An Empirical Analysis of RMB Exchange Rate changes impact on PPI of China

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Abstract. This article selected monthly data of PPI and Nominal Effective Exchange Rate from 2010 to 2014, the former was regarded as interpreted variable and the later was explanatory variable. And then this paper utilize a series of econometric model such as unit root test, co-integration regression test and Granger causality test to certify whether NEER can influence the trend of PPI. As a result, NEER really can affect the trail of PPI, and is the Granger cause of it. Moreover, there exist co-integration relationship and error correction mechanism between them.

1. Introduction

Regarding the average annual nominal effective exchange rate of 2010 as a standard reference, RMB nominal effective exchange rate fluctuations was into upward trend. In a smaller time range, it tended to be down trend from 2010 to 2014. Its growth speed were extremely rapid after the third quarter of 2011 to 2014.

Each month's PPI had a great increase and annual growth rate remained at about 4% to 8% from 2010 to 2011. And every monthly index decreased about 2% -3% when comparing the same period from 2012 to 2014.

2. Theoretical analysis of the RMB exchange rate changes impact on PPI

In an open economy model, changes in exchange rates will directly affect bilateral Current Account and Capital and Financial Account. Under the Marshall - Lerner condition was met, devaluing home currency can improve the status of their BOP. Therefore, in order to greatly speed the global economic recovery, the United States, Japan, European Union and other major trading partners utilized a series of quantitative easing monetary policy by means of increasing the general monetary supply (M2) and lowering the discount rate and deposit-reserve ratio. In addition, RMB exchange rate has been rising as a result of nearly to 2 trillion's foreign exchange reserves every year's favorable balance of trade made.

In the short term trading environment, rising nominal effective exchange rate directly affected the current account. The domestic currency appreciation meant prices of goods and services in local currency-denominated decline. Subsequently, import-substitution sectors in industrial enterprises would increase the number of imports about raw materials from international market. As a result, it would be a favor of reducing production costs and expanding adjustable price space can be cut. Especially, as to a series of smaller industrial enterprises running daily necessities whose price elasticity of demand is small, it could expand inventory variation and cut down its PPI. What is more, foreign export encouragement policies with a quantitative easing monetary policy environment would cause capital to inflow and then FDI increase, they stimulated export credit to be prosperous. These external factors indirect reduces the cost of purchasing and financing and lower the PPI.

3. An empirical analysis of RMB exchange rate changes impact on PPI

3.1 Selecting variables and sample

Selecting PPI as interpreted variable and regarding nominal effective exchange rate (NEER), general import-export value (GIE), purchasing manager's index about raw materials (PMI) and general monetary supply (M2) as explanatory variables, this article was intended to investigate the extent of the RMB exchange rate on PPI with multiple regression econometric methods.

GIE indicated the basic situation of a domestic and foreign trade, more importantly, it was likely to affect prospect of producers. Tremendous amounts of GIE meant that business was booming, consequently, manufacturer tended to expand production and lower PPI. Therefore, GIE and the year-on-year growth rate of PPI had a negative correlation.

To ensure that companies were able to gain huge profits, the over-payment was seen as a part of production costs on raw material purchasing would be added to product prices. So PMI positively affected the year-on-year growth rate of PPI.

From traditional financial theory proposed by Friedman, the demand of money was steady, obviously, increasing the general money supply was the main cause of inflation. There existed a positive correlation between M2 and PPI.

Selecting monthly China Yuan nominal effective exchange rate data from 2010 to 2014 published by Bank for International Settlements (BIS) and seeing annual average effective exchange rate of China Yuan in 2010 as a reference, the subsequent monthly data was converted effectively and then it would indicate year-on -year growth of monthly PPI. The data of other variables including GIE, PMI and M2 all came from National Bureau of Statistics.

3. 2 Model specification

In this paper, using multiple regression model, PPI was explanatory variables and NNER, GIE, PMI, M2 were regarded as explanatory variables.

$$PPI = c + \beta 1NEER + \beta 2\ln (GIE) + \beta 3PMI + \beta 4\ln (M2) \qquad (1)$$

3.3 The results of empirical analysis

We could obtain the regression results as follows:

$$PPI=203.3552-0.374094NEER+0.078886PMI-3.398031\ln (GIE) \qquad (2)$$

t= (4.378016) (-4.855712) (1.505240) (-1.3620006)

R2=0.689716 adjusted R2=0.673094 F=41.49326 DW=0.852683

As the regression equation was shown for us, each percentage point of nominal effective exchange rate growth caused that PPI would drop by 0.3741%, comparing the same period in last year. Similarly, when general import-export value increased by 1%, the year-on-year growth of PPI would intend to decline 3.3983 percentages. Oppositely, if purchasing of raw materials index increased by one percentage, the PPI would change in same direction and increase by 0.0789%.

We have removed auxiliary regression variable (M2) which led to multicollinearity by using stepwise regression. Consequently, all the symbols of the explanatory variables are consistent with earlier expectations, that is to say, year-on year growth of PPI was negatively correlated with nominal effective exchange rate besides general import-export value and was positively correlated with purchasing of raw materials index.

In spite of these, the regression results was likely to be unstable as the selected variables were time-series data. If unstable, we needed to explore whether there existed an automatic error correction mechanism between PPI with auxiliary explanatory variables in above. Therefore, we had a unit root test and co-integration test for the results we have obtained.

3.4Unit root test of each variable

After having a series of unit root test on each variable and selecting proper lag intervals for endogenous, we could get results listed in the following table (Table 1). The null hypothesis of each variable was that all of them had unit root table. Comparing t-value with Augmented Dickey-Fuller critical value shown in the Table 1 under different confidence level such as 1%, 5% and 10%, if the t-value was significantly greater than ADF critical value, we could not reject the null hypothesis that variable series did have unit root and it was not smooth. Certainly, we also estimated which variable series had a unit root according to the number of probability in table 4.

From the results shown in Table 1, we know that t-value of every variable was greater than ADF critical value. It meant that four variables all had a unit root and they were not stable time-series data.

Table 1. Unit root test results of each variable

variable name	1%	5%	10%	t value	（probability）	（lag length）
PPI	-3.54821	-2.912631	-2.59402	-1.125941	0.6998	1
NEER	-3.54821	-2.912631	-2.594027	0.008186	0.9552	1
GIE	-2.60544	-1.946549	-1.613181	0.625111	0.8486	1
PMI	-3.55502	-2.915522	-2.595565	-1.311026	0.6183	4

3.5 Unit root test of each variable after first order difference

Because PPI in the second stage presents long-term stable trend, we could infer that there might be co-integration relationship between the four variables in some degree. Consequently, after having first order difference on each variable and then having a unit root test on them, we could obtain the results as the following table (Table 2).

Table 2. Unit root test results of each variable after first order difference

Variable name	1%	5%	10%	t value	（probability）	（lag length）
PPI	-3.550396	-2.913549	-2.594521	-7.887164	0.0000	1
NEER	-3.550396	-2.913549	-2.594521	-4.201963	0.0015	1
GIE	-3.550396	-2.913549	-2.594521	-9.35988	0.0000	1
PMI	-6.055268	-3.550396	-2.913549	-2.594521	0.0000	1

In the form, t-value is significantly greater than the critical value of ADF. It showed that every variable could change into stable time-series data after first order difference. In other words, they were integrated of order 1, according to the basic definition of integration.

3.6 The Co-integration test on regression model

Each variable was integrated of order1, namely PPI ~ I (1), NEER ~ I (1), GIE ~ I (1), PMI ~ I (1). In order to verify whether there was a balanced relationship in long term between the variables, we used ordinary least square method to estimate the regression model, regarding PPI (Y_t) as interpreted variable and NEER (X_{1t}), GIE (X_{2t}), PMI (X_{3t}) as explanatory variables. Before us having a co-integration test on these variables, we would be better to the log of some of variables. In this way, it not only could reduce heteroscedasticity due to the existence of some special discrete data singularities but also could decrease one order of magnitude. Having a co-integration test, we obtained the regression equation as follows:

$$Y_t=203.3552-0.374094X1_t-3.398031\ln(X2_t)+0.078886X3_t \quad (3)$$

t= (4.378016) (-4.855712) (1.505240) (-1.3620006)

R^2=0.689716 adjusted R^2=0.673094 F=41.49326 DW=0.852683

From the above model, the China Yuan effective nominal exchange rate certainly had a significant impact on the PPI basing annual average nominal exchange rate in 2010 as the baseline. Each percentage point of nominal effective exchange rate growth caused that PPI drop by 0.3741%.

Subsequently, for the sake of testing whether residuals was stable, we symbolized "e" as new residual and had a unit root test on new residual series. Then we got the following results (Table 3).

Table 3. Unit root test results of new error-series

Variable name	1%	5%	10%	t-value	（probability）	(lag length)
e	-3.5446	-2.9117	-2.5935	-4.0009	0.0027	0

As can be known from the table, t-value was significantly less than the ADF critical value, thus we should reject H0. That is to say, there was no unit root into the new residual sequence. It was a smooth sequence, specifically, there existed co-integration relationship between PPI with NEER, ln (GIE) and PMI. Furthermore, even if the residual error of PPI deviated because of impact caused by short-term chance factor, it still could become stable gradually with time passing.

3.7 The error correction model

After co-integration analysis above, we knew that there was a long-term stable relationship between these variables. Maintaining long-term stable relations was depended on the continuous adjustment in the dynamic process, the reason why there was co-integration among these variables was that the time-series data was stationary after first order difference. In addition, linear combination of after first difference in the co-integration test also was proved to be steady. It indicated that component of variable in long-term mutually offset. The reason for this was that there existed a self-regulating process in the regression model, and it worked. To be specific, regression error mechanism effectively prevented bias in long-term relationships form expanding no matter what in quantity or size. So we set up a error correction model consequently.

After difference disposal was applied to each variable in co-integration test, then we reconstructed new variables with their forms after first difference. More importantly, we added residual series regarded as the fourth explanatory variable into regression equation. It indicated degree of deviation occurred at different time in process of realizing long-run equilibrium. Of course, we could use its coefficient in the short-term error correction model to estimate capability of error correction. The error correction model was shown as following that:

$$dY_t=\alpha+\beta_1 dX1_t+\beta_2 dX2_t+\beta_3 dX3_t+\beta_4 e_{t-1} \qquad (4)$$

Specifically, $dX1_t=\Delta\ X1_t=X1_t-X1_{t-1}$; $dX2_t=\Delta\ X2_t=X2_t-X2_{t-1}$; $dX3_t=\Delta\ X3_t=X3_t-X3_{t-1}$;

As mentioned in the same token, seeing dYt as interpreted variable and et-1 as the fourth explanatory variables, we could obtain estimation results of error correction model as follows:

$$dY_t=-0.185912+0.229583dX1_t-1.265372dX2_t+0.043035dX3_t-1.0000e_{t-1} \qquad (5)$$

t = (2.93E+15) (3.95E+15) (-2.86E+15) (2.99E+15) (3.24E+16)

R^2=1.0000 DW=2.367926

As can be known from regression equation, the year-on-year growth of PPI was not only depended by NEER, ln(GIE) and PMI but also what degree the year-on-year growth of PPI in last term deviated from equilibrium level. The estimated coefficient of first-lagged error term equaled 1.0000, it indicated the subsequent residual error could correct its last-term deviation oppositely. The larger the last-term deviation was, the more the amount of deviation in current period could be corrected.

In summary, there was a long-term stable relationship between the year-on-year growth of PPI, general import-export value, and purchasing managers index about raw materials. Maintaining long-term stable relations was depended on the continuous adjustment in the dynamic process. That is, even if the year-on-year growth of PPI was impacted by chance factor, but it still could be corrected and realized ultimately to long-run equilibrium with the internal co-integration and error correction mechanism.

3.8 Granger causality test

Granger causality test was mainly based on historical data of the economic variables. An economic variable which changed earlier than the other economic variable in another variable. Adding the variable which changed earlier into the regression model of variable which changed latter, if it could enhance regression model explanatory power, we called that economic variable which changed earlier was the Granger cause of the variable which changed latter. This meant that if there was Granger causality between two variables, we were able to predict the trend of a variable based on the other variable. Therefore, we had a series of Granger causality test between Y_t and each of other variables and then obtained the following results (table 4).

Table4. The results of Granger causality test between Yt and each of other variables

Null hypothesis	obs	F-value	probability	lag length
$X1_t$ does not Granger Cause Y_t	59	10.4914	0.0002	1
Y_t does not Granger Cause $X1_t$	59	0.1658	0.6854	1
Ln($X2_t$) does not Granger Cause Y_t	59	1.6737	0.2011	1
Y_t does not Granger Cause ln($X2_t$)	59	9.1754	0.0037	1
$X3_t$ does not Granger Cause Y_t	59	8.4728	0.0052	1
Y_t does not Granger Cause $X3_t$	59	0.8241	0.3679	1

As is shown for us in a column of probability on the table, $X1_t$ and $X3_t$ were the Granger cause of Y_t significantly. That is to say, adding the lagged variable of $X1_t$ and $X3_t$ into their respective regression model, it could obviously increase their explanatory power in their respective regression model. X_2 was the Granger cause of Y_t strictly. Because it's F-value in the regression equation was not so large and its probability in null hypothesis was large. Oppositely, adding the lagged variable of Y_t into regression model about ln ($X2_t$), its F-value in the regression equation was very large and its probability in null hypothesis was small. It indicated that ln ($X2_t$) was not Granger cause of Y_t strictly.

To sum up, the nominal effective exchange rate and the purchasing managers index about raw materials were Granger cause of PPI. We could forecast the trend of the PPI in the future based on historical data of them. In addition, although general import-export value was not the Granger cause of PPI, however, they could impact each other. We could still regard general import-export value as a preliminary indicator of PPI.

4. The empirical results of nominal effective exchange rate impact on the PPI

After a series of econometric analysis, we knew that nominal effective exchange rate did affect production price index for industrial products in the opposite direction. That is to say, if the nominal effective exchange rate rose, PPI would decline. Specifically, each percentage point of nominal effective exchange rate growth caused that PPI would drop by 0.3741%.

There existed co-integration relationship between production price index for industrial products with nominal effective exchange rate. That is to say, even if the residual error of PPI deviated from the regression model because of impact caused by short-term chance factor, it still could become stable gradually with time passing under the internal co-integration and error correction mechanism.

Nominal effective exchange rate is the Granger cause of production price index for industrial products. Therefore, we can forecast the trend of production price index for industrial products based on past data of variable.

All in all, as is shown for us from the results about empirical analysis, we knew that the long-term appreciation of the China Yuan did reduce domestic inflationary pressure in some degree, but the long-term huge foreign exchange and tremendous domestic credit funds increased fiercely domestic inflationary pressure. Taken together, in the short term, the power of increasing was stronger than the power of decreasing. This was reason why production price index for industrial products rose and theoretical analysis deviated from reality in the first stage; In the long run, foreign exchange was released and the anticipation was realized, that the speed of economic growth would decline. They would make production price index for industrial products remain stable trend, or even no year-on-year growth trend. That was reason that theoretical analysis was consistent with reality in the second phase.

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