The Effects of COVID-19 Epidemic on the AUD/CNY Currency Exchange Rate

Qingyun Li[1, *]

[1]Department of Arts and Humanities, University College London, London, the U. K.

*Corresponding author: uclqlic@ucl.ac.uk

Abstract. Contemporarily, the COVID-19 has affected various fields around the world, which has strongly affected the global economy. As a macroeconomic indicators, exchange rate might has been influenced at least in some exytents. On this basis, this article examines empirically whether the COVID-19 outbreak has an impact on the Australian foreign exchange markets in terms of SARIMA and LSTM models. The results are obtained and analyzed based on daily AUD/CNY exchange rate data with one-year time intervals from 2018 to 2021. According to the analysis of the RMSE values of the SARIMA and LSTM models, it is revealed that the Australian foreign exchange market experienced a transitory shock. Thus, some possible explanations for the shock are put forth. Assuming the Efficient Market Hypothesis holds, these included the Australian lock-down policy, a shift in confidence, and the conventional Uncovered Interest Parity theorem. Overall, these results shed light on guiding further explortaion of currency exchange rates variations during pandemic.

Keywords: Finance; Exchange Rate; COVID-19; Australia.

1. Introduction

During tumultuous crisis, the exchange rates are influenced in various ways. One specific example for this were the global financial crisis. Other examples include the 1998 Russian debt default and the 1997-1998 Asian crisis. These are associated with financial crises, which related heavily with upswing or downswing in exchange rates. One possible explanation suggests both rising risk aversion and changes in how risky investing in particular currencies is regarded [1]. It reflects the speedily adjustment of financial markets under turbulent periods. In line with the efficient market hypothesis, it is not clear if the tumultuous crisis brings new information to the market, hence resulting in transitory or permanent effects on the exchange rate market of a specific country. With regard to the COVID-19 pandemic, the relationship between such widespread disease and the change on seasonality in exchange rate, remains unclear. Previous work on exchange rate movements during the COVID-19 crisis focused on, for instance, whether the shock on exchange rate have a permanent or transitory effect [2]. Other founding also revealed that the news on COVID cases causes a depreciation in domestic exchange rate. The fact that currency rates react considerably and very swiftly to change in fundamentals, is confirmed by this [3]. In addition, the policy responses and macroeconomics fundamentals also affected the abnormal exchange rate returns [4]. With the lockdown measure in place during 2020, this without doubts closely related to the movement of exchange rate. Inspiring by these papers, an interesting question is proposed. Given the possible correlation between COVID-19 and the exchange rate of Australian dollar, this paper contributes to the literature by analyzing whether the outbreak of COVID-19 affected the AUD/CNY exchange rate from two perspectives. First, the nature of the shock such as transitory or permanent, will be analyzed.

In addition, the efficient market theory will be used to develop a potential explanation for the shock' causes. Several papers are chosen to support the premise so that it can be tested for validity in the context of the foreign currency market. Milton Friedman proposed that the assumption made by exchange rate models that the market force of arbitrage and speculation are what drive exchange rates to revert to their fundamentals is a potential explanation for the disconnect between observed exchange rate fluctuations and fundamentals [5]. It explains the reasons why the efficient market hypothesis stands. Secondly, it was defined by Fama that information and transaction costs can be used to interpret departures from the strong form of the efficient market hypothesis [6]. If this theory is correct, rational traders will factor in all the information that is currently available regarding the

underlying value of exchange rate, when determining the value of a currency. These relevant assumptions were tested by Nguyen, such that for the foreign exchange market, the efficient market hypothesis' related null hypothesis is true [7]. Therefore, the primary goal of this paper will be to investigate potential reasons why the Australian dollars' exchange rate may have changed in response to the dangerous, widespread COVID-19 outbreak.

The first step for this study is to analyze the data so as to perceive the difference in pattern of trend before, during and after the pandemic. This will ensure there is certainly a shock to the AUD exchange rate during the time period. The AUD/CNY exchange rate is selected on this paper, for the purpose of simplicity. In fact, for many other currencies such as pound and US dollars, this still holds, which ensure that AUD depreciation was not initiated by other currencies' appreciation.

2. Data & Method

The method relies on daily exchange rate data over three forecast horizons: 1-year before COVID, 1-year during COVID and 1-year after COVID. For the specific purpose of simplifying the process, AUD to CNY exchange rate data is selected from Yahoo finance open-source database. By investigating from the chart, it is clear that AUD exchange rate experienced rapid depreciation from 05/03/2020 to 26/03/2020. For validating the finding, SARIMA and LSTMs model are chosen to examine the RMSE value of each time period. The RMSE value is expected to be the highest during COVID compared to other two selected time periods.

2.1 SARIMA

By effectively applying an ARIMA model to lags that are integer multiples of seasonality, the SARIMA model takes seasonality into account. The SARIMA applies an ARIMA model to the remining non-seasonal structure for the Exchange Rate data's seasonal pattern after adjustment. For ARMA (P, Q), it can be described as:

$$\Delta \mathrm{Dsyt} = \theta(\mathrm{Ls})\mathrm{P}\Delta\mathrm{Dsyt} + \phi(\mathrm{Ls})\mathrm{Q}\Delta\mathrm{Ds}\epsilon\mathrm{t} + \Delta\mathrm{Ds}\epsilon\mathrm{t} \quad (1)$$

Absorbing constants into polynomials yields:

$$\theta(Ls)P\Delta Dsyt = \phi(Ls)Q\Delta Ds\epsilon t \quad (2)$$

Once seasonality has been eliminated, another ARIMA(p,d,q) model will be applied to ΔDsy. By multiplying the seasonal model by the new ARIMA model:

$$\Theta(L)p\theta(Ls)P\Delta d\Delta Dsyt = \Phi(L)q\phi(Ls)Q\Delta d\Delta Ds\epsilon t \quad (3)$$

Hence, one yields the general form of a SARIMA(p,d,q)(P,D,Q,s) model.

Stationary test is first implemented to perceive whether transformations will need to be applied to make the data stationary. ACF and PACF figures suggested the order of the model. This is validated by running the auto_arima package. The rmse value for the time period of 2018-09-01 to 2019-09-01, 2019-09-01 to 2020-09-01, 2020-09-01 to 2021-09-01 are the following: 0.06718, 0.09224 and 0.04835. This indicates that the null hypothesis of "having the highest RMSE value amid COVID" cannot be rejected adopting SARIMA Model.

2.2 LSTM

Long Short-Term Memory network (LSTM) will be selected to implement seasonal time series prediction. The Timeseries-Generator is defined as three lookback day, and the n_feature is chosen to be 1. The results are generated multiple times due to the random nature of LSTM Model. Despite this, the RMSE value amid COVID is always the highest among the three time periods. Typical values are "0.043093, 0.048645 and 0.041857". This proved that our null hypothesis of "having the highest RMSE value amid COVID" cannot be rejected adopting LSTM Model.

3. Results & Discussion

According to the RMSE values suggested from LSTM and SARIMA models, the pandemic shock to AUD/CNY exchange rate is transitory, as the RMSE value increased and then fall back close to its previous level. The results of SARIMA of different periods are given in Table. 1, Table. 2 and Table. 3. With the assumption of efficient market hypothesis (EMH), this strongly supported the claim that one can't beat the market. As in its stronger forms, financial asset prices such as currency exchange rate represent its 'fundamental value', except in some special cases they are deflected by temporary departures due to shocks. After the crisis, rationality brought the price back to its fundamental value without departures. This is persistent with the core concept of rational expectations in mainstream macroeconomics and financial economics. In contrast to other time periods, as shown in Fig. 1, the predicted means for 2019-2020 diverged significantly from the Adj Close, which suggests that a transitory shock may have had an effect on the seasonality of the AUD/CNY exchange rate.

Table. 1 SARIMA Results in 2018-2019.

Dep. Variable:	y	**Log Likelihood**	543.734
Model:	SARIMAX(0,1,1)	**AIC**	-1083.467
Sample:	09-04-2018 - 08-30-2019	**BIC**	-1076.362
Covariance Type:	opg	**HQIC**	-1080.61
	coef	**std err**	**z**
ma.L1	-0.2931	0.047	-6.187
sigma2	0.0009	5.71E-05	15.148
Ljung-Box(L1) (Q):	0	**Jarque-Bera(JB):**	97.85
Prob(Q):	0.95	**Prob(JB):**	0
Heteroskedasticity (H):	1.01	**Skew:**	-0.18
Prob(H) (two-sided):	0.96	**Kurtosis:**	6

Table. 2 SARIMA Results in 2019-2020.

Dep. Variable:	y	**Log Likelihood**	513.033
Model:	SARIMAX(0,1,0)	**AIC**	-1024.065
Sample:	09-04-2019 - 08-31-2020	**BIC**	-1020.512
Covariance Type:	opg	**HQIC**	-1022.637
	coef	**std err**	**z**
sigma2	0.0011	7.27E-05	15.085
Ljung-Box(L1) (Q):	2.63	**Jarque-Bera(JB):**	25.11
Prob(Q):	0.11	**Prob(JB):**	0
Heteroskedasticity (H):	2.89	**Skew:**	0.06
Prob(H) (two-sided):	0	**Kurtosis:**	4.52

Table. 3 SARIMA Results in 2020-2021.

Dep. Variable:	y	**Log Likelihood**	557.487
Model:	SARIMAX(0,1,1)	**AIC**	-1110.975
Sample:	09-04-2020 - 08-31-2021	**BIC**	-1103.853
Covariance Type:	opg	**HQIC**	-1108.112
	coef	**std err**	**z**
ma.L1	-0.1412	0.056	-2.544
sigma2	0.0008	6.06E-05	13.252
Ljung-Box(L1) (Q):	0	**Jarque-Bera(JB):**	8.65
Prob(Q):	0.97	**Prob(JB):**	0.01
Heteroskedasticity (H):	0.86	**Skew:**	-0.31
Prob(H) (two-sided):	0.49	**Kurtosis:**	3.64

The EMH holds provide us with the direction of analyzing the events happening during COVID (from 2019-09-01 to 2020-09-01). The first event that draws attention is lockdown. One paper indicates the atypical returns show that lockdown restrictions have had a negative impact on PSI-20 constituents while the correspondent withdrawals have had a positive impact [8]. The abnormal profits of stock market violate the EMH assumption, so it is likely that lockdown restriction could be considered as a shock to the AUD/CNY exchange rate movement.

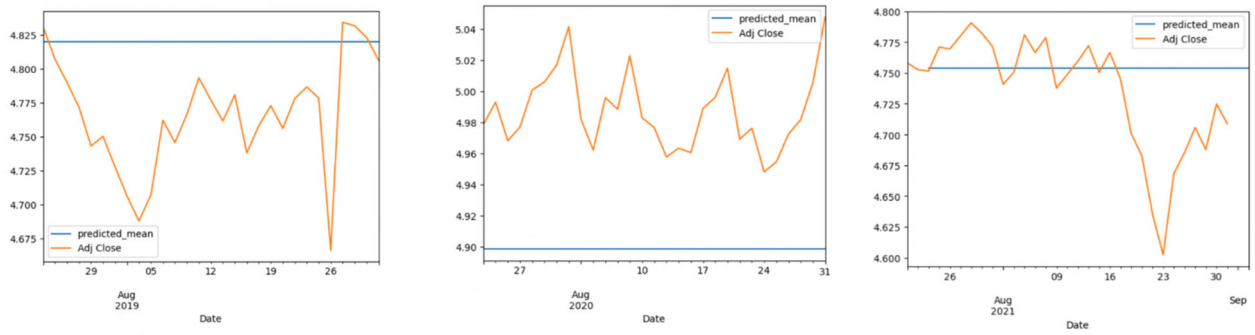


Fig. 1 The adjusted close and predicted means for 2018-2019, 2019-2020, 2020-2021 (from the left to right).

Another assertion made by one study is that there is a typically positive association between the pact of increase in exchange rates and the rate of growth in the number of infected cases [9]. The average daily growth rate of confirmed cases and fatality cases, as revealed by the research, suggests that the choice to impose a state of lockdown is helpful in limiting the spread of COVID-19. This implies that the lockdown policy could potentially restraint COVID cases, hence affect the growth rate of exchange rate, which causes exchange rate movement. When it comes to the Australian government policy, it is stated that the lockdown started from Friday 13 March, and ended on Friday, 1 May [10]. When the lockdown started, the AUD exchange rate fell sharply and them recover back to approximate its initial level. It is reasonable to deduct that there is correlation between the Australian lockdown policy and the movement of AUD exchange rate. This needed to be examined in the subsequent research.

In this paper, a few potential causes for such a correlation will be highlighted. First, according to one article, Lockdown policy was also found to have a negative and significant influence on stock market returns, suggesting that lockdown also has depressing effect on stock market returns, a financial loss [11]. Consequently, they urged policymakers to ease the lockdown policy, so that numerous corporate activities might resume, which would increase investors' confidence or optimism in turn. In addition, they urge regulators to implement monetary and fiscal policies to lessen the negative effects of the COVID-19 epidemic. Aside from that, they recommended relief package as a way of transforming cash to those who needed it, also the lowering of monetary policy rate will lead to cheaper funds so as to resuscitate their business. Although there are dissimilarities between foreign exchange market and the stock market, but the regulating nature of foreign exchange market suggested higher chance of being influenced by government policy.

In the case of Australian government tackling the negative effects of COVID-19 and lockdown policy, a health package was released back in 11, March 2020. Not surprisingly, after a day an economic support package was announced, which includes support for business investment, support for small and medium firms, and stimulus payment support for households [12]. This coincides with the argument of relief package recommendation which is supposed to relief the influence of lockdown policy. Analyzing from the AUD/CNY exchange rate chart from Yahoo Finance, the sharp depreciation of AUD began in 11, March 2020, just the same day as the health package was announced. It is reasonable to assume that these two events are correlated. One possible explanation for this correlation is confidence. The lack of confidence has been one of the main reasons behind financial crisis, as claimed by Economists. As a result, Fukuya proposed that social capital could be viewed of as the confidence of economic agents [13]. An increase in economic agents' confidence is seen to have a favorable impact on macroeconomic indicators. This can be demonstrated by a straightforward example: If economic actors' confidence rises, demand and investment should rise and unemployment should fall, and vice versa. One study looks at how the Consumer Confidence Index (CCI) affects key macroeconomic factors, including the real exchange rate, the stock market index, and the Gross National Product [14]. From their study, they investigated if a rise in economic agents' confidence would result in a strengthening of the home currency. This will look at how CCI and currency rate are related. Given that the devaluation of home currency is expected to reduce CCI,

the inverse relationship also true. Results from the GARCH-M and OLS models after modelling indicated that when consumer confidence rises, their need for foreign currency will decline and the value of home currency will consequently increase. This purposes that the correlation between CCI and Australian exchange rate during the specific time period (amid COVID) should be well studied. The potential explanation could be that investors being pessimistic about the future, so bringing domestic exchange rate down. However, this should be examined with carefulness because COVID-19 is not a regional event. In fact, its global nature supposed to influence the CCIs of multiple nations, which may be detrimental for the specific research on one region, assuming other countries' CCIs hold constant amid COVID.

Aside from the parameters suggested by recent studies, the textbook-classical link between interest rate and exchange rate may merit investigation. The UIP (Uncovered Interest Rate Parity) requirements state that the interest benefits from retaining home currency (AUD dollars) as opposed to an alternative currency is equivalent to the loss from the latter's anticipated depreciation. This suggests that the forward-looking foreign exchange market will anticipate the government announcement of interest rate reduction and anticipate that there will be arbitrage opportunities. Hence, they will immediately sell AUD dollars, causing depreciation of AUD dollars. This could well explain the devaluation of AUD dollars during March 2020 as the interest rate was cut by the Australian government since the emergence of COVID-19. However, the assumptions of UIP may not hold during the COVID outbreak as many national governments were reducing interest rates altogether. This may not suggest an arbitrage opportunity for the AUD foreign exchange market. Hence, it is necessary to investigate further into the correlation between interest rate reduction and exchange rate depreciation during this period; also, the effectiveness of UIP conditions should be assessed so as to not missing the fault likelihood of adopting this theory in the analysis.

4. Limitations & Prospects

The EMH suggests that all the changes persuaded in a way as information, are subsequently to be incorporated into the market, if rational expectation assumption holds. The transitory nature of the shock well-fitting into the EMH hypothesis, as rational agents will absorb that new information and suck out the abnormal profits once the information has been announced. However, the rationality of UIP conditions suggested that the news on interest rate changed will cause immediate movement of exchange rate the same as the period of the change in interest rate. This is not the case when it comes to the AUD depreciation. Analyzing from the chart, despite the continuous reduction in interest rate by Australian government, the AUD exchange rate bounced back to its initial level within 8 days once it hit the lowest level. This reflects the facts that the UIP conditions may not be applicable under this circumstance. As some other new information arrived and being incorporated into the market. This could be the parameters suggested above, such as lockdown policy and confidence. Aside from these parameters, many other factors may well be considered as the COVID-19 influences on AUD exchange rate were so complex. Proposed by Chatjuthamard et al, risk factors as a categorizer separating countries into high financial risk countries and high political risk countries [15]. This implies that the stock reaction to COVID-19 induced financial market instability is strongly influenced by country characteristics.

5. Conclusion

In summary, this study examines the impact of COVID-19 epidemic on the Australian dollar's exchange rate; for the simplicity purpose, the AUD/CNY exchange rate is used in this analysis. In order to compare the RMSE values of three time periods, SARIMA and LSTM models are used (before, amid and after COVID-19). According to the analysis, the values suggested that the null hypothesis of 'having the highest RMSE value amid COVID' cannot be rejected. The EMH assumption then suggests the new information is incorporated into the rational foreign exchange

market, causing the change in seasonal pattern of AUD/CNY exchange rate. These factors may include COVID-19 lockdown policy, change in confidence, and UIP condition. However, the classic UIP condition does not hold during the rapid up-and-down movement of AUD/CNY exchange rate, which suggests that new macroeconomics model needed to be adopted to explain such correlation. This paper proposes several new research directions into analyzing the COVID-19 impact on foreign exchange market, which could be beneficial for understanding such volatile market especially the performance during tumultuous crisis.

References

[1] Kohler M. Exchange rates during financial crises. BIS Quarterly Review, March, 2010.

[2] Narayan P K. Has COVID-19 changed exchange rate resistance to shocks?. Asian Economics Letters, 2020, 1(1): 17389.

[3] Aquilante T, Di Pace F, Masolo R M. Exchange-rate and news: Evidence from the COVID pandemic. Economics letters, 2022, 213: 110390.

[4] Beckmann J and Czudaj R. Exchange rate expectation, abnormal returns, and the COVID-19 pandemic. Journal of Economic Behavior & Organization, 2022, 196, pp.1-25.

[5] Friedman M. Essays in Positive Economics, University of Chicago Press, 1953.

[6] Fama E. Efficient Capital Markets: II, Fiftieth Anniversary Invited Paper. Journal of Finance, 1991, 46, 1575-1617.

[7] Nguyen J. The Efficient Market Hypothesis: Is It Applicable to the Foreign Exchange Market?. UOW Edu, 2004.

[8] Galarza M. The Impact Of Lockdown Announcements During The COVID-19 Crisis: An Event Study From The Portuguese Stock Market. Iscte Business School, 2021.

[9] Banerjee I, Kumar A, Bhattacharyya R. Examining the Effect of COVID-19 on Foreign Exchange Rate and Stock Market--An Applied Insight into the Variable Effects of Lockdown on Indian Economy. arXiv preprint arXiv:2006.14499, 2020.

[10] Australia's Coronavirus Lockdown – The First 50 Days. The Guardian, 2022, Retrieved from: https://www.theguardian.com/world/2020/may/02/australias-coronavirus-lockdown-the-first-50-days.

[11] Raifu I A, Kumeka T T, Aminu A. Reaction of stock market returns to COVID-19 pandemic and lockdown policy: evidence from Nigerian firms stock returns. Future Business Journal, 2021, 7(1): 1-16.

[12] COVID-19: A Chronology Of Australian Government Announcements (Up Until 30 June 2020). Aph.Gov.Au, 2022, Retrieved from:
https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp2021/Chronologies/COVID-19AustralianGovernmentAnnouncements.

[13] Fukuyama F. Social capital and civil society. Available at SSRN 879582, 2000.

[14] Görmüş Ş, Güneş S. Consumer confidence, stock prices and exchange rates: The case of Turkey. Applied Econometrics and International Development, 2010, 10(2): 103-114.

[15] Chatjuthamard P, Jindahra P, Sarajoti P, et al. The effect of COVID‐19 on the global stock market. Accounting & Finance, 2021, 61(3): 4923-4953.