What Affects Exchange Rate When COVID-19 Spread

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Abstract. This essay focuses on what factors would have impacts on the exchange rate between USD and CNY before and after the pandemic of COVID-19, and what economic results the pandemic brought. According to the research, the factors, inflation rate of the US, effective federal funds rate, real disposable personal income, and unemployment rate were studied and summarized one by one and have been analyzed in a linear regression simultaneously. Besides, this paper also ran multiple regressions to see the comparison before and after the COVID-19. After the analysis, the conclusion showed that the factors of inflation and unemployment rate which change greatly before and after the COVID-19 have significant effects on the exchange rate, but some factors of real disposable personal income that change slightly have no obvious linear relationship with the exchange rate. In a word, some economic indexes that have been affected should be taken into account to make a prediction and help the economy recover in the future, especially when the effect of COVID-19 was evident.

Keywords- Exchange Rate; COVID-19

1. INTRODUCTION

With the formation of globalization, economy in all industries of most countries in the world was in an unprecedented period of rapid development in the 21th century. While it is definitely unsustainable to deny that the COVID-19 which is extremely quick spreading all over the world since March, 2020 inflicted heavy losses on the economy for the same reason. Normally, globalization informs the concept of business and culture communications among countries in different continents, so no matter invisible intertwine or realistic exchanges, countries are not independently growing. And as the intermediate bridge of multinational transactions, exchange rates should be paid main attention to, particularly when coronavirus brought worldwide horror and damage. It is spotted that inflation of the U.S. has decreased from 1.62% to 0.99% in February 2020, which was an intense monthly change in recent years. Considering the correlation between inflation and other economic indexes, especially exchange rate, such alteration deserves a deeper thinking of the exact influence with the global pandemic of COVID-19. China and the United States would be two objects in later research

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and on the exchange rate between them as they are the two of the biggest economy entities in the world and the effect of COVID-19 to the international economy could partly be represented.

This study has explored many variables related to target issues and the following variables are closer to real life and are representative enough to illustrate the problem.

To find out the real effect of COVID-19 on exchange rate, various variables must be considered. This research mainly focuses on effects of effective federal funds rate, Inflation rate, unemployment rate, real disposable personal income and cumulative cases of COVID-19 on the U.S to exchange rate between USD and CNY. Therefore, the target of the research is to reveal these effects statistically and economically, in another word, how pandemic influenced the exchange rate between USD and CNY with several variables via comparing the stats before and after the burst of COVID-19.

In the United States, tremendously increased cumulative cases of COVID-19 yielded a hazard effect on the exchange rate between USD and CNY that additional million of cumulative cases of COVID-19 caused USD worth 0.022 CNY less. And assemble results presented by inflation. The Federal Reserve adopted an extremely low inflation rate during the pandemic just as what they did for the Subprime Mortgage Crisis, and the following result of declining US dollar could not be avoidable as well. Conversely, the exchange rate between China and the US increases as the effective federal funds rate increases and this trend turned to be more intense and correlated after the COVID-19 in March, 2020. What showed the most astonishing change with the outbreak of the pandemic was the impact of the unemployment rate. In the absence of the impact of COVID-19, the increasing unemployment rate gradually caused the decline of USD, but after it, the unemployment rate turned to bring the result of USD appreciation. The high unemployment rate has also appeared in 2008 with the Subprime Mortgage Crisis, when the history was in a reenactment, the causal effect must be analyzed sweepingly. And what the COVID-19 led to the economy, especially the exchange rate, were more complicated.

Admittedly, the real disposable personal income showed more negative percentage changes after the COVID-19, but its fluctuation was relatively unusual and highly correlated to the governmental policy, such as emergency funds. Thus, the stats of this variable had complicated endogeneity that could not be a useful prediction. This is one of the most meaningful parts in the research that policy makers must care about the currency of its country and the personal income of residents simultaneously in a pandemic, but a macro national and a micro personal variable do not have an inevitable connection to some extent.

Moreover, the exchange rate is the most imperative component of international business that no country could be economically independent. When COVID-19 yields a grand hit financially, study on the fluctuation of exchange rate and future prediction has global substance that each country could prepare to keep a stable economy inside. This research is based on the time periods before and after the pandemic of COVID-19, so the results of economic indexes in the cholera period would be more accurate and persuasive. In addition, many scholars have studied the effect of a single variable with the pandemic, but this article included more comprehensive variables' effect on the exchange rate between China and the US before and after the COVID-19, which is undoubtedly more valuable.

2. LITERATURE REVIEW

There were abundant researches focused on the exchange rate fluctuation, some of them have been even analyzed with the background of COVID -19 pandemic. Considering the pandemic, it would be necessary to inspect the feasibility of those results; and for those included COVID-19 as a variable, more factors had better be taken into account to have a comprehensive economic insight.

The correlation between inflation and exchange rate has been the most popular study object for decades in economic fields. Precious Wedaga Allor revealed the relationship between inflation and exchange rate in Ghana from 1970 to 2017: inflation and monetary policy indeed affect the exchange rate [1]. Precious Wedaga Allor [1] showed that rising inflation contributes to the depreciation of the local currency in Ghana in both long term and short term, indicating a negative causal effect on exchange rate. To prove such result would not be biased geographically, such as the special economy of Ghana, correlation between inflation and exchange rate also suggested in Hüseyin Şen, et al.'s research based on data collected from Brazil, India, Indonesia, South Africa and Turkey during 2013-2018, that is the obvious co-move of two variable [2].

Furthermore, it is worth noting that the relationship between interest rate and exchange rate was also mentioned in Hüseyin Şen, et al. 's work. A cointegrated relationship between interest rates and exchange rates has been confirmed in 3 countries: Brazil, India, and Turkey, but existence of such a relationship was not significant in the remaining 2 countries, Indonesia and South Africa. Similar results of the relationship between interest rates and exchange rates in Brazil, India and Turkey were also interpreted in Frédérique Bec, et al. 's research, which observed their correlation through a nonlinear model perspective, and it's also a supplement to Hazari et al. 's research for the objects were USD, GBP, FRF, DEM, CAD, ITA and JPY [3]. The result reminded the necessity to examine whether the same relationship is also performed in USD-CNY exchange.

Another remarkable index that might affect the exchange rate would be the unemployment rate that increased from 3.5% to 14.8% from February to April, 2020. And the probable correlation between unemployment rate and exchange rate, Bharat R. Hazari et al.'s research provided a theoretical model applied to LDC (less developed countries) to reveal such correlation: the rate of unemployment is a key determinant of the real exchange rate in the short run, but irrelevant in the long run [4]. However, both articles were mainly based on economic models rather than realistic fluctuation of the global economy today, it is worth inspecting whether the result is still significant or not in COVID-19 pandemic period.

Since the COVID-19 is the background of this research, the virus itself should not be underrated. Taro Abe's research revealed the impact of COVID-19 to macro economy of Japan that the COVID-19 damaged economy running of a country in almost every aspect, and it would be a long-lasting influence since lacking of effective management and hygiene resource from a domestic perspective [5]. Research of R. Ramakumar et al. showed impact of COVID-19 would damaged India's economy through analyzing several important economy index of India [6]. R. Ramakumar et al.'s research focused different country with Taro Abe's, but presented same opinion. The influence of COVID-19 to economy is a worldwide phenomenon, regardless developing or developed country.

As for the influence of COVID-19 to some specific economic index, research of Nurdany et al. that focused on Indonesian market performance and COVID-19 pandemic has reported an extreme impact of the virus on the market performance in the first month as the virus was announced [7]. More importantly, Nurdany et al. have shown the result that COVID-19 has a positive and significant impact on exchange rate, and this is the attractive part that it will study later to check if the uniformity exists in USD-CNY exchange rate. More has been acknowledged to prove the impact of COVID-19. Neluka Devpura has done a specialization of oil price and Euro/USD exchange rate with COVID-19 that presented the existing influence in economic and financial systems of COVID-19. Yet, Devpura could not attain plentiful data since his research was relatively early and to have a more persuasive regression, and this research included a more diverse and comprehensive data set [8].

Besides, Paresh Kumar Narayan has proposed that the exchange rate of JPD has been affected tremendously by the pandemic, and COVID-19 was the biggest global shock. Including the virus as an independent variable a would be wise and earthshaking in a special period [9].

Regarding frequent change of personal income before and during COVID-19 pandemic, it's meaningful to analyze the relationship between real disposable personal income and exchange rate, which is also lacking in published research. Relevant analysis could be a contribution to current literature.

There is no denying the effect of COVID-19 in the economy by reviewing research on diverse fields. Exchange rate is a vital index to all the countries, and it has been noticed that some unusual fluctuations due to the virus, so a prediction would be necessary. As mentioned before, many scholars have done relevant research on the factors that affect the exchange rate and the influence of COVID-19 on it. Relevant literature indicated that the exchange rate was affected by many factors before and after the outbreak of COVID-19. However, variables that involved in current research were relatively single, and the relationship between all factors and the exchange rate before and after the pandemic and the impact of personal income on the exchange rate are not involved, which considered current research hardly fully revealed new economic circumstance brought by COVID-19 pandemic. This research question is precisely carried out around this topic. It will lead to more specific and persuasive conclusions.

3. METHODOLOGY

The COVID-19 has been spread worldwide for a whole year from March, 2020 and the intercontinental business received unfavorable feedback from COVID-19 from the macro perspective. To have a clear view of the effect, monthly data of a few variables from March 2018 to February 2021 from Federal Reserve Economic Data and COVID-19 data from Corona virus Resource Center of Johns Hopkins University since March 2020 were collected(shown in Figure 1). First of all, this study chose to observe the monthly fluctuation of China/U.S. Foreign Exchange Rate, since currency is the fundamental of global transactions. The first case of COVID-19 was found in China and the United States has the most cumulative cases so far, thus the exchange rate between these two countries has been chosen as a representative. From March, 2018 to February, 2021, the China/U.S. Foreign Exchange Rate showed irregular fluctuations, but there was an obvious and intense downward sloping after May, 2020. To find out the influential factors, the inflation and interest rate of the US could not be ignored when studying

the exchange rate. According to the research of Thygesen, changes in the exchange rates of EC member currencies predominantly reflect inflation differentials [10]. And as the quantity theory of money showed, there is a negative relationship between inflation and interest rate. Therefore, it is vital to consider both. By analyzing the data of 10-Year Breakeven Inflation Rate and effective federal funds rate, it is discovered that in February, 2020, both variables presented a decreasing trend and the latter was influenced more.

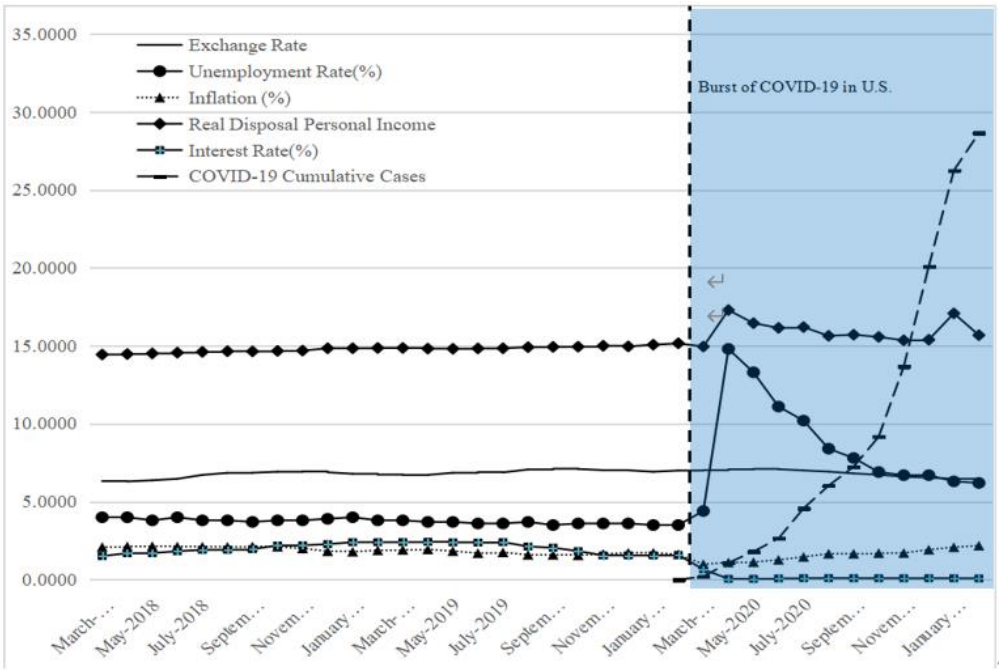

Figure 1: Economic data from March, 2018 to February, 2021
(Source: Federal Reserve Economic Data)

What the COVID-19 brought to countries are far more than the observations mentioned above. The most noticeable phenomenon was the extremely unstable unemployment rate. From February to April 2020, the unemployment rate in the US has reached its peak in the 21st century with an unprecedentedly rapid increase. Besides, there is no doubt that the United States has kept a relatively higher income level than other countries. As the intercontinental business received unfavorable feedback from COVID-19, the real disposable personal income of the US also experienced unexpected vibration in 2020. It would be meaningful to inspect the effect of the aberrant unemployment rate and real disposable personal income on the exchange rate. This research used the monthly percentage change of real disposable personal income instead of the original data in the following research, because the original data has the unit of billion dollars which does not match the units of other variables and caused redundant bias to the regression.

In this research, a multiple linear regression will be used to check the reality. The Estimated model is read as:

$$EXRATE_i=\beta_0+\beta_1*inflation_i+\beta_2*INRATE_i+\beta_3*UNRATE_i+\beta_4*PIchange_i+\beta_5*COVID_i+u_i$$

where EXRATE represents the China/U.S. Foreign Exchange Rate; inflation stands for 10-Year Breakeven Inflation Rate in the US; INRATE is the effective federal funds rate in the US; UNRATE means the unemployment rate in the US; PIchange refers to the monthly percentage change of real disposable personal income; and COVID defines the cumulative cases of COVID-19 in the US.

Furthermore, excluding the total regression of **Model 1** from March, 2018 to February 2021, the regression is separated into two by periods which are **Model 2** from March, 2018 to February, 2020 and **Model 3** from March, 2020 to February, 2021. It is supportive to take March, 2020 as a turning point inasmuch as that the COVID-19 bursted multinationally in this month, especially in the U.S. society, and yielded a gigantic effect on the economy. That's exactly the reason why this paper only included COVID-19 as a variable in the regression of **Model 3**. In this way, the comparison would be lucid to study the real effect of the pandemic of coronavirus.

4. RESULT

Three regressions would be ran in the following formula (1) to (3) models.

4.1 Total

$$EXRATE_i=\beta_0+\beta_1*inflation_i+\beta_2*INRATE_i+\beta_3*UNRATE_i+\beta_4*PIchange_i+\beta_5*COVID_i+u_i \quad (1)$$

4.2 Before COVID-19

$$EXRATE_i=\beta_0+\beta_1*inflation_i+\beta_2*INRATE_i+\beta_3*UNRATE_i+\beta_4*PIchange_i+u_i \quad (2)$$

4.3 After COVID-19

$$EXRATE_i=\beta_0+\beta_1*inflation_i+\beta_2*INRATE_i+\beta_3*UNRATE_i+\beta_4*PIchange_i+\beta_5*COVID_i+u_i \quad (3)$$

TABLE 1: REGRESSIONS OF EXCHANGE RATE WITH AND WITHOUT COVID-19

	Total	Before COVID-19	After COVID-19
	Exchange Rate Coeff./Std.err	Exchange Rate Coeff./Std.err	Exchange Rate Coeff./Std.err
Inflation rate, %	-0.650***	-0.436*	0.404
	(0.101)	(0.212)	(0.251)
Effective Federal Funds Rate, %	0.114*	0.160	0.962*
	(0.044)	(0.099)	(0.374)
Unemployment Rate in the US, %	-0.008	-0.732*	0.071*
	(0.016)	(0.272)	(0.021)
Monthly Percentage Change of the Real Disposable Personal Income, %	-0.004	0.048	-0.005
	(0.007)	(0.111)	(0.003)

Cumulative cases of COVID-19 in the US, million			-0.022**
			(0.005)
Constant	7.764***	10.036***	5.681***
	(0.2630)	(0.756)	(0.563)
R^2	0.648	0.694	0.979
Adjusted R^2	0.602	0.629	0.961
Number of Observations	36	24	12

Note: ***, ** and * represent statistical significance at 0.01, 0.05, 0.10 respectively. Robust standard errors in parentheses.

From the Total Regression which has a period from March, 2018 to February, 2021, with the ceteris paribus assumption, the China/U.S. Foreign Exchange Rate will decrease by 0.65 which indicates that one USD worth 0.65 CNY less as the inflation rate gets 1% higher, on average. This result is statistically significant at 0.01 level, and there is strong evidence that inflation changes the China/U.S. foreign exchange rate. Holding all else equal, the China/U.S. Foreign Exchange Rate will increase by 0.114 averagely which indicates that one USD worth 0.114 CNY more as the effective federal funds rate increases by 1%. This result is statistically significant at 0.1 level, and there is mild evidence that the effective federal funds rate is in charge of the change of the China/U.S. Foreign Exchange Rate. However, on average, the China/U.S. Foreign Exchange Rate will decrease by 0.008 and 0.004, denoting that one USD worth 0.008 and 0.004 CNY less when the unemployment rate in the US gets 1% higher and the real disposable personal income in the US is 1% higher than last month. Both results are not statistically significant which indicate insufficient evidence and the small coefficients also showed tiny effects.

From the Regression Before COVID-19 from March, 2018 to February, 2020, held the ceteris paribus assumption, the China/U.S. Foreign Exchange Rate will decrease by 0.436, which indicates that one USD worth 0.436 CNY less when the inflation rate gets 1% higher, on average. It shows a statistical significance at 0.1 level and there is mild evidence to conclude that inflation of the US is a causal factor of the change of the China/U.S. Foreign Exchange Rate before the spread of COVID-19. Holding other things the same, the China/U.S. Foreign Exchange Rate will decrease by 0.732 when the Unemployment Rate in the U.S. increases by 1%, indicating that one USD will worth 0.732 CNY less when the unemployment rate gets 1% higher on average. It shows a statistical significance at 0.1 level and mild evidence to the effect as well. As for the influence of effective federal funds rate and Monthly Percentage Change of the Real Disposable Personal Income, the China/U.S. Foreign Exchange Rate will increase by 0.160 and 0.048, bespeaking that one USD worth 0.160 and 0.048 CNY more when effective federal funds rate rises 1% and the Real Disposable Personal Income is 1% higher than last month. Whereas, both results are not statistically significant and hence, there is no adequate evidence for the effect of both variables.

On the contrary, with the effect of COVID-19, the inflation rate showed a positive effect on the China/U.S. Foreign Exchange Rate that as it increases by 1%, the exchange rate increases by 0.404 on average, other things being equal. This means that one USD worth 0.404 CNY more, but it is not statistically significant and consequently no evidence for this effect. And the

Monthly Percentage Change of the Real Disposable Personal Income displayed a negative effect that the China/U.S. Foreign Exchange Rate decreases by 0.005 as it gets 1% higher than last month. This result is not statistically significant and few evidence, for its effect, likewise. Additionally, the effective federal funds rate and the unemployment rate exhibited positive outcomes that the China/U.S. Foreign Exchange Rate will increase 0.962 and 0.071 if each increases by 1%. These results pointed out that one USD worth 0.962 and 0.071 CNY more, and both are statistically significant at 0.1 level with mild evidence that both variables are accountable to the change of the China/U.S. Foreign Exchange Rate. As for Cumulative cases of COVID-19 in the US, the China/U.S. Foreign Exchange Rate will decrease 0.022 when Cumulative cases of COVID-19 in the US increased by one million, demonstrating that one USD worth 0.022 CNY less when there are one million more cumulative cases of COVID-19 in the U.S. than last month. The result is statistically significant at 0.05 level, so there is sufficient evidence that COVID-19 has brought an unignorable effect on the change of the China/U.S. Foreign Exchange Rate.

By comparing, the difference of with and without COVID-19 effect in the regressions is definitely meaningful by studying the results of **Model 3**. First of all, the effect of effective federal funds rate increased a lot to 0.962 at 0.1 significance level. It is noticed that the Federal Reserve has decreased the rate from 1.58 to 0.05 from February to April 2020. Since that, the effective federal funds rate kept the extremely low level, and coincidentally, the rate also showed the same morbid trend from December, 2008 to November, 2015. It is widely acknowledged that the federal reserve implemented such policy to help its damaged economy recover from the subprime mortgage crisis, so it is reasonable to tell that the government was trying to use the same policy to resist the pandemic of COVID-19 and it would last in the following five years.

Another salient result is the coefficient of the Unemployment rate in the US. In the long run, this variable is not effective for the change of the China/U.S. Foreign Exchange Rates, but in the short run, it does matter. Without the effect of COVID-19, the effect of unemployment rate was positive, but turned to be negative when the virus spread. The same situation also happened in 2008, but the trends of exchange rate were diametrically opposed. This unusual phenomenon might be caused by political factors that both periods of subprime mortgage crisis and pandemic of COVID-19 included the president election in the US, and population's attitude to Barack Obama and Donald Trump and their policies are various. There is evidence to show that the unemployment rate is responsible for the change of exchange rate, nonetheless, the specific change is not predictive with the limited data collected. Moreover, the coefficient of the cumulative cases of COVID-19 in the US is statistically significant as mentioned above. In short, the influence of COVID-19 deserves to be included in the regression since it brought magnificent feedback.

In **Model 1&2**, the R-squared of 0.648 and 0.694 mean that 64.8% and 69.4% variances in the China/U.S. Foreign Exchange Rates are explained by the variances of inflation rate, effective federal funds rate, unemployment rate, and the Monthly Percentage Change of the Real Disposable Personal Income. In **Model 3**, the R-squared of 0.979 means that 97.9% variances in the China/U.S. Foreign Exchange Rates are explained by the variances of inflation rate, effective federal funds rate, unemployment rate, the Monthly Percentage Change of the Real Disposable Personal Income and the cumulative cases of COVID-19 in the US.

So far, the coefficients of Monthly Percentage Change of Real Disposable Personal Income are distinctive since they did not make statistical sense in each regression. In order to reduce the error caused by the effect from other independent variables, this study ran a regression of the China/U.S. Foreign Exchange Rate on this variable only. In consonance with the following regression result that has been generated (**Figure 2&3**), it can been seen that the points on the both Figures are simply scattered. What is more, before March, 2020, R-squared is equal to 0.0002, after that, it equals to 0.0024. These express that only 0.02% and 0.24% variances in the China/U.S. Foreign Exchange Rates are explained by the variances of the real disposable personal income. Thus, the tiny R-squared allows us to draw a conclusion that the correlation between the real disposable personal income and the China/U.S. Foreign Exchange Rate is negligible. And the variable of real disposable personal income in the US cannot be an efficacious factor when examining the fluctuation of the exchange rate.

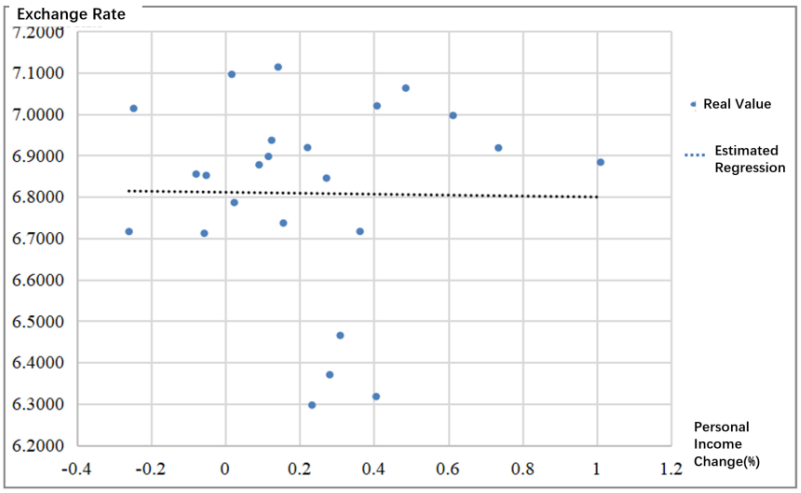

Figure 2: Effect of real disposable personal income on EXRATE before COVID-19

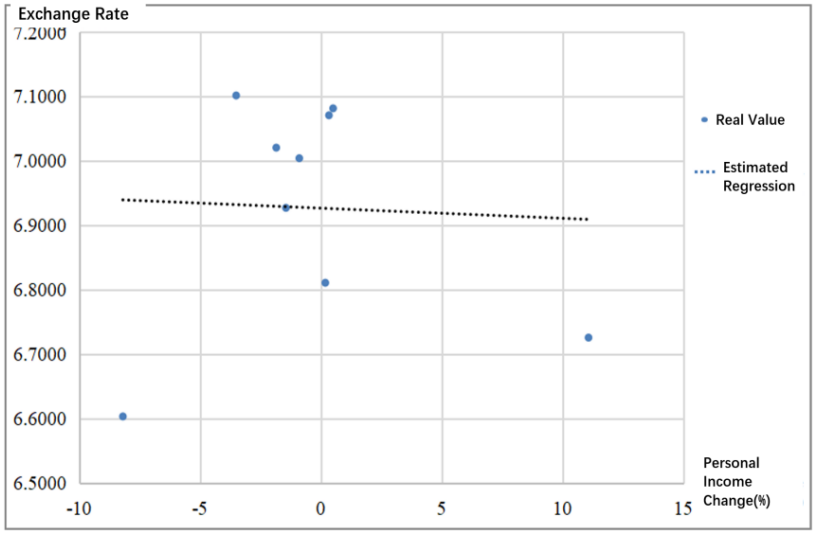

Figure 3: Effect of real disposable personal income on EXRATE after COVID-19

From the Figures above, it could be seen clearly if the existence of COVID-19 influenced the effect of each variable on China/U.S. Foreign Exchange Rate. From **Figures 4&5**, without the effect of COVID-19 (before March, 2020), the exchange rate slightly increased with the rise of interest rate of US; while it becomes obvious that the positive relationship between the exchange rate and the interest rate of US with the pandemic of COVID-19.

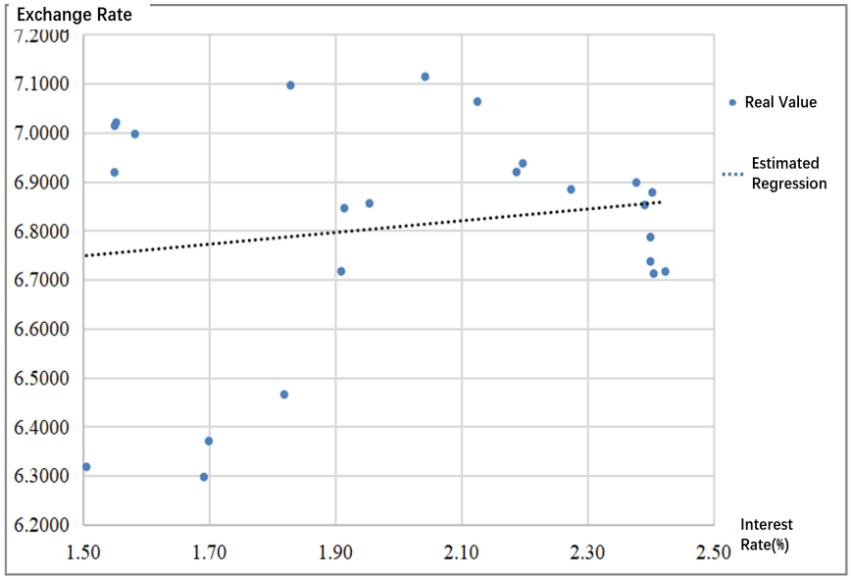

Figure 4: Effect of Interest rate on EXRATE before COVID-19

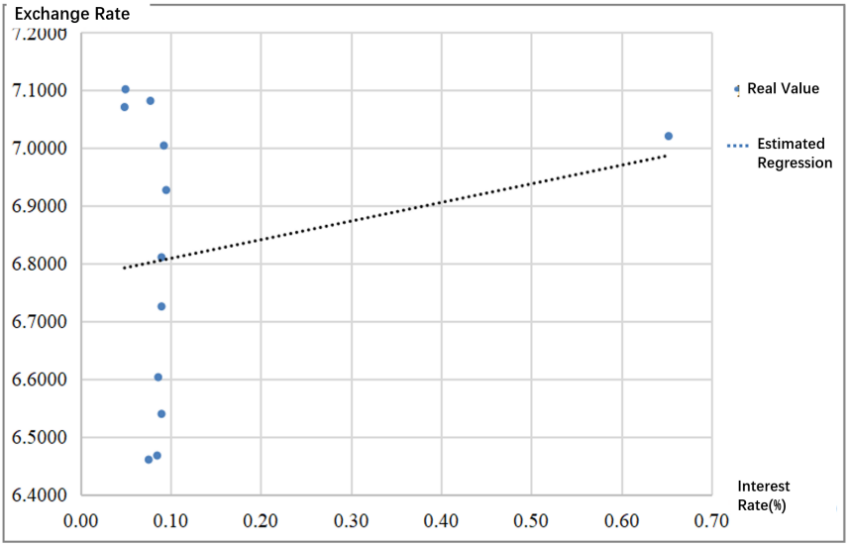

Figure 5: Effect of Interest rate on EXRATE after COVID-19

It is worthy to pay attention to **Figures 6&7** that the impact of unemployment rate on the exchange rate shows a completely different trend before and after the COVID-19. Before the pandemic of the virus, the exchange rate decreased as unemployment rate increased, but after the outbreak, the exchange rate rose with the increase of unemployment rate. Due to complicated political reasons, the unemployment rate would show irregular fluctuations and unpredictable effects on the change of China/US Foreign Exchange rate.

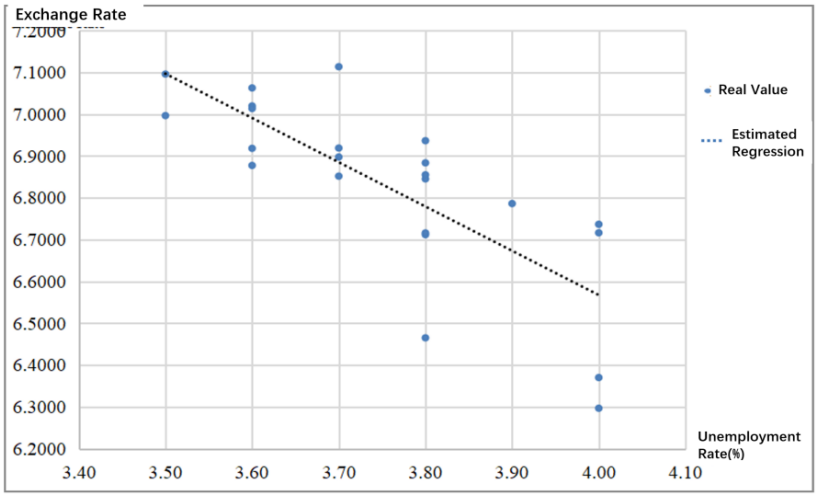

Figure 6: Effect of Unemployment rate on EXRATE before COVID-19

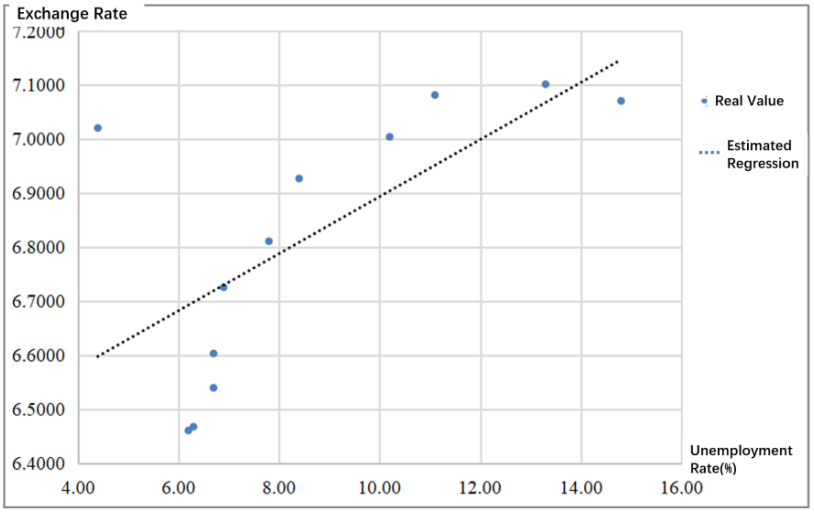

Figure 7: Effect of Unemployment Rate on EXRATE after COVID-19

Literally, the three regressions for the effect of real disposable personal income, effective federal funds rate, and unemployment rate on the China/US foreign exchange rate refined some detailed problems in the comprehensive regressions in **Table 1**. The regression line of the monthly percentage change of real disposable personal income in **Figure 2&3** exhibited tiny slopes, and the estimated regression had blatant gaps with the real value, it would be wise to save some effort for the future related research on this variable no matter before or after COVID-19. effective federal funds rate is a realistic and controllable variable and its effect on China/US foreign exchange rate after COVID-19 could not be underestimated by the odd estimated regression line. It is highly related to the inflation rate, thus the government chose to use remarkably low rates in an economic recession period. Lastly, unemployment rate is an erratic variable that is deeply correlated to the governors policy. Predictions in the short run were meaningful, but should be more careful when considering it in the long run.

5. CONCLUSION

To demonstrate potential impact of unemployment, inflation, interest rate and personal income on exchange rate between USD and CNY from March, 2018 to February 2021, this paper designed multiple linear regressions on variables mentioned before, also inviting the cumulative cases of COVID-19 as a independent variable into the regression to analyze the influence of the pandemic on the exchange rate between USD to CNY. Here are results and findings in summary:

1) Through the whole period of March 2018 to February 2021, inflation rate showed a negative impact on exchange rate, and effective federal funds rate had a positive impact.

2) Before COVID-19 pandemic, inflation rate and unemployment rate in the US showed a negative impact on exchange rate between USD and CNY.

3) After COVID-19 pandemic, effective federal funds rate and unemployment rate showed a positive tendency to the relationship with exchange rate and cumulative cases of COVID-19 had a negative impact on exchange rate.

4) However, influence from real disposable personal income was not significant before or after COVID-19 pandemic, as well the whole period.

5) Impact of unemployment rate on the exchange rate was negative before COVID-19 pandemic, while it was positive after COVID-19 pandemic.

6) Some insignificant impact and almighty differences were observed, but it is not appropriate to totally deny the result, for these status might be caused by governmental policy or lacking data.

These findings developed current research by providing analysis about the impact of inflation, interest rate, personal income and unemployment status to exchange rate via employing more kinds of data to regression, especially data after the burst of COVID-19 in February 2020. The results also indicated a similar relationship between COVID-19 cases and exchange rate in Nurdany, Achmad, et al.'s research. These contributions and findings may provide a thorough perspective to observe the global economic status under COVID-19 pandemic and are also sensible and helpful for policy makers with more precise predictions of economic indexes at the background of COVID-19 pandemic.

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