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A study on the Transmission Effect of RMB Exchange Rate fluctuation on Import Price after Exchange Rate Reform--Based on Vector Auto-regression Model

Qingyun Zhou[1, a, *] and Yang Mo[2]

[1]School of economics, Jinan University, Guangzhou, 510632, China

[2]School of economics, Jinan University, Guangzhou, 510632, China

[a]Corresponding author e-mail:17373055130@163.com

Abstract

This paper explores the influence of exchange rate fluctuation on import price at the second moment level. Based on the general analysis framework of ERPT and GARCH (1, 1) model and VAR model, this paper empirically analyzes the transmission effect of RMB exchange rate fluctuation on import price from the level of exchange rate fluctuation (second moment), and puts forward that RMB exchange rate risk directly affects import price, and the exchange rate risk is completely transferred to import price 16 months after exchange rate reform in 2005. The increase of production cost of foreign manufacturers and RMB exchange rate have obvious influence on import price index. The rise in the import price index came more from its own stickiness.

Keywords

RMB nominal effective, exchange rate fluctuation, import price vector autoregression model.

1. INTRODUCTION

Exchange rate transmission refers to "the degree of change in the prices of imported goods expressed in their own currencies as a result of changes in exchange rates between commodity importing and exporting countries" [1]. The research on the exchange rate transfer effect focuses on the mean level, that is, the first moment level, but the information transmission not only exists between the price level change (the first moment), the variance measured by the volatility (the second moment) is also the main source of information transmission. Based on the transmission theory model of RMB exchange rate fluctuation to import price change, this paper constructs a VAR empirical analysis model to analyze the transmission effect of RMB exchange rate on import price by adding RMB exchange rate risk variables.It is divided into four parts: the first part summarizes the literature related to exchange rate transmission effect; the second part makes theoretical analysis and model setting of RMB exchange rate transmission effect; the third part constructs empirical analysis model and analyzes; the fourth part gives relevant policy recommendations.

At present, a large number of literatures have studied the exchange rate transfer effect. Most of the research results show that the exchange rate transfer effect is incomplete, and different explanations are given from the micro and macro levels.Krugman (1989) holds that there are various frequent changes in the actual economic operation[2].When the exchange rate changes, in order to avoid excessive fluctuations in product prices, export enterprises are likely to absorb the costs caused by exchange rate changes in order to maintain their original market share, so the exchange rate transmission is incomplete.Taylor (2000) took the lead in studying the

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relationship between inflation and exchange rate transfer effect in a country, and found that the decline of exchange rate transfer effect was related to the low level of inflation[3].In the environment of monopoly competition, the price of the firm has a great relationship with the persistence of the production cost or the price change.According to Frederic (2008), if a country's monetary authorities are committed to implementing a sound monetary policy and creating a good price environment, the exchange rate transmission effect will be lower.Ozkan and Erden (2015) point out that there is a negative correlation between economic openness and exchange rate transmission effect. They think that because of the fierce competition in the international market, multinational corporations will not completely transfer the change of exchange rate to the price[4].

With the development of econometrics, the empirical methods of ERPT research are also developing.The elastic analysis method was the first to be used.For example, Kreinin (1977) compares the percentage of price and exchange rate changes to determine whether the ERPT is complete.This is also the most classic way to analyze the relationship between exchange rate and price. But the drawback of this method is that we can't judge the speed of exchange rate to price, and it is impossible to know whether there is a lag effect. The majority of the studies were then based on the addition pricing model and started using a single-equation regression. In estimating the simultaneous equation model, Baldwin (1988) uses two-stage or three-stage least square method. Substantially all of the methods introduce the lag form of the variable to analyze the dynamic effects over time. However, many researchers believe that in the least square method, the variables may have a correlation problem, and the stability of the data sequence is suspected.

By the early 1990s, many scholars began to use difference variables to solve the nonstationary problem of data sequences. but after the variable is differential, Some important information will be left out, and the final economic explanation is difficult to clarify. Therefore, some scholars use cointegration analysis and error correction model to study ERPT. In recent years, many scholars, such as Choudhri and Hakura (2006), have used the VAR model to study the transmission effect of exchange rate changes on multiple price levels at the same time. VAR is a kind of non-structural equation, which can not be recognized for the interaction between exchange rate and other variables, so some scholars optimize on this basis and form a structural VAR model. There are also some cutting-edge research methods that are beginning to appear in the study of exchange rate transmission. Such as random fluctuation time-varying parameter model (Sekine, 2006), DCC-GARCH model (Ozkan and Erden, 2015), smooth transformation model (Kilic, 2016), Bayesian threshold VAR method (Donayre and Panovska, 2016).

From the above literature, it is known that the study of the transfer effect of exchange rate on price is limited to the level of the first moment, that is, the mean level. There is an extension in the study of the second moment, that is, the wave level. In this paper, VAR model is used to incorporate exchange rate fluctuation into the general exchange rate equilibrium to analyze the influence of exchange rate risk on import price index.

2. METHODOLOGY

2.1. Theoretical Analysis and Model Setting

According to the research method of Ba Yu and Fujing (Bailliu and Fujii, 2004, the transmission effect of exchange rate change on import price is studied on the premise of maximizing exporter's profit.

According to equation: $\pi = P(Q)*Q - C(Q)$, When the right derivative of the equation is 0, the profit can be maximized.

That is

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$$\frac{\partial P(Q)*Q}{\partial Q} = MC \tag{1}$$

$$\text{i.e. } P + P*(1/E_d) = MC \tag{2}$$

Of which, P Indicating the price of export commodities, Q Indicating the quantity of goods, MC Means marginal cost, E_d For demand price elasticity.

With e represents the exchange rate under the direct pricing method, P_d Represents the price of a commodity expressed in national currency, C_q Represents marginal cost, μ represents a cost bonus with $\mu = 1/(1+1/E_d)$ The formula (2.2) can be converted to

$$P_{\mathrm{d}} = eC_q\mu \tag{3}$$

The log is taken on both sides of the formula (2.3) to simplify the availability

$$P_d = \alpha + \beta M_t + \omega E_t + \gamma D_t + \varepsilon \tag{4}$$

Where, P_d represents the price index, E represents the exchange rate, M and D represents the foreign and domestic control variables, respectively.

The variables selected in this paper include not only the exchange rate elements, but also the risk variables of exchange rate fluctuations to comprehensively investigate the influencing factors of the price transmission effect of RMB exchange rate changes.thus establishing a new model of exchange rate Formula (2.5):

$$MPI_t = \beta_0 + \beta_1 NEER_t + \beta_2 GDP_t + \beta_3 WCPI_t + \beta_4 VARNEER_t + \varepsilon_t \tag{5}$$

Of which, MPI Indicating the price index of imported goods, $NEER$ means the exchange rate of RMB, GDP express our domestic demand, $WCPI$ means the production cost of foreign manufacturers, $VARNEER$ Represents the risk of exchange rate fluctuations.

2.2. Empirical Analysis

This paper takes the sample since the exchange rate reform in 2005 as the research object, the reason is that the RMB exchange rate is actually pegged to the US dollar before 2005.The floating of the nominal effective exchange rate depends on the exchange rate of the United States dollar for other currencies. The yuan has a large appreciation of the US dollar since the 2005 exchange rate, and the nominal effective exchange rate is largely dependent on the US dollar for the US dollar. Therefore, the study of the exchange rate fluctuation transmission effect since the exchange rate reform in 2005 can highlight the impact of the RMB exchange rate reform, and has a good reference value for the formulation of RMB exchange rate policy in the future.

In this paper, Eviews10.0 measurement software was used to study the monthly time series data from August 2005 to June 2017, and a total of 143 observations were carried out. All the original data were converted to August 2005 = 100 as the base period, and the seasonal trend

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was removed by X12 method. The explained variables in this model are import price index, including RMB nominal effective exchange rate, quarterly GDP and world consumer price index. Table 1 is a description of the variables.

Table 1. Description of variables

Theoretical variables	substitute variable	abbreviation	variable declaration	data sources
exchange fluctuations	RMB effective exchange rate	NEER	Us dollars in units of RMB	BIS
Import price index	Import price index	MPI	Import price index	WIND
domestic demand	gross domestic product	GDP	Quarterly GDP data are converted into monthly data by interpolation method	State Statistical Bureau
foreign manufacturer's price	World consumer price index	WCPI	World consumer price index	IMF
Risk of exchange rate fluctuations	Conditional Variance calculated by GARCH (1, 1) Model	VARNEER	exchange rate margin	Calculated

The GARCH (1, 1) model was estimated using EVIEWS10.0, and the conditional variance estimated by GARCH method represents the fluctuation of VARNEER.

Mean equation: $E_t = 0.4643E_{t-1} + \delta_t$

(5.0869)

Variance equation: $\sigma_t = 0.1366 + 0.2530\delta_{t-1}^{\ 2} + 0.5803\sigma_{t-1}^{\ 2}$

(1.6667) (2.1711) (3.2293)

The Z value of each variable in the equation is significant, which indicates that the GARCH (1, 1) model estimates the RMB exchange rate fluctuation well. By ARCH-LM test, the P value is more than 0.05, which indicates that the autoregression conditional heteroscedasticity has been eliminated. Thus, a conditional variance may be used to represent the RMB exchange rate fluctuation VARNEER.

3. RESULTS AND DISCUSSION

3.1. ADF Test

The stability of each sequence is tested by ADF test. The original variable, VARNESR, GDP, WCPI, and MPI, is a non-stationary sequence, and the first order difference is a stable sequence at 1% level. The original variable NEER is a stable sequence. Building a VAR model with a stationary sequence ensures the effectiveness of the estimation.

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Table 2. ADF test results

variable	Difference order	(C,T,K)	DW value	ADF value	5%critical value	1% critical value	conclusion
VARNEER	1	(0,0,0)	1.91	-17.38	-2.88	-3.47	I(1)*
GDP	1	(C,0,0)	2.07	-4.67	-2.88	-3.47	I(1)*
WCPI	1	(0,0,0)	2.12	-7.20	-2.88	-3.47	I(1)*
MPI	1	(0,0,0)	2.02	-8.96	-2.88	-3.47	I(1)*
NEER	0	(0,0,0)	1.82	-7.43	-3.44	-4.02	I(0)*

Note: (C, T, K) indicates whether the ADF test contains a constant term, a time trend term, and a hysteresis period; * indicates that the ADF test is performed at a significant level of 1% after the variable differential.

3.2. Co-integration Test

Table 3. Co-integration test results

Number of co-integration equations	characteristic value	Trace statistics	5%critical	Maximum eigenvalue statistics	5%critical
Zero	0.231380	97.00085***	69.81889	36.05273***	33.87687
Up to 1	0.222476	60.94811***	47.85613	34.47485***	27.58434
Up to 2	0.082493	26.47326	29.79707	11.79503	21.13162

Note: *** indicates a significant level of 5% significance.

From the test results, it can be seen that both trace statistics and maximum eigenvalue statistics show that there are two cointegration relationships between variables. Therefore, it will not cause pseudo regression.

3.3. Estimation and Test of VAR Model

Because the first order difference of each variable is a stationary sequence, the VAR model can be constructed. FPE, AIC, SC and HQ criteria show that the optimal lag order of VAR model is order 2. Therefore, the VAR model with lag of two periods is established.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-833.5606	NA	0.187579	12.51583	12.62396	12.55977
1	253.7591	2077.267	2.44e-08	-3.339688	-2.690918	-3.076048
2	339.1882	156.8327	9.92e-09*	-4.241616*	-3.052204*	-3.758277*
3	356.2812	30.10394	1.12e-08	-4.123599	-2.393546	-3.420561
4	377.2075	35.29369	1.20e-08	-4.062799	-1.792103	-3.140061
5	392.6373	24.87193	1.40e-08	-3.919960	-1.108623	-2.777523
6	424.4435	48.89603*	1.29e-08	-4.021544	-0.669565	-2.659408
7	442.1006	25.82679	1.47e-08	-3.911949	-0.019328	-2.330113
8	456.1435	19.49249	1.79e-08	-3.748411	0.684851	-1.946876

3.4. AR Root Test

Figure.1 Inverse Roots of characteristic Polynomials of VAR Model

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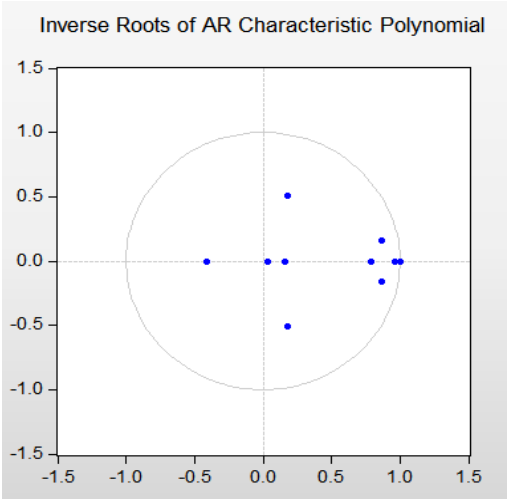

Fig 1. Shows an illustration of the inverse root of the lag 2-order VAR model feature polynomial, in which all the inverse roots are within the unit circle, further demonstrating the stability of the VAR model.

3.5. Impulse Response

Using impulse response and variance decomposition to evaluate the effect of exchange rate change on import price. The result of impulse response function is shown in figure 3 -2.The horizontal axis represents the number of lag periods of the impact action, the vertical axis is the response of the inlet price of the impact variable, the blue solid line represents the response of the inlet price index to the corresponding impact, and the red dotted line on both sides indicates the positive and negative twice the standard deviation deviation zone. From the figure, it is concluded that the RMB exchange rate unit shock has a significant negative impact on import prices in the first 13 months, and reached the maximum negative impact in the fourth month, and then gradually stabilized. The impact of the GDP unit import price index was positive in the first 13 months, peaked in the sixth month, and then fell to a steady level. The impact of foreign manufacturers' production cost unit impact on China's import price index was positive in the first 16 months, and then turned to negative fluctuation. The unit impact of exchange rate fluctuation has been a significant negative impact on China's import price index for 24 months, and reached the greatest negative impact in October.

3.6. Variance Decomposition

By comparing the contribution of each factor to the impact of dependent variables, the relative importance of each variable can be seen by comparing the contribution of each factor to the impact of dependent variables.

As can be seen from table 3 / 1, in addition to the impact of its own changes, GDP contributes the most to changes in import prices, at about 23 per cent. The second is the exchange rate shock, the contribution is about 12%, the third is the production cost of foreign manufacturers is about 11%, and finally, the impact of exchange rate fluctuations, the contribution is about 10%.Exchange rate changes and exchange rate risks will have an impact on import prices. Therefore, to maintain the stability of RMB exchange rate in the short term, reduce exchange rate fluctuations, is conducive to maintaining the stability of import price index.

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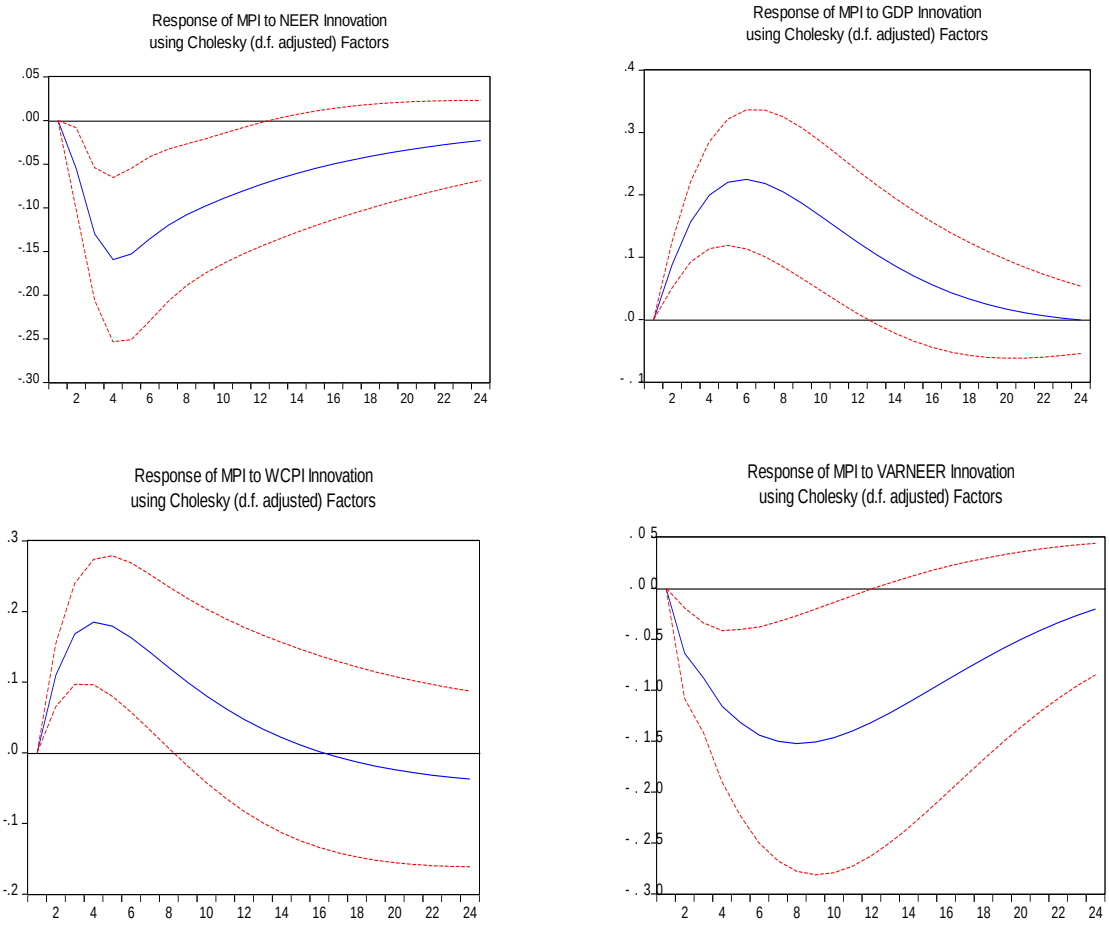

Figure 2. Impulse response function diagram for impact of import price on each index

Table 4. Variance decomposition of the forecast error of the import price index

Variance Decomposition of MPI: Period	S.E.	MPI	NEER	GDP	WCPI	VARNEER
1	0.249776	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.368391	91.55515	1.725923	2.250778	2.707905	1.760241
3	0.475104	79.06535	5.033370	6.384885	5.885160	3.631230
4	0.573443	67.40571	7.947448	11.01740	8.297662	5.331777
5	0.660846	58.31677	9.831567	15.26818	9.906342	6.677149
6	0.735174	51.62017	10.98411	18.79938	10.85811	7.738223
7	0.795724	46.78695	11.70922	21.60233	11.34249	8.559012
8	0.842820	43.34833	12.15331	23.78807	11.50787	9.202403
9	0.877596	40.96027	12.38718	25.46813	11.46878	9.715651
10	0.901812	39.36114	12.46774	26.72633	11.31331	10.13149

3.7. Transmission Elasticity of RMB Exchange Rate Fluctuation to Import Price Index

This paper defines the ratio of the cumulative change rate of exchange rate fluctuation to the import price index and the cumulative change rate of the RMB exchange rate fluctuation (VARNEER) on the exchange rate of the RMB (VARNEER). The results from the VAR model are shown in Table5.

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Table 5. Cumulative impulse function results of import price index and RMB exchange rate fluctuations

lag phase	1 month	4 months	8 months	12 months	16 months	20 months	24 months	28 months	32 months	36 months
MPI Cumulative change rate	0.000	-0.300	-0.800	-1.400	-1.800	-2.100	-2.200	-2.300	-2.200	-2.200
VARNEER Cumulative change rate	0.390	1.020	1.590	1.860	1.920	1.880	1.810	1.74	1.69	1.66
The transfer elasticity of VARNESR to MPI	0.000	-0.294	-0.503	-0.753	-0.937	-1.117	-1.210	-1.320	-1.300	-1.325

It can be seen from the table that with the prolongation of the impact time, the transfer effect of the exchange rate risk on the import price index is also increasing, and after 16 months, the exchange rate risk is overtransmitted to the import price index, and the transmission elasticity is about -1.3.

4. CONCLUSION

Through the above analysis, this paper draws the following conclusions: first, there is a cointegration relationship between the five variables in the long run. Second, the risk of RMB exchange rate is over-transferred after 16 months after the change of the import price index. The greater the volatility of the exchange rate, the greater its elastic change to the import price. Therefore, in an environment where the exchange rate fluctuates sharply, the sensitivity of the import price to the exchange rate change is increased, and the foreign exchange risk is increased. Therefore, it is necessary to deepen the reform of RMB exchange rate system and make the exchange rate give full play to the function of spontaneous adjustment. The fluctuation of exchange rate may be "to take one's hair and move the whole body", but in the process of RMB internationalization, whether the RMB has the perfect market price discovery, the risk pricing ability and the risk hedging ability are the key, Therefore, it is necessary to enhance the flexibility of RMB exchange rate, improve the market formation mechanism of RMB exchange rate, and let RMB exchange rate play its role in a sound market mechanism.

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