THE CURRENCY EXCHANGE RATE BETWEEN THE U.S. AND CHINA

Yipeng Han[1]
Shun Li[2]
Kexin Zhang[3]
New York Univeristy

Abstract

In this research paper, we aim to study the factors that influenced the currency exchange rate between the U.S. and China over the recent 17 years from 1994 to 2010. By regression analysis, we find that the exchange rate between these two countries can be well explained by the following variables: 1) the ratio of U.S. net exports with China over U.S. GDP (denoted as NXR), 2) the U.S. nominal interest rate (denoted as USNOMINAL), and 3) the U.S. unemployment rate (denoted as UE). To be more specific, we conclude that the exchange rate between the U.S. and China is positively correlated with the first two variables NXR (+) and USNOMINAL (+); and negatively correlated with the last variable, the U.S. unemployment rate (-).As will be discussed in more detail, all three variables are statistically significant at a five-percent level. It is a heatedly-discussed topic so far, and we want to apply rigorous statistical methods to narrow down the determinants of the exchange rate to three variables we are discussing in this paper by regression analysis. In this way, we aim to provide a better view of what determines this important economic factor between the U.S. and China.

1 Yipeng Han is currently a junior student of New York University majoring in Mathematics and Economics. He is a grader under Courant Institute of Mathematical Sciences, NYU. As an international student, together with her background in mathematics, he chose to use statistical methods and E-Views to study the currency exchange rate between the U.S. and China

2 Shun Li is currently a senior student of New York University majoring in Economics. As an international student, he wants to delve deeper into the exchange rate and the determinants of this important economic factor.

3 Kexin Zhang is a junior student majoring in economics and mathematics at New York University. Following a science concentration at High School Affiliated to Renmin University in China, she cultivated strong interest and laid a solid footing in mathematics and science. As an international student, together with her background in mathematics, she chose to use statistical methods and E-Views to study the currency exchange rate between the U.S. and China, including its fluctuations over the past 17 years as well as the determinants of it in the econometrics course last semester, which turned out to be the top-5-percent paper in class.

Keywords: currency exchange rate between the U.S. and China, U.S. net exports, U.S. nominal interest rate, the U.S. unemployment rate

I. Introduction

As of year 2014, the United States is the world's largest economy and China has become the second largest, replacing Japan. Undoubtedly, the bilateral trade between the United States and China contributes a large part to these achievements. The U.S. and China have maintained a stable relationship since they resumed trade relations in 1972, which turned out to be a milestone in history. As seen in FIGURE 1.1 and FIGURE 1.2, net exports between the two countries exhibit an increasing trend over the past years and would continue to rise in the years to come. This trade relationship brings tremendous benefits to both countries and creates a win-win situation. U.S. companies purchase a wide range of raw materials from China, greatly boosting China's exports and substantially reduce their costs of production through the trading activities with China. And now, we could actually find products labeled "Made in China" everywhere in the U.S., which is evidence for the mutual reliance in terms of trade between the two countries.

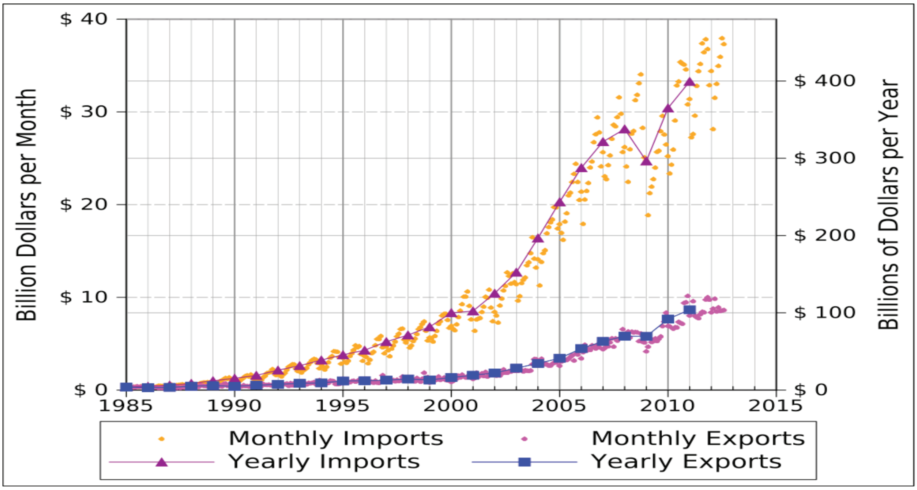

FIGURE 1.1
Exports Growth Between China and the United States Since 1985

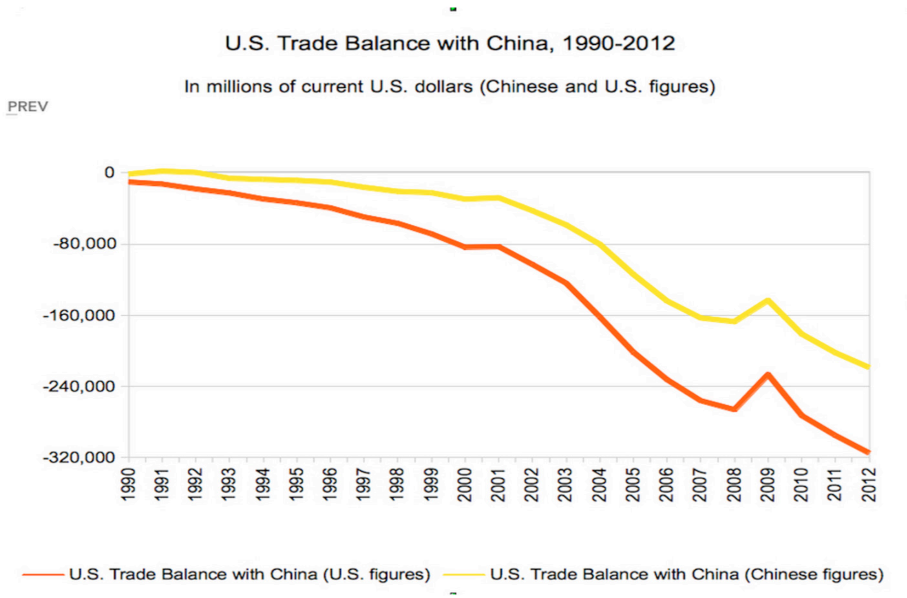

FIGURE 1.2

Trading across borders requires the purchase of foreign currency, whose price is named as "the exchange rate". International businessmen and cross-country consumers care about the exchange rate, since a correct prediction of future exchange rates enables them to make wise decisions on the exchange behavior and thereby earn higher profits. As the U.S. and China become more interlocked in trade agreements, it is increasingly important to understand the factors that determine the exchange rate. Therefore, this paper will attempt to isolate and identi fy these factors and their specific effects.

The final model we construct s:

$EXR = \beta_1 + \beta_2\ NXR + \beta_3\ UE + \beta_4\ USNOMINAL$

In this model, NXR represents the ratio of net exports of the U.S. to China over the U.S. GDP, UE represents the U.S. unemployment rate, and USNOMINAL represents the U.S. one-year-deposit nominal interest rate.

When selecting variables, several candidates were initially proposed but discarded after problems arose in the results after running the first regression (insignificance of NIR and small absolute value of net exports' coefficient). After modification of certain variables, the three variables discussed above were decided upon: U.S. unemployment rate (UE), U.S. nominal interest rate (USNOMINAL) and the ratio of net exports over U.S. GDP (NXR). The new regression turned out to be successful in explaining the exchange rate between the two countries, with the coefficients of the three variables all statistically significant at a five-percent level and with two of them possessing the expected signs.

II. Literature Review

Most literatures on the subjects seem to reach a consensus that the exchange rate is mainly affected by the terms of trade, or by the net exports between the two countries. In the proposition below by Usman Afridi, "it is not a foregone conclusion that the terms of trade depreciation would always cause exchange rate depreciation. (1995)" He believes that there is a direct relationship between the net exports between two countries and their exchange rate. In our model, therefore, we choose net exports as an important independent variable to explain the exchange rate between China and the U.S.. Since net exports are one of the four components of GDP, it is predictable that the inclusion of both GDP and the net exports would lead to serious collinearity problems. Since we know net exports are the only factor that is directly related to international trading activities among the four factors (consumption, domestic investment, government spending and the net exports of GDP), we want to choose net exports as our independent variable, instead of the much broader economy index, GDP.

Some literatures imply a subtle relationship between the unemployment rate and the degree of international trade. In Steven J. Matusz's paper, "International Trade, the Division of Labor, and Unemployment", he "merge(d) a model of monopolistic competition in the production of intermediate goods with the Shapiro-Stiglitz model of efficiency wages" to show that "the introduction of international trade leads to increased employment in both countries. (1996)" He also states "changes in resource allocation resulting from a move toward (or departure from) freer trade can easily affect the equilibrium unemployment rate." To summarize, an active international trading system can influence the unemployment rate in both countries, which is surprising because international trade actually plays a role in complementing domestic trade/production, which lowers unemployment rate (UE). This would be opposed to the view that the world is fixed, and so increased production/employment in China would lower production/employment in the U.S.. This seemingly surprising relationship between the international trading activities and the unemployment rate further leads us to think over the relationship between the exchange rate and the unemployment rate, which has not been proposed by any literatures we have encountered. What's more, intuitively speaking, the unemployment rate, together with GDP and inflation, are the most important economic factors that reflect an economy's current situation, and this information can provide people some insights about the prospects of this currency. Thus, in our paper, we take the U.S. unemployment rate as another independent variable in explaining the exchange rate between the U.S. and China.

In the available research, some papers discuss the relationship between the real interest rate and the exchange rate. As proposed by Wu Jyh-Lin and Chen Show-Lin, "The real interest rate differential model introduced by Frankel (1979) implied that real interest parity holds in the long run when the exchange rate reaches its long-run equilibrium. Moreover, the real interest differential is an important determinant in explaining exchange rate movement. Shafer and Loopesko (1983) and Sacs (1985) provided evidence to show the strong relationship between real interest differentials and real exchange rate." We see that there is a positive connection between the exchange rate, which is the price of currency seen by a foreign country, and interest rate, which is the price of a currency domestically. Therefore, we want to add the real interest rate as another independent variable in explaining the exchange rate. We finally choose the nominal interest rate rather than the real interest rate for convenience. Moreover, since the exchange rate measures the relative currency price between two countries, we choose the nominal interest rate ratio (NIR) between the U.S. and China in our first regression, so that every independent variable reflects a relative relationship.

Inflation, as an important economic index, is another factor that might exert influence on the exchange rate. However, in the Phillips Curve that there is a strong linear, negative relationship between the unemployment rate and inflation. In other words, there is a short-run trade-off between them: decreased levels of unemployment (increased levels of employment) in an economy would imply a higher rate of inflation (See FIGURE 2.1). Therefore, including both "inflation rate" and "unemployment rate" would cause a serious collinearity in our regression. So we only choose the unemployment rate in our first and final regressions, rather than adding both of them.

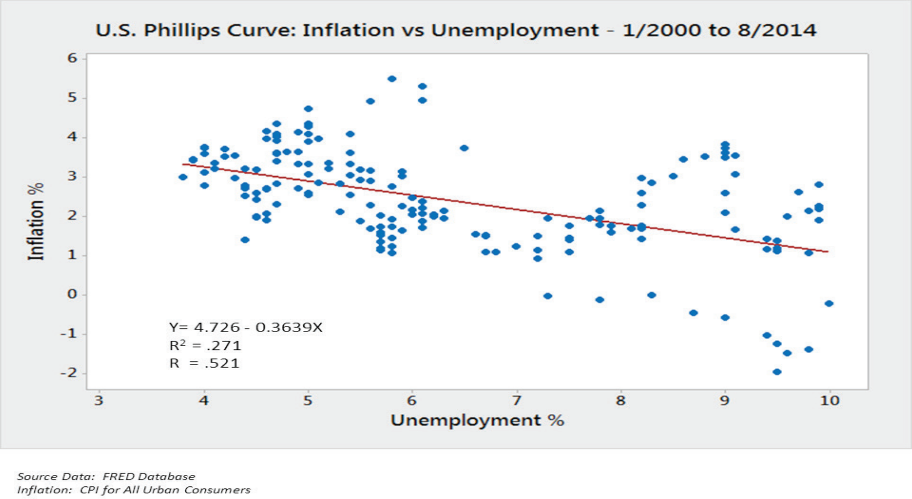

FIGURE 2.1

1. Model

Based on the review of literature, the three independent variables that might be closely related to exchange rate between the U.S. dollars and Chinese RMB are chosen, namely, 1) the unemployment rate of the U.S. (UE), 2) the nominal interest rate ratio of the U.S. and China (NIR); and 3) the net exports of the U.S. (NX). To clarify, these three variables are chosen for our first regression only, and, in fact, some defects with the usage of these three variables are observed after reviewing our results from the first regression. Adjustments to the variables are made in our second (final) one. The specific adjustments as well as the reasons for those changes will be discussed in detail in sections to come. So now, with these three variables, the first regression function is:

$EXR = \beta_1 + \beta_2 UE + \beta_3 NIR + \beta_4 NX$

Where EXR denotes the exchange rate (USD/CNY), amount of Chinese RMB for one U.S. dollar

UE denotes the unemployment rate of the U.S. (%)

NIR denotes the interest rate ratio (decimal)

NX denotes the net export of U.S. to China (in millions)

In this regression function, UE, the first independent variable, which denotes the unemployment rate of the U.S., is the proportion of the unemployed over the U.S. population who are in the labor force. The unemployment rate is calculated monthly in the U.S., and here we use the average number of the 12-month unemployment rates as the annually average unemployment rate. This variable is a proxy variable that measures the stability of the U.S. economy, and therefore is a crucial economic index that determines people's confidence in the USD. By intuition, if the unemployment rate in the U.S. increases, the concern over the stability of the U.S. economy will be fueled, and the concern would discourage people from holding a lot of U.S. dollars. Then, with other factors being held constant, the demand for U.S. dollars would increase, and the exchange rate of USD with respect to Chinese RMB would decrease. So, we use unemployment as a factor that might affect the exchange rate between USD and RMB, and we expect β_2 to be a negative number. [1]

NIR, the nominal interest rate ratio, which is calculated by dividing the U.S. one-year deposit nominal interest rate by China's one-year deposit nominal interest rate, measures the relative yield of holding U.S. Dollars compared to holding Chinese RMB. This nominal interest rate ratio is expected to exhibit a strong positive relationship with the exchange rate according to the Interest Rate Parity. To elaborate, let us refer to the equation as follows: $(1+i_{\$})= (1+i_{rmb})$, where $i_{\$}$ denotes the interest rate in the U.S., i_{rmb} denotes the interest rate in China, EXR_t denotes the spot exchange rate at time t, and EXR_{t+k} represents the exchange rate between the U.S. and China at time t+k. If the U.S. nominal interest rate increases, with China's interest rate and the exchange rate after k periods being kept constant, the spot exchange rate, which is the exchange rate at this point, would increase. These theoretical considerations imply that there should be a positive relationship between the exchange rate and the nominal interest rate ratio of the U.S. and China. Another way to state the relationship between the exchange rate and the interest rate ratio is by intuition as follows: when the interest rate ratio of the U.S. over China increases, then the return of holding U.S. dollars compared to holding Chinese RMB is relatively higher. This difference in the yield of holding different currencies will lead people to demand for more U.S. Dollars than Chinese RMB. With other variables being held constant, the exchange rate between the U.S. and China would increase. Via the two ways of explanations as above, one can predict a positive relationship between the exchange rate of the USD to the RMB and the U.S. nominal interest rate, so the sign of β_3 is expected to be positive.

NX, the annual net exports from the U.S. to China, is calculated by

1 Note that the first regressor we used is the U.S. unemployment rate, with no consideration of China's unemployment. It is because it is very hard to obtain the correct data of China's unemployment rate. To avoid messing up the model with wrong data, we decide to use U.S. unemployment rate only, which is sufficient to reflect the economic situation in the U.S.

subtracting the U.S. spending on Chinese exports from China's spending on U.S. exports within a year. It is in fact a most essential factor that affects the exchange rate between the U.S. and China. Since before 1972 -- when the U.S. and China were not trading yet -- the exchange rate between the two countries was at an approximately constant level. It is only after 1972 that the exchange rate between the two countries started exhibiting some changes. Therefore, the relationship between the exchange rate and net exports or trade is very strong and obvious. By intuition, when the net export of the U.S. to China increases, China's companies and households would need more U.S. dollars to purchase the imported goods from the United States. In this way, the demand for U.S. dollars by China would increase. With other variables being held constant, the exchange rate would increase. So, we expect the coefficient β_4 to be positive in this regression model.

2. Data Source

The data for the U.S. one-year deposit nominal interest rates, the U.S. GDP, and the net exports between the U.S and China is gathered directly from United States Census Bureau Statistics website, and data for the U.S. unemployment rate is obtained from Bureau of Labor's website. As for the Chinese statistics we use in the first regression, the nominal interest rates of China are obtained from the official website of the Agricultural Bank of China, one of the five biggest banks in China. Among the different types of interest rates listed, the one-year deposit interest rate is chosen. During the years when there is no new policy changing the one-year deposit interest rate, the rate from previous year is reused. And, if the central bank changes the one-year deposit interest rates several times in one year, the rate in the middle of the several changes is used. For example, in 2007, the interest rate was changed six times, thus the interest rate after the third change was chosen. As for the dependent variable, we obtain the exchange rates from forecastchart.com.

As mentioned, since the exchange rate reflects a relative relationship between two currencies, in the first regression, the nominal interest rates in the U.S. and China are transformed into a ratio, with the U.S. nominal interest rate being the numerator and the nominal interest rate of China being the denominator.

3. Reasons for Using Data for Only 17 Years

The years during which the data for each variable is available are as follows:

1) U.S. one-year-deposit nominal interest rate: 1984-2010
2) China's one-year deposit nominal interest rate: 1980-2013
3) U.S. GDP: 1980-2010

4) U.S. unemployment rate: 1948-2014
5) Net exports between the U.S. and China: 1985-2010
6) Exchange Rate: 1985-2013

So the years during which data for all variables are available are from 1985 to 2010, which is 26 years. However, after observing the trend of the exchange rate over these 26 years, a very strange phenomenon is revealed, where the exchange rate goes up in years from 1981 to 1994 and jumps to 8.64 in 1994 from 5.78 in 1993. Afterwards, though, the exchange rate starts decreasing steadily until 2010. Statistically speaking, this up-and down trend cannot be explained by the one-direction trend of the net exports. To see where the problem lies, Table 4.1 is the regression between the exchange rate and the three variables we ran over the 26 years. Since we want to compare it with our final result which uses 17 years of data, we would like to keep other things same with the final result and use the final three variables, namely, the U.S. nominal interest rate, the net export ratio, and the U.S. unemployment rate.

Dependent Variable: EXR
Method: Least Squares
Date: 12/04/14 Time: 21:14
Sample: 1985 2010
Included observations: 26

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.51172	1.564852	9.912577	0.0000
NXR	40.47319	51.20902	0.790353	0.4378
UE	-0.853084	0.149017	-5.724754	0.0000
USNOMINAL	-0.764799	0.146163	-5.232491	0.0000

TABLE 4.1

From the regression above, we see that for NXR, although it has the expected positive sign, it is not statistically significant even at the 50% level of significance. We deduce that it is because the relationship between the exchange rate and the net export ratio between 1985 and 1994 is different from our a priori expectations, which is a positive relationship. More specifically, from 1985 to 1994, the net export decreased continuously, while the exchange rate increased. And after 1994, when the exchange rate reached its peak, the exchange rate started to decrease with the net exports also decreasing. For the reasons above, in the two regressions in next section, to use data that makes more practical sense, only data from the recent 17 years from 1994 to 2010, where the exchange rate is positively related to the net export ratio, is used.

Certainly, we know that the data for only 17 years is comparatively insufficient, but due to the limit of the data, we have to use 17 years of data instead of 26 years.

4. Mean and Standard Deviation

First Regression:

	EXR	NX	NIR	UE
Mean	7.998235	-135133.8	0.935765	5.629412
Std. Dev	0.586209	90225.97	0.541941	1.571132

Second Regression (Final):

	EXR	NXR	USNOMINAL	UE
Mean	7.998235	-0.011161	3.340000	5.629412
Std. Dev.	0.586209	0.005423	1.623418	1.571132

TABLE 4.2

III. Result

Based on the model, together with the first three variables we set, namely, the U.S. unemployment rate(UE), the net exports of the U.S. with China (NX) and the ratio of the U.S. one-year-deposit nominal interest rate over China's one-year-deposit nominal interest rate(NIR), the first regression runs as follows.

- First Regression:

EXR = 9.6662 + 3.9945e-06*NX - 0.1846*UE - 0.0948*NIR

Independent Var.	Signs	Coefficients	Std. Error	t-statistic	p-value
NX	β_2 (+)	3.9945E-06	8.60E-07	4.6436	0.0005

UE	β_3 (-)	0.1846	0.0642	0.8760	0.0130
NIR	β_4 (-)	0.0948	0.1684	-0.5629	0.5831

TABLE 4.3

As seen from the regression results in Table 4.3, the coefficients of NX (Net Exports) and UE (Unemployment rate) have the correct signs as expected, and they are both statistically significant at five-percent level of significance. However, the negative sign of NIR's coefficient, β_4, is different from our a priori expectation, which means the interest ratio between the U.S. interest rate and China's interest rate negatively affects the currency exchange rate, contradicting our expectation. Many reasons could account for this contradiction, one of which is that we did not take the different inflation rates of the two countries into consideration, so the nominal interest rates may not fully represent the returns of holding a currency, buy also reflect some levels of inflation in the two countries. In our next regression, therefore, we will use the U.S. nominal interest rate only instead of the ratio, in order to exclude the effect of the difference in the levels of inflation within the two countries. Moreover, β_4 is not statistically significant even at a twenty-percent level of significance, which requires further investigation. In addition, even though the coefficient of NX (Net Exports) has the correct sign and is significant as we mentioned above, its value is too small to be worth considering. These outcomes are quite different from what we expected.

Due to the insignificance of the variables NX and NIR in this regression, the individual regressions are ran as follows to figure out whether these two variables are significant in determining the exchange rate by themselves, without the influence of other factors.

Regression I
EXR = 8.7196 + 5.3380E-06*NX
p-value= (0.0000)(0.0001) r^2=0.6750

Regression II
EXR = 7.7117+ 0.3062*NIR p-
p-value =(0.0000) (0.2709)

From Regression I, we could see that the NX (Net Exports) exhibits a positive relationship with exchange rate at a one-percent level of significance. Although the sign is as expected (positive), the coefficient of NX is so small that the effect of net exports on exchange rate could be ignored. Since, as discussed above, the exchange rate is mainly determined by the trading activities between two countries, this result is quite unpersuasive. So, we figure out that the problem lies in the fact that the data for NX (Net Exports) is given in thousands (of millions), while the dependent variable EXR (Exchange

Rate) is given in numbers less than ten, so it is easy to imagine that the average change in EXR caused by a one-unit change in NX is extremely small. To remedy this problem, the variable NX is transformed into a ratio, with NX being the numerator and the U.S. GDP being the denominator in the second regression. The two-variable regression between the exchange rate and the new variable net export ratio (NXR) can be seen as follows:

EXR = 8.932 + 83.669*NXR
p-value=(0.0000)(0.0003)

By substituting the NXR for net exports as before, we find the coefficient not only has the correct sign, but also has a much larger value, 83.669, which implies a much stronger relationship between the exchange rate and the net exports. This result is more convincing and is also more consistent with our a priori expectation that exchange rate between two countries is highly related to the net exports between them. A scatter plot can be seen in Figure 4.1.

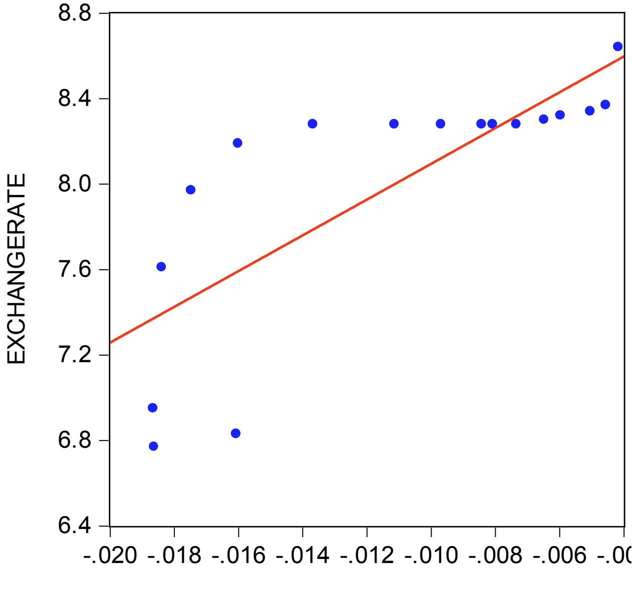

FIGURE 4.1

From Regression II above, we find that the coefficient of the nominal interest rate ratio between the U.S. and China is not statistically significant even at a twenty-percent level (p-value=0.2709). So we consider changing the form of this interest rate variable. More specifically, instead of using the interest rate ratio of the two countries, we choose to use the nominal interest rate in the U.S. only and drop China's interest rate from the model. The justification for this decision is that the interest rate in China is, to a great extent, controlled by the central bank, which caused the data to be unnatural and manipulated, where the interest rate could keep unchanged for many years. To figure out the natural relationship between the exchange rate and the interest rate, we believe it is better to use the nominal interest rate of the United States, where the market is freer. We come up with the result as follows after running a regression between the exchange rate and the U.S. nominal interest rate.

EXR = 7.2932 + 0.2111*USNOMINAL

p-value=(0.0000) (0.0137)

A scatter plot of the exchange rate and the U.S. nominal interest rate could be seen below.

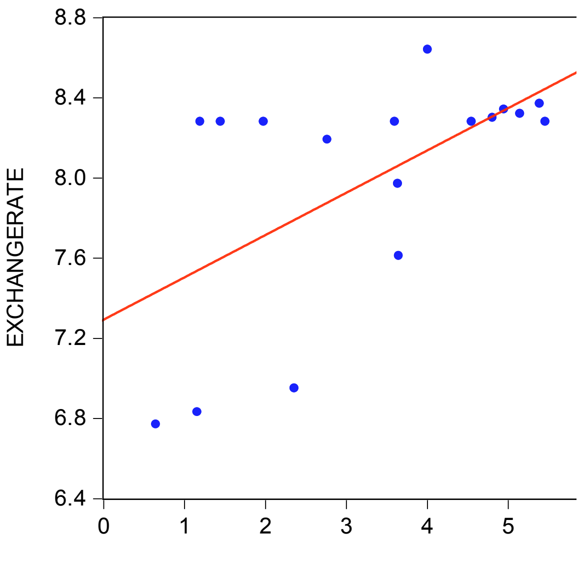

FIGURE 4.2

Clearly, we see that the new interest variable we use is statistically significant at a five-percent level in determining the exchange rate. What's more, the sign of the coefficient has also changed from negative to positive, a correct sign as we expected.

Therefore, so far, we have solved the problems both with NX and the nominal interest rate through transforming the form of variables from a ratio to a value, and changing the scale of data. Now we can proceed to our second regression.

- Second Regression (Final)

Having changed the variable NX to the variable NXR (ratio of NX over the U.S. GDP), and having changed the nominal interest rate ratio to the U.S. nominal interest rate, we could run our second regression based on the three new variables: NXR (ratio of NX over the U.S. GDP), the U.S. nominal interest rate and the unemployment rate in the U.S., and thereby come up with the results as below: EXR = 11.0586 + 88.0697*NXR - 0.2688*UE - 0.1689*US-NOMINALINTEREST

Independent Var.	Signs	Coefficients	Std. Error	t-statistic	p-value
NXR	$\widehat{\beta_2}$ (+)	88.0697	15.1513	5.8127	0.0001
UE	$\widehat{\beta_3}$ (-)	-0.2688	0.0539	-4.9884	0.0002
USNOMINAL	$\widehat{\beta_4}$ (-)	-0.1689	0.0653	-2.5866	0.0226

TABLE 4.4

The interpretations of the three coefficients can be seen as follows:

1) $\widehat{\beta_2}$: A one-unit increase in ratio of the net exports over U.S. GDP, ceteris paribus, on average, would lead the exchange rate to increase by 88.0697 CNY/USD.
2) $\widehat{\beta_3}$: A 1% increase in unemployment rate, ceteris paribus, on average, would lead the exchange rate to decrease by 0.2688 CNY/USD.
3) $\widehat{\beta_4}$: A 1% increase in the U.S. nominal interest rate, ceteris paribus, on average, would lead the exchange rate to decrease by 0.1689 CNY/USD.: A one-unit increase in ratio of the net exports over U.S. GDP, ceteris paribus, on average, would lead the exchange rate to increase by 88.0697 CNY/USD.

The R^2 is equal to 0.8648, and the adjusted R^2, which takes into account the effect of the inclusion of new variables, is equal to 0.8337. The two statistics imply that more than 80% of the variations in the dependent variable, the exchange rate, could be explained by the variations in the three independent variables. In addition, the F-statistic is equal to 27.73008 > $F_{df1=2,df2=14,\alpha=1\%}$ =6.5149, so we have 99% confidence to reject the null hypothesis that .

As can be seen from the table above, now β_2 and β_3 both have the expected signs and are also statistically significant at one-percent level. However, for β_4, its sign flips from positive to negative now. To figure out whether this problem arises from multicolliearity within these three variables, let us refer to the correlation table and matrix as follows:

	NXR	UE	USNOMINAL
NXR	1	-0.3816	0.6747
UE	-0.3816	1	-0.6978
USNOMINAL	0.6747	-0.6978	1

TABLE 4.5

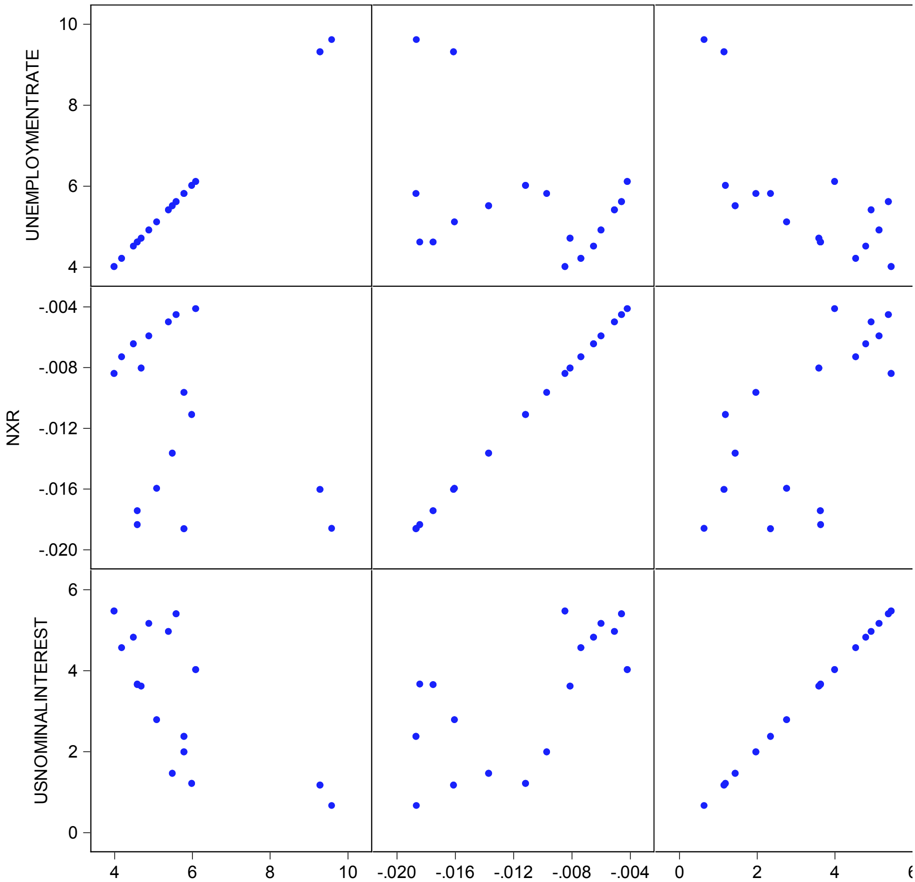

FIGURE 4.3

The correlation table and matrix above indicate that there is some collinearity between the U.S. one-year-deposit nominal interest rate and the NXR; and between the U.S. one-year-deposit nominal interest rate and the U.S. unemployment rate. However, since the U.S. nominal interest rate is statistically significant in determining the exchange rate in the two-variable regression, the reason for the insignificance of the variable is purely due to multicolliearity; and also, in the overall regression, the other two coefficients have the correct signs and are both statistically significant at 1% level. We could, therefore, ignore the problem of multicollinearity here.

To ensure the validity of our classical linear regression model, we need to test whether the assumptions of heteoscedasticity and normality of the error term are satisfied.

Now to test the heteroscedasticity of the result, we could first use the White test, which is shown as below.

u_i^2 = -6.479 - 202.998*NXR + 1.174*UE + 1.270*USNI + 11.382*NXR*UE + 23.592*NXR*USNI - 0.101*UE*USNI - 0.061*UE^2 - 0.069*USNI^2 - 2353.083*NXR^2 R^2=0.8121

- NXR represents the ratio of net exports between the two countries over the U.S. GDP;
- UE represents the unemployment rate in the U.S.;
- USNI represents the U.S. nominal interest rate.

H_0: There is no heteroscedasticity in the final regression;

H_1: There is some heteroscedasticity.

Since n=17, R^2=0.8121, df=n-k=17-9=8; so n*R^2=13.8057 $>\chi^2_{df=8,\alpha=10\%}$=13.36

So we have 90% confidence to reject the null hypothesis, which means there is some heteroscedasticity. And then we apply White heteroscedasticity-consistent standard errors & covariance method to see whether it is necessary to remedy the problem of heteroscedasticity.

Original

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.05856	0.565484	19.55592	0.0000
NXR	88.06971	15.15131	5.812681	0.0001
UNEMPLOYMENT RATE	-0.268792	0.053883	-4.988407	0.0002
USNOMINAL INTEREST	-0.168923	0.065307	-2.586604	0.0226

White heteroscedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.05856	0.311802	35.46667	0.0000
NXR	88.06971	17.22297	5.113503	0.0002
UNEMPLOYMENT RATE	-0.268792	0.034633	-7.761059	0.0000
USNOMINAL INTEREST	-0.168923	0.033697	-5.012972	0.0002

TABLE 4.6

From Table 4.6, we could see that even in the original table without the adjustment in standard errors and the t-statistics, the three coefficients are already statistically significant. So, we could conclude that it is not necessary to remedy heteroscedasticity in this regression. In addition, the Durbin-Watson d statistic is 1.0282 as can be seen from the final regression table. Since the upper limit and the lower limit of the d statistic at a 5% level of significance are 1.71 and 0.897 respectively, the d-statistic in our final regression falls between the upper limit and lower limit, which means that we are not certain whether there are autocorrelations among the residuals or not. And from the residual histogram below, the probability is very high, the skewness is near zero (-0.3315), and the kurtosis is around 3 (3.2902), so we are confident to draw a conclusion that the residuals are normally distributed.

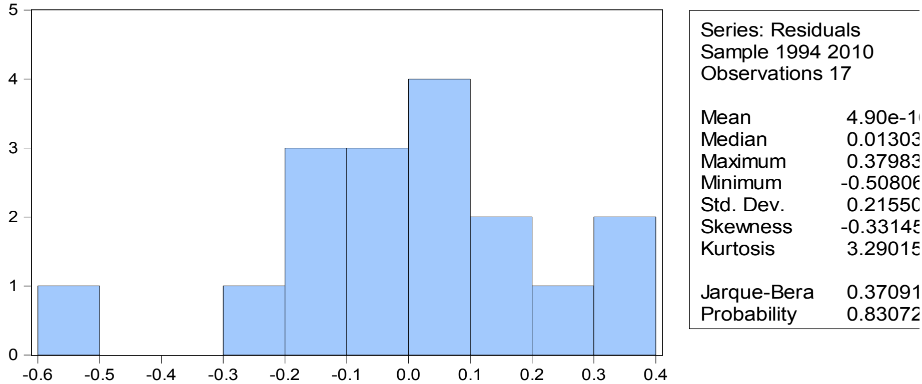

FIGURE 4.4 Residual histogram

To explain how this result applies to a complete time range of 26 years from 1985 to 2010, we should take a look at FIGURE 1.1 and FIGURE 1.2 again. From 1985 and 1994, China had little international trading behavior, with a net export to the U.S. staying at a level near zero. It was because China was then at the primitive stage of trading, and the Chinese Yuan was very valuable at that time. Once China opened up its door to trading activities, Chinese Yuan gradually depreciated for some time until 1994, leading the exchange rate between USD and CNY to increase from 1985 to 1994. From 1994 onwards, on the other hand, the increasing net exports from China to the U.S. started to play a more important role in determining the currency exchange rate between the two countries, which led the exchange rate to decrease steadily year by year from 1994 to 2010. Therefore, the currency exchange rate between the two countries from 1985 to 1994 was not purely explained by the change in net exports, unemployment rate and U.S. nominal interest rate, rather, was also partly due to the fact that China was at the neophyte stage of trading.

IV. Summary

By regression analysis using OLS method with E-Views, we establish a model explaining the currency exchange rate between the U.S. and China based on three independent variables. The variables are: the ratio of the U.S. net exports with China over the U.S. GDP (denoted as NXR), the U.S. nominal interest rate (denoted as USNOMINAL), and the U.S. unemployment rate (denoted as UE). The results from the two regressions reveal that the coefficients of all three independent variables are statistically significant at a five-percent level, and that the signs are all correct except for the U.S. nominal interest rate, which is expected to be positive but turns out to be negative. The R^2 is as high as 0.8649, and the adjusted R^2 is 0.8337, which means 0.8337 of the variations in the currency exchange rate could be explained by the three independent variables we studied. In the three individual regressions between the exchange rate and the other three variables respectively, it is found that the explanatory variables are all statistically significant at a five percent level in explaining the exchange rate individually with correct signs. Based on these facts, one can reach the conclusion that there is some collinearity between the U.S. nominal interest rate and the other two variables, but still, the variations in the exchange rate are well explained by the variations in three variables. A drawback of our research is the limited number of observations, which could be remedied by including more years of variables in further research in the future.

References

Afridi Usman, "Determining Real Exchange Rates" *Pakistan Institute of Development Economics, Islamabad,* Page [263] of 263-276

Bureau of Labor Statistics. Retreived from http://www.bls.gov/home.htm

Matusz, Stevem J.,"International Trade, the Division of Labor, and Unemployment", *International Economic Review*, Vol. 37, No. 1 (Feb., 1996), pp. 71-84

Pingfan Hong, "China's Economic Prospects and Sino-US Economic Relations," *China & World Economy 14*, no. 2 (2006): 45-55.

United States Census Bureau, "Gross Domestic Product in Current and Chained (2005) Dollars http://www.census.gov/compendia/statab/cats/income_expenditures_ poverty_wealth/gros_domestic_product_gdp.html

United States Census Bureau, "*Money Stock"* http://www.census.gov/compendia/statab/cats/banking_finance_insurance/money_sock_interest_rates_bond_yields.html

United States Census Bureau, "*Trade in Goods with China*" http://www.census.gov/foreign-trade/balance/c5700.html

Wu Jyh-Lin and Chen Show-Lin, "A Re-Examination of Real Interest Rate Parity" *Canadian Journal of Economics Revue canadienne d'Economique*, Vol. 31, No. 4 (Oct.,1998), pp. 837-851

Appendix

APPENDIX 1 Regression printouts

- First Regression

Dependent Variable: EXCHANGERATE
Method: Least Squares
Date: 12/02/14 Time: 18:52
Sample: 1994 2010
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.666155	0.445178	21.71301	0.0000
NX	3.99E-06	8.60E-07	4.643605	0.0005
UNEMPLOYMENT RATE	-0.184641	0.064201	-2.875997	0.0130
NIR	-0.094787	0.168388	-0.562909	0.5831

R-squared	0.829143	Mean dependent var	7.998235
Adjusted R-squared	0.789715	S.D. dependent var	0.586209
S.E. of regression	0.268817	Akaike info criterion	0.412752
Sum squared resid	0.939413	Schwarz criterion	0.608802
Log likelihood	0.491607	Hannan-Quinn criter.	0.432240
F-statistic	21.02903	Durbin-Watson stat	0.702806
Prob(F-statistic)	0.000029		

- Final Regression

Dependent Variable: EXCHANGERATE
Method: Least Squares
Date: 12/02/14 Time: 18:50
Sample: 1994 2010
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.05856	0.565484	19.55592	0.0000
NXR	88.06971	15.15131	5.812681	0.0001
UNEMPLOYMENT RATE	-0.268792	0.053883	-4.988407	0.0002
USNOMINAL INTEREST	-0.168923	0.065307	-2.586604	0.0226

R-squared	0.864851	Mean dependent var	7.998235
Adjusted R-squared	0.833663	S.D. dependent var	0.586209
S.E. of regression	0.239082	Akaike info criterion	0.178303
Sum squared resid	0.743082	Schwarz criterion	0.374353
Log likelihood	2.484428	Hannan-Quinn criter.	0.197790
F-statistic	27.73008	Durbin-Watson stat	1.028192
Prob(F-statistic)	0.000006		

APPENDIX 2 Statistics

	EXR	US UE	NXR	USNIR	NX	NIR
1994	8.64	6.1	-0.00416	4.01	-29505.1	0.365
1995	8.37	5.6	-0.00456	5.39	-33789.5	0.491
1996	8.34	5.4	-0.00504	4.95	-39520.2	0.539
1997	8.32	4.9	-0.00596	5.15	-49695.5	0.908
1998	8.3	4.5	-0.00647	4.81	-56927.4	0.921
1999	8.28	4.2	-0.00734	4.55	-68677.1	1.204
2000	8.28	4	-0.00842	5.46	-83833	2.427
2001	8.28	4.7	-0.00808	3.6	-83096.1	1.6
2002	8.28	5.8	-0.00968	1.98	-103065	1
2003	8.28	6	-0.01114	1.2	-124068	0.606
2004	8.28	5.5	-0.01367	1.45	-162254	0.644
2005	8.19	5.1	-0.01601	2.77	-202278	1.231
2006	7.97	4.6	-0.01747	3.64	-234101	1.444
2007	7.61	4.6	-0.01838	3.65	-258506	1.096
2008	6.95	5.8	-0.01865	2.36	-268040	0.656
2009	6.83	9.3	-0.01607	1.16	-226877	0.516
2010	6.77	9.6	-0.01863	0.65	-273042	0.26