition and cooperation between China and Japan in the field of international trade significantly impact world economy. Since the reform and opening up, the total trade volume between the two countries has grown from 4.82 billion USD in 1978 to more than 300 billion USD in 2018. China-Japan bilateral trade has attracted lots of attention in the context of economic globalization.

In recent years, due to the continuous loose monetary policy of the Japanese government and the market-oriented reformation for the CNY exchange rate, the CNY to JPY exchange rate has been constantly appreciating. Using the time frame of 2013-2018 as an example, the CNY to JPY exchange rate appreciated from 100 JPY to 7.03 CNY, to 100 JPY to 6.13 CNY. On the other hand, according to data from the Japanese Customs, the Japan-China trade deficit is one of the primary reasons hindering the current economic and trade cooperation between the two countries. For example, the bilateral trade volume between China and Japan in 2018 was 317.53 billion USD, where 173.54 billion USD was import from China and 143.99 billion USD was export to China. Thus, the trade deficit between Japan and China was 29.55 billion USD [1]. Obviously, this phenomenon differs from the traditional balance-of-payments theory. Can the changes in the exchange rate between China and Japan effectively influence the volume of import and export trade between China and Japan? Besides, can the “Abenomics” leading by the Japanese government improve its foreign trade status to achieve substantial results through the depreciation of JPY? This study will analyze the data of Chinese and Japanese exchange rate during 2013-2018, and use the SVAR model to study the impact of the exchange rate on the import and export trade between the two countries.

The economic development of Japan and China depends on good bilateral trade relations. Also import and export trade has a positive effect on raising residents' income and improving living standards, as well as promoting multi-level and multi-dimensional political and cultural exchanges between the two countries. Besides, as the leading countries in Asia, trade between China and Japan are not only of considerable significance to their own countries but also can promote the healthy economic development of the surrounding areas and even entire Asia. In the era of economic globalization, although the economic and trade cooperation between China and Japan have expanded, the trade imbalance between them has become increasingly severe.
According to the balance-of-payments theory of international trade, when a country faces trade deficit, a large amount of domestic capital flows abroad, resulting in decrease in household income and decline in the economic. To reverse the deficit, the common approach is to devalue the currency. After depreciation, the purchasing power of the domestic currency declines, which is equivalent to the relative decrease in the price of export commodities. As a result, the international competitiveness of domestic exports is strengthened compared to foreign goods, and then the trade deficit is reversed. On the contrary, the appreciation of the domestic currency will lead to decrease in the export volume, and the increase in the purchasing power of the domestic currency will increase imports. To a certain extent, it worsens the balance of imports and exports. However, the depreciation of JPY in recent years has not effectively adjusted the trade imbalance between the two countries, in other words, the facts do not entirely agree with the traditional balance-of-payments theory. Therefore, this study will explore the relationships between the exchange rate and China-Japan trade, draw relevant conclusions and provide recommendations.

Literature Review

The influence of the exchange rate on trade balance has been a research hot spot for a long time. Most previous studies discussed it through checking the Marshall-Lerner condition and exchange rate fluctuations. Sasaki claimed that the depreciation of JPY could improve Japan's trade balance, but due to the impact of various factors, such as industrial transformation, despite the sharp depreciation of the JPY, it had little improvement on trade balances (Sasaki Yuri [2] (2015)); Shimizu et al. [3] (2014) considered that the fundamental reason for the deterioration of Japan’s trade balance was not the exchange rate, but rather the decline in the international competitiveness of domestic products; Chen [4] (2013) thought that the impact of exchange rates on trade balance was quite limited. China was less affected by exchange rate than Japan, due to the current low degree of marketization of CNY. Li showed that the Marshall-Lerner condition held in the long run in China, thus the exchange rate would have effects on trade balances (Li Zhanfeng [5] (2014)); based on the data of the exchange rate from 2005 to 2015, Chen et al [6] (2015) did an empirical study and found that the exchange rate had little impact on the trade balance between China and Japan. The deficit of the China-Japan trade cannot be resolved solely by the appreciation of CNY. In the short term, China-Japan trade and the exchange rate would have a negative correlation, and the depreciation of CNY would not effectively change the situation of the trade deficit (Li Fuyou et al. [7] (2013)); Ding [8] (2018) conduct an empirical study with the VAR model and found that the sharp depreciation of JPY indeed worsened China's trade condition with Japan in the long run, but statistically, the coefficient of elasticity was so small that the interpretation is not strong. At the same time, the short-term and lagging effects on international trade caused by exchange rate fluctuations had been at a positive level, and the J curve did not exist; Mei [9] (2012) analyzed the categories of China-Japan trade by products and found that primary products and resource-based manufactured goods were more affected by the appreciation of CNY; however, it also worsened trade conditions of low-tech products. In addition, the effect of the exchange rate on medium and high technology products was not significant. Lai [10] (2014) suggested that the Marshall-Lerner condition was not established in the trade between China and Japan. The exchange rate of JPY was not the determinant factor, it is rather the domestic income and expenditure of both countries affected the China-Japan trade balance most.

In summary, there is still controversy about the relationship between the exchange rate fluctuation and China-Japan trade balance. This study used the SVAR model to analyze the long and short-term effects of the exchange rate on the import and export trade between China and Japan, and verify if the results would be in accordance with the theory of traditional exchange rate and balance-of-payments. A series of targeted conclusion and policy recommendations are also summarized.
Empirical Analysis and Results

Data Collection

We selected the monthly data of the exchange rate as well as import and export trade between China and Japan during 2013-2018 for study and analysis. The exchange rate data were from State Administration of Foreign Exchange represented by EXCH in statistics. The data of China-Japan trade came from “the import data of both China and Japan”; in other words, the data of China’s exports to Japan can be presented by Japan’s imports from China, because statistically, exports adopt destination rules and imports adopt rules of origin. China’s exports to Japan via Hong Kong are not included, while imports include all products originally from Japan. Therefore, the import statistics of the two sides are calculated and used as the China-Japan trade volume, which is considered to be more conform to the actual situation between the two countries. The export amount is named as EXPORT and the import amount as IMP. All the data used in this study can be found at the website of “General Administration of Customs, China” and “Ministry of Finance, Japan”.

Analytical Model

This study used the structural vector autoregression (SVAR) model to analyze the impact of the exchange rate between China and Japan on import and export trade. SVAR model based on certain theoretical assumptions, by constraining the parameters, the number of estimated parameters of the model can be reduced, while the response of each variable to the structural impulse can be also recovered. Compared to the VAR model, the SVAR model can effectively capture the structural relationship between each variable in the system, thus was selected in this paper.

An SVAR model consisting of three variables can be written as:

$$Ay_t = A\Gamma_1y_{t-1} + \cdots + A\Gamma_p y_{t-p} + u_t \quad t = 1, 2, ..., T$$

where $A = \begin{pmatrix} 1 & a_{12} & a_{13} \\ a_{21} & 1 & a_{23} \\ a_{31} & a_{32} & 1 \end{pmatrix}$, $\Gamma_i$ is a 3x3 matrix, $u_t$ is a 3x1 column vector.

Rearrange Equation (1) yields:

$$A(I - \Gamma_1L - \cdots - \Gamma_p L^p)y_t = Au_t$$

Assume $Au_t = B\varepsilon_t$, let $B = \begin{pmatrix} b_{11} & 0 & 0 \\ 0 & b_{22} & 0 \\ 0 & 0 & b_{33} \end{pmatrix}$, a 3x3 matrix; $\varepsilon_t$ is a 3x1 column vector and is the structural disturbances, in which no contemporaneous correlation exists, its variance-covariance matrix is further standardized into unit matrix. Then from Equation (2) we obtain:

$$A(I - \Gamma_1L - \cdots - \Gamma_p L^p)y_t = Au_t = B\varepsilon_t$$

Thus Equation (3) is the common form of the SVAR AB-model.

Unit Root Test

First, an ADF unit root test was performed to analyze the robustness of each variable (Table 1).

| Variables | Test parameters | AIC  | SC   | ADF  | 5% threshold | p-value | Robustness |
|-----------|----------------|------|------|------|--------------|--------|------------|
| EXC       | (C,0,1)        | -1.2709 | -1.1745 | -2.1638 | -2.9036 | 0.221 | N          |

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According to Table 1, EXCH could reject the null hypothesis at the 5% significance level, and its first-order differential passed the ADF test at 5% confidence level, which shows that the variable EXCH is I(1) sequence. The variable EXPORT also passed the robustness test at 5% significance level. Even though the variable IMP could not reject the null hypothesis, its first-order differential passed the ADF test at 1% confidence level, which indicates that the IMP variable is I(1) sequence. Therefore, the VAR model can be established based on the robust DEXCH, EXPORT and DIMP.

### Optimal Lag Period Analysis

The optimal lag analysis (Table 2) shows that the optimal lag period was 2 based on LR, FPE, AIC, SC and HQ information criteria. Therefore, the VAR(2) model was chosen and established in this paper. Then we performed eigenvalue test and the results show that all the reciprocals of eigenvalues are within the unit circle (Figure 1), which proves that the model is robust and the lag period is determined to be 2.

| Lag | LogL      | LR  | FPE     | AIC    | SC      | HQ     |
|-----|-----------|-----|---------|--------|---------|--------|
| 0   | -525.0133 | NA  | 1405.243| 15.76159| 15.86031| 15.80065|
| 1   | -508.2961 | 31.43833| 1116.575| 15.53123| 15.92610| 15.68748|
| 2   | -480.4064 | 49.95162*| 636.5227*| 14.96736*| 15.65838*| 15.24079*|
| 3   | -475.0756 | 9.070367| 713.3639| 15.07688| 16.06406| 15.46751|
| 4   | -466.6790 | 13.53476| 732.3169| 15.09490| 16.37822| 15.60271|

*Stands for the optimal order selected by system
Correlation Analysis

**Long-term Relationship.** DEXCH, DIMP and EXPORT are all stationary sequences; even though it is not necessary to perform a cointegration test, a test was conducted and we found the existence of cointegration relationship at 5% confidence level, which agreed with the prediction. The long-term relationship between each variable was then examined based on the traditional OLS regression model with concurrent variables.

Table 3. Estimation Based on OLS Regression Model with Concurrent Variables.

| Dependent variables | Independent variables | DEXCH | DIMP | EXPORT |
|---------------------|-----------------------|-------|------|--------|
| DEXCH               |                       | -0.000935 | (0.000872) | -0.001986* | (0.001013) |
| DIMP                |                       | 17.77999 | (16.57862) | -0.181571 | (0.141800) |
| EXPORT              |                       | -26.95727* | (13.74481) | -0.129670 | (0.101267) |
| Results             | Long term EXP has significantly negative effect on DEXCH | Long term DEXCH has significant negative effect on EXP | DEXCH and EXP have no significant effect on DIMP |

Note: ① In this table, the values in parentheses are standard errors, the values without parentheses are regression coefficients; ② "*" means that the null hypothesis can be rejected at 10% confidence level.

The results from OLS estimation, as shown in Table 3, demonstrated that long-term EXP had a significantly negative impact on DEXCH, and long term DEXCH also had a significantly negative impact on EXP. DEXCH and EXP had no significant effect on DIMP. This result indicated that in the long run, there is a stable mutual influence between China's export trade with Japan and the exchange rate. The long term exports have a significantly negative impact on the exchange rate; the exchange rate also has a significantly negative impact on exports.

**Short-term Relationship.** This study used Granger test to examine the short-term relationship between variables. Granger test can reflect if short-term relationships exist. The results, as shown in Table 4, show that DEXCH is the cause of DIMP; EXPORT and DIMP are causal relationships with each other; other variables do not have significant causality.
Table 4. Results of Granger Test.

Pairwise Granger Causality Tests
Sample: 2013M01 2018M12
Lags: 4

| Null Hypothesis                        | Obs | F-Statistic | Prob. |
|----------------------------------------|-----|-------------|-------|
| DIMP does not Granger Cause DEXCH      | 67  | 0.09954     | 0.9822|
| DEXCH does not Granger Cause DIMP      |     | 2.56894     | 0.0473|
| EXPORT does not Granger Cause DEXCH    |     | 1.93497     | 0.1167|
| DEXCH does not Granger Cause EXPORT    | 67  | 0.90254     | 0.4685|
| EXPORT does not Granger Cause DIMP     |     | 3.86430     | 0.0075|
| DIMP does not Granger Cause EXPORT     |     | 4.41544     | 0.0035|

**Impulse Response Analysis**

To further analyze the short-term impact of the China-Japan exchange rate on the trade of both sides, it is necessary to perform impulse response analysis and variance decomposition in the SVAR model.

![Response of DIMP to DEXCH Innovation using Cholesky (d.f. adjusted) Factors](image)

Figure 2. The Response of China’s Import from Japan to the Random Pulse of Exchange Rate.

The main purpose of the impulse response analysis is to observe how a positive impact from the first-order differential DEXCH affects the first-order differential DIMP, from the shape of the pulse response function, the influence of a positive standard deviation impact DIMP can be observed, as shown in Figure 2. In the whole reaction period, positive and negative response occurred alternately, and the negative response reached the peak of -5.1 units in the 1st period; then the response amplitude gradually rose; after the 3rd period, it reached 4 units; after the 10th period, the response gradually approached to 0.

According to the impulse response analysis, the influence of a positive impact from DEXCH on the DIMP will oscillating converge over time and will have significant negative influence at the beginning, then positive influence in a few periods, and then gradually weaken. This indicate that the positive fluctuations in the exchange rate, in other words, the appreciation of CNY to JPY will have a significant inhibitory effect on China’s import trade with Japan in the early stage, but a weak promoting effect later. According to this, this study concluded that the appreciation of CNY in short term would inhibit the trade development between China and Japan as a whole.
Variance Decomposition

The purpose of variance decomposition is to study the source and factors of the impact of the DIMP and EXPORT variables. Here DIMP is impacted by two variables, DEXCH and EXPORT, while EXPORT only suffers from the impact of DIMP.

Table 5. The Impact of Different Variables on China’s Imports from Japan.

| Period | S.E.  | DEXCH  | DIMP     | EXPORT  |
|--------|-------|--------|----------|---------|
| 1      | 0.12764 | 14.61700 | 85.38300 | 0.00000 |
| 2      | 0.13133 | 14.25420 | 81.30062 | 4.44518 |
| 3      | 0.13689 | 18.46212 | 77.33439 | 4.20349 |
| 4      | 0.13772 | 19.91966 | 76.40882 | 3.67151 |
| 5      | 0.13950 | 19.59885 | 75.96708 | 4.43407 |
| 6      | 0.13994 | 20.18110 | 75.50335 | 4.31555 |
| 7      | 0.14036 | 20.25838 | 75.50191 | 4.23971 |
| 8      | 0.14052 | 20.26051 | 75.38715 | 4.35234 |
| 9      | 0.14064 | 20.35203 | 75.32148 | 4.32649 |
| 10     | 0.14068 | 20.34650 | 75.33143 | 4.32206 |

The results of variance decomposition was shown in Figure 5 and Table 6. The impact of DIMP was mainly from itself (its trend was monotonically declined from 85% in the 1st period to 76% in the 5th period, and then it roughly maintained this level), the impact of DEXCH and EXPORT was relatively stable, and DEXCH has an essential influence on it (its trend was monotonically inclined from 15% in the 1st period to 20% in the 6th period, and then it stayed at this level); EXPORT had a little effect on it (except the impact during initial period was small, the other periods were stable at around 4%).
Table 6. The Impact of Different Variables on China’s Exports to Japan.

| Period | S.E.   | DEXCH  | DIMP   | EXPORT |
|--------|--------|--------|--------|--------|
| 1      | 13.44885 | 0.66390 | 0.00192 | 99.33417 |
| 2      | 16.14809 | 4.32373 | 0.06891 | 88.60737 |
| 3      | 16.93271 | 7.16576 | 6.08231 | 90.20112 |
| 4      | 18.19875 | 3.66794 | 5.96036 | 90.37170 |
| 5      | 18.36539 | 3.59557 | 6.32945 | 90.07498 |
| 6      | 18.61708 | 3.59418 | 6.32422 | 90.08160 |
| 7      | 18.78308 | 3.61705 | 6.29167 | 90.09128 |
| 8      | 18.79752 | 3.61764 | 6.35981 | 90.02255 |
| 9      | 18.86130 | 3.61504 | 6.36242 | 90.02254 |
| 10     | 18.87686 | 3.61914 | 6.36370 | 90.01716 |

Similarly, the impact of EXPORT is mostly from itself (its trend was monotonically decreased from 99% in the 1st period to 89% in the 2nd period, and then it remained roughly 90%). The impact of DEXCH and DIMP was small during the initial period, but was relatively stable otherwise and remained roughly at 3.6% and 6%, respectively, as shown in Table 6.

These results indicated that EXPORT and DIMP were mainly affected by their own; the impact from DEXCH had a higher contribution to the impact of DIMP, but smaller contribution to the impact that EXPORT suffered; the contribution of the impact from EXPORT on DIMP and the contribution of the impact from DIMP on EXPORT were both relatively small, but in comparison, the latter was a little more than that of the former.

In summary, the exchange rate fluctuation in short term has a significant impact on China-Japan trade balance, and especially impacts China's import from Japan; there is little correlation between China's export to Japan and the import trade from Japan, but in comparison, the impact of imports on exports is more significant.

Discussion and Policy Suggestion

Conclusions

This study utilized the SVAR model to analyze the data of the exchange rate and the international trade between China and Japan during 2013-2018. It is obvious that the influence of exchange rate on the international trade between the China and Japan is not completely in accordance with the expectations of traditional balance-of-payments theory.

First, there is a stable mutual influence between the exchange rate and China's export trade with Japan in long term, but there is no strong correlation between exchange rate and imports from Japan. According to a report from the Ministry of Commerce in 2018, the primary Japanese export goods to China are mechanical and electronic products (43.1%), chemical products (11.5%), and transportation equipment (9.7%), while the main commodities of Japan’s imports from China are mechanical and electronic products (45.5%), textiles and raw materials (12.6%), and furniture and toys (6.2%). [1] Capital and technology-intensive products are much less sensitive to the exchange rate than that of labor-intensive products. According to the statistics of export and import above, China's export products are highly affected by the exchange rate because most China’s imported products from Japan are capital and technology-intensive, which lack alternative and have high added value and profits; China’s export products to Japan are mostly labor-intensive products. According to the theory of incomplete exchange rate transfer, the effect of balancing the trade deficit with the exchange rate is limited. When the exchange rate is not conducive to Japanese exports, Japan can increase sales by lowering the price of the product, thereby maintaining the original market and absorb the impact of the exchange rate,
leading to incomplete transfer of the exchange rate. Thus, the import amount has not been correspondingly changed with the fluctuation of the exchange rate.

On the other hand, the exchange rate will not improve the balance of income between China and Japan in the short term, which means the appreciation of CNY over JPY will not significantly improve Japan’s trade deficit with China, this indicates that the Abenomics, which relying on loose monetary policy to promote the depreciation of JPY and therefore stimulate exports, may not work. The first reason is that China’s marketization of the exchange rate has not yet been fully realized. The space of change for the CNY exchange rate is still narrow, the market is not sensitive to its fluctuation, and participants are less affected by exchange rate fluctuations when making decisions. Another reason is that China's exports to Japan are mainly growing in the sector of export processing. According to Cheng (2015), the international trade between China and Japan is strongly complementarity. In recent years, with the rapid development of Chinese economy, processing export has become the most important composition of China-Japan trade. The primary products in China-Japan trade concentrate in the fields of electronic, mechanical and chemical products, and this growth type is not greatly influenced by the exchange rate.

Policy Suggestion

**Handle the Appreciation of CNY with Caution.** Affected by a series of loose monetary policies in Japan, the CNY has faced greater pressure of appreciation in recent years. However, China’s exports to Japan still concentrate in labor-intensive industries, which are strongly impacted by the exchange rate and the appreciation of CNY. Although fluctuation of the exchange rate between China and Japan may not be reflected on the data in the short term; while in the long run, its impact should not be underestimated. Therefore, Chinese government should be cautious in coping with the appreciation of CNY, accelerate the construction of foreign currency exchange market and also maintain its stability.

**Optimize the Structure of Import and Export Trade with Japan and Change the Type of Growth.** Regarding the imbalance of China-Japan economic and trade structure, China should actively carry out industrial structure upgrading. It is necessary to maintain the original advantages of labor-intensive industries, in the meantime, continue introducing new technologies, deepen the development of labor-intensive products, and increase its technology and added value to consolidate this competitive advantage further. At the same time, China should change the export type to focus on the quality rather than quantity, encourage Chinese enterprises to continuously invest in independent research and development, develop innovative technologies, guide and support them to develop their own brands and intellectual properties, and promote industrial structure transformation to capital and technology-intensive products. All those methods could gradually reduce China’s dependence on Japanese high-end products, and domestic enterprises can gradually improve their strength to take more initiative in import and export trade. Thus, China can form new trade growth points to increasingly promote China’s exports to Japan in the fields of high-end mechanical and electronic products, precision instruments and advanced chemical products.

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