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An Analysis of the Dynamic Asymmetric Impact of the COVID-19 Pandemic on the RMB Exchange Rate

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In this paper, we assume that the COVID-19 pandemic exerts a time-varying asymmetric impact on the RMB exchange rate. Based on the Taylor rule model, we examine the RMB exchange rate fluctuations around the outbreak of COVID-19. We find that the RMB rate rose steadily before the outbreak but fluctuated during the pandemic. This shows that the pandemic had a transient time-varying impact on the RMB exchange rate.

I. Introduction

Following the China-US trade war at the end of 2019, the RMB exchange rate was on the rise; however, the unexpected outbreak of the COVID-19 pandemic ended the trend of RMB appreciation (see Iqbal et al., 2020).

In this paper, we discuss the dynamic asymmetric impact of the COVID-19 pandemic on the RMB exchange rate. We assume that capital flow has a negative impact on the RMB exchange rate in the context of the pandemic. Our hypothesis is that the impact of variables in the expansion of the Taylor rule model on the RMB exchange rate is time-varying but asymmetry. The motivation for testing this hypothesis is the extended Taylor rule model, where capital flow can be used as a variable to capture monetary policy. The hypothesis is tested by using the vector error correction model (VECM), which is used to examine the dynamic impacts of different variables on the exchange rate. Optimizing the formation mechanism for RMB exchange rate and maintaining the basic stability of the RMB exchange rate are important policy goals for Chinese monetary authorities and identifying dynamic changes in the RMB exchange rate has critical implications for the monetary authorities to devise exchange rate policies.

Based on the Taylor rule model, we take capital flow as a variable, and assume that capital flows (*CFUS*), China-US output gap (*GAP*), China-US inflation gap (*CPI*), and China-US interest rate gap (*ID*) have negative impacts on the RMB exchange rate in the context of the pandemic. Interested readers are referred to Wang et al. (2019). We select monthly data from January 2005 to June 2020, and use the VECM for the empirical test. The robustness of the empirical results is also tested.

Based on theory and empirical evidence, at different stages of economic development, the thresholds mentioned by the monetary authorities when formulating monetary policies are not long-term fixed values and should be adjusted continuously over time (see Dueker et al., 2013). On the other hand, Chen et al. (2017) show the difference in the direction and degree of influence on the time-varying characteristics of asset prices through interest rate differential and exchange rate expectations. Moreover, Wang et al. (2019) endogenously treat international capital flows to investigate the dynamic determination mechanism of the RMB exchange rate. Given the popularity of the Taylor rule model, we employ it for our hypothesis test. The differences between our study and previous studies, such as Devereux & Yu (2019), who show a time-change relationship between exchange rates and fundamentals, are as follows. First, we study capital flow-exchange rate nexus. Second, the fluctuations in the RMB exchange rate are characterized by nonlinearity; yet, studies using the VECM model to study exchange rate dynamics are limited. We, therefore, add to this literature by considering the nonlinearity angle. Third, the COVID-19 pandemic has impacted the macro-economic fundamentals (see Narayan, 2020a, 2020b; Narayan et al., 2020); therefore, in light of the pandemic, it is important to understand the exchange rate dynamics. We, as a result, contribute to this evolving COVID-19 literature on exchange rate responses to the pandemic.

II. Data and results

A. Data

This paper selects monthly data on five variables: namely, the RMB-USD exchange rate (*EX*), *CFUS*, *GAP*, *ID*, and *CPI*. In our model, *EX* is the dependent variable, and the explanatory variables include: *GAP* (is industrial value-added to represent the output gap difference), *ID* (is the difference between the Shanghai Interbank Offered Rate and the US Federal Funds Rate), *CPI* (is the difference between the CPI growth rate of China and the United States); and *CFUS* (is China's new foreign exchange expressed as the difference between reserves and trade surplus and actual use of foreign direct investment). These data are from the WIND Economic Database, the National Bureau of Statistics of China, the General Administration of Customs of China, and the US BEA Database. The sample size is chosen from January 2005 to June 2020, leading to a total of 186 observed values.

B. Model

According to Lansing & Ma (2017), the mathematical de-

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rivation of the Taylor rule model is:

$$\begin{aligned} e_t =& s_t E e_{t+1} - s_t CFUS_t - s_t \lambda (i_{t-1} - \widetilde{i_{t-1}}) \\ & - s_t (1-\lambda)(\mu_t - \widetilde{\mu_t}) - s_t (\varepsilon_t - \widetilde{\varepsilon_t}) \\ & - s_t (1-\lambda)\{[\alpha_1 - (\alpha_3 - \alpha_3^*)](p_t - \widetilde{p_t}) \\ & - \alpha_2 (y_t - \widetilde{y_t})\} \end{aligned} \quad (1)$$

The model rests on the assumption that *CFUS*, *ID* $(i_{t-1} - \widetilde{i_{t-1}})$, *GAP* $(y_t - \widetilde{y_t})$, and *CPI* $(p_t - \widetilde{p_t})$ have an asymmetric effect on the RMB exchange rate.

The precondition of VECM analysis is that "all the roots of the equation fall within the unit circle is a stable process", but in the process of using data difference to obtain data stability, some effective information will be lost, and more attention will be paid to the relationship between variables. In the short-term change process, less attention is paid to the long-term change process. In order to maintain the original appearance of the data and obtain the long-term equilibrium relationship between time series, a VECM can be established to investigate the long-term equilibrium relationship between time series vectors.

C. ADF and Johansen cointegration tests

We use the ADF test to examine the stationarity of variables. The test results show that the original sequences of all variables are not stationary at the 1% level of significance, but their first-order difference sequence are all stationary, which indicates that these sequences are first-order integrated series. Next, the Johansen cointegration approach is used to conduct the cointegration test. We find that there are at least two long-term cointegration relationships between the variables. Therefore, the VECM can be estimated.

The essence of the VECM is a restrictive VAR model, which can examine the dynamic impact of various variables on the RMB exchange rate in the context of the COVID-19 pandemic from both short-term fluctuations and long-term equilibrium. The following equations can be obtained by estimating the VECM:

$$\begin{aligned} \Delta ER_t =& 6.08 * ECM_{t-1} - 0.007885 * ECM_{t-2} \\ & + 5.36 * \Delta CFUS_{t-1} + 1.14 * \Delta CFUS_{t-2} \\ & - 0.005995 * \Delta CPI_{t-1} \\ & - 0.000580 * \Delta CPI_{t-2} \\ & - 0.001392 * \Delta GAP_{t-1} \\ & - 0.002134 * \Delta GAP_{t-2} \\ & + 0.011711 * \Delta ID_{t-1} \\ & + 0.003913 * \Delta ID_{t-2} - 0.004603 \end{aligned} \quad (2)$$

The coefficient of ΔCPI is negative—that is, *CPI* expansion is negatively correlated with the rise of the RMB exchange rate, the stability of the price level difference contributes to the stability of the RMB exchange rate. The coefficient of ΔGAP is negative–that is, the *GAP* is negatively correlated with the rise in the RMB exchange rate. In the long run, we should maintain stable output, if the output gap is too large, it will be detrimental to China's economic growth.

In order to test the stability of the VECM, the unit root test is performed on it. Except for the unit root assumed by the VECM itself, all the eigenvalues of the adjoint matrix fall within the unit circle, and most of them are far away from the unit circle. The model is stable, which ensures the significance analysis of impulse response analysis.

D. Impulse response analysis

The impulse response function can be used to describe the impact of a standard deviation shock on the random error term, reflecting the current and future impacts on endogenous variables. The figure shows the effects of *CFUS*, *GAP*, *ID*, and *CPI* on the *ER*.

Figure 1 shows that by comparing the impact of *CFUS* on the *ER* at different times, we can find that long-term fluctuations are greater than short- and mid-term fluctuations, and the short-term dynamic asymmetry is the strongest. A positive impact of a one standard deviation of *CFUS* shock has a positive impact on the *ER*. Here, the *ER* adopts the direct pricing method, that is, the positive changes in capital flows bring about the appreciation of the *ER*. The reason is that China reformed its exchange rate system after 2005, from a fixed exchange rate system to a floating exchange rate system and established a mechanism for the formation of the central parity rate of the RMB exchange rate. The impact of *CFUS* on the *ER* has increased, especially during the COVID-19 pandemic. It will be able to return to a stable level in the short term, and the confidence of other global economies in the Chinese market will increase. Capital inflows in the short term will bring about an appreciation of the *ER*.

As for *CPI*, a positive impact of a one standard deviation *CPI* shock has a negative impact on the *ER*, and the negative impact was greatest in period 2. The negative impact in the short-term is more pronounced than in the mid- to long-term, indicating that the impact of the COVID-19 pandemic on the RMB exchange rate is short-lived, and in the long run it still depends on macroeconomic fundamentals. In February 2020, China's *CPI* remained at a high level of 5.2%. To relieve inflationary pressures, monetary authorities issued base currency in the market. However, an increase in the currencies circulated in the market gave rise to inflation. In case of inflation, domestic currency depreciates, and foreign currencies appreciate; as a result, international hot money flows out from the home country and flows into the foreign currency markets, prompting a tighter monetary policy response from the central bank. Raising interest rates has led to an increase in the demand for the RMB and an appreciation of the *ER*. However, in the long run, the continued increase in inflation will bring about a devaluation of the RMB exchange rate. According to purchasing power parity theory, the price level rises and the purchasing power of the RMB declines, leading to a depreciation trend.

The positive impact of a one standard deviation increase in *GAP* has a negative impact on the *ER*, and the negative impact reached the maximum effect in period 4.5. The *GAP* variable has a greater negative impact on the *ER* in the short term than in the long term. This shows that *GAP* has a negative impact on the stability of the *ER*. This negative impact is small and has a certain lag. When China's output growth rate is higher than that of the United States, it will lead to an appreciation of the RMB exchange rate in the short term. However, as China's economy continues to grow, in order to stimulate exports and absorb excess domestic production capacity, the RMB exchange rate will depreciate. On the other hand, the continuous increase in China's output growth will bring about a higher inflation rate, and it will also bring about the devaluation of the RMB exchange rate. In February 2020, China's trade surplus declined rapidly due to the impact of the COVID-19 pandemic. When China's output gap widens, market expectations will rise, and China will adopt a tighter monetary policy.

In terms of *ID*, the positive impact of a one standard deviation increase in *ID* mainly has a negative impact on the *ER*, and the negative impact reached its maximum in 4 periods. The larger the *ID*, that is, when the RMB interest rate

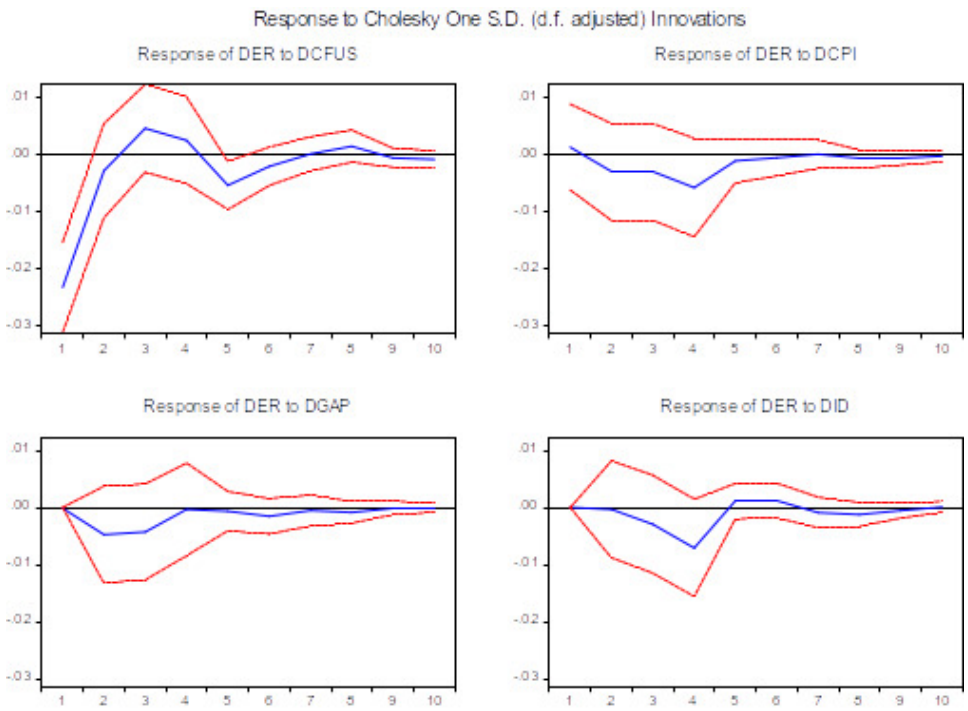

Figure 1: Impulse response function (IRF) results of various variables to RMB exchange rate

Note: The blue line represents orthogonalized IRF; the red line represents 95% confidence interval; the abscissa is the lag period; and the ordinate is the impact of a standard deviation.

is higher than the USD interest rate, the RMB will appreciate. This is because when the RMB interest rate rises, the demand for the RMB increases, and the RMB shows an appreciating trend. The impact of *ID* on the *ER* has a time lag. In February 2020, influenced by the pandemic, the China Banking Regulatory Commission required banks to lower loan interest rates, and the negative impact of China-US interest rate differential on the RMB exchange rate weakened.

III. Conclusion

In this paper, we study the evolution of the RMB exchange rate. Our analysis shows that the impact of the COVID-19 pandemic on the RMB exchange rate is transient. We discover that the short-term fluctuations in the RMB exchange rate are largely influenced by the China-US interest rate differential, while the mid- and long-term fluctuations are influenced by capital flows. Increase in capital inflows in the short term will lead to an appreciation of the RMB exchange rate. Moreover, the asymmetry of the impact of inflation and output gap on the RMB exchange rate is more obvious in the long term. The reason is that inflation levels and output gaps still depend on long-term economic fundamentals.

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