Asian Journal of Empirical Research
Volume 11, Issue 7 (2021): 59-71.
http://www.aessweb.com/journals/5004

IMPACT OF MACROECONOMIC INDICATORS ON THE YUAN-SDR EXCHANGE RATE

Debesh Bhowmik

Ex-Principal, Now, Research Professor, Lincoln University College, Malaysia.

✉ *debeshbhowmik269@gmail.com*

Article History

Received: 2 September 2021
Revised: 15 October 2021
Accepted: 5 November 2021
Published: 22 November 2021

Keywords

Yuan per SDR
Macroeconomic indicators
Cointegration
Short run causality
Long run causality
International monetary system..

JEL Classification

C32; C58; E31; E44; F14; F31; F55; G15.

ABSTRACT

The paper endeavours to explore the macroeconomic impact on the Yuan SDR exchange rate of China during 2017m1-2021m6 to justify the internationalization of RMB which had entered into the SDR basket of IMF in October 2016.To evaluate the impact ,the paper used the methodology of Johansen (1988) cointegration and vector error correction model considering monthly Yuan per SDR as dependent variable and monthly GDP, inflation rate, foreign exchange reserves, export and import as the independent macro-economic variables. The pattern of trendline of Yuan per SDR is found nonlinear having cyclical fluctuations and seasonal variations according to Hamilton (2018). The paper also found that Yuan per SDR has significant long run causalities with export, import, inflation rate, GDP and foreign exchange rate of China during the specified period. Even, Yuan per SDR has significant short run causality with export only. The cointegrating equation converged towards the equilibrium with the speed of adjustment 11.83% per month significantly. The impulse response function of import to Yuan per SDR showed significantly convergent. The VECM contains autocorrelation problem and unit root for which it is non-stationary.

Contribution/Originality: The paper contributes the first logical analysis of cyclical character of Yuan per SDR and cointegrating relationship among macro variables with Yuan per SDR.

DOI: 10.18488/journal.1007.2021.117.59.71
ISSN(P): 2306-983X/ ISSN(E): 2224-4425
How to cite: Debesh Bhowmik (2021) Impact of Macroeconomic Indicators on the Yuan-SDR Exchange Rate. *Asian Journal of Empirical Research*, 11(7), 59-71. 10.18488/journal.1007.2021.117.59.71

1. INTRODUCTION

Chinese GDP always dominated the world economy from 0-1820AD except during 1000+AD and 1700+ AD where supremacy of India's GDP was prevalent in the world when Europe and USA were lagged behind China and India (Maddison, 2007).During the Gold Standard and even in the Silver standard the currency Pound-Sterling dominated the international payments mechanism and Pound-Sterling was accepted as universal choice of international money because England dominated world trade, finance and world monetary system (Bhowmik, 2003). Since after Bretton Woods Era USA was appeared as the supreme power in international trade and international finance and even as a super economic and political power. Hence, in International Monetary System, US dollar is treated as dominant or hegemonic currency that is widely accepted by all the countries.

Horesh (2011) described that during Tang (CE 618-907) and Song dynasty (CE 960-1279) Chinese copper coins were widely used in Japan, North and South East Asia, South Asia, as currency and in mid12th century Japan imported Chinese copper coins. During 7-14th century, Chinese copper coins were exchanged in India, Ceylon, South India and in East Africa respectively. During1636 and 1678, Chinese copper coins were found in Japan and Korea and later, Dutch also found those copper coins of China in South East Asia although they supplemented silver coins in 18th century. Since1724, Dutch introduced the European style copper coinage. From CE 1368 to 1912, China also used silver coins with copper due to huge silver production in Latin-America and Europe was involved in exchanging with silver currency. There was no truly global currency before the discovery of rich silver deposits in Latin America

and the spread of the Spanish American silver dollar in the 17th century but before that Chinese copper coins were widely exchanged as international currency. On the historic context of Chinese monetary evolution, todays RMB's role in SDR basket and in international currency exchanges is of great importance.

The internationalisation of Rouble had collapsed the Soviet Union and the rise of Yen, South African Rand, Germany's DM as dominating key currencies in the international currency market did not prove that key currency like US Dollar can be prevalent as an international acceptable currency for exchange in international trade and finance. So that internationalisation of RMB has just began and flourishing in both international currency and capital market vis-à-vis dollar, euro, franc, pound sterling and DM respectively. If the criteria of liquidity, breadth, and openness, are to be considered for internationalisation then Chinese financial markets still have a long way to go before they catch up with those of other major currencies (Frankel, 2012).

Therefore, the entry of Chinese RMB into the SDR basket since October,2016 will surely innovate huge economic reforms and structural shifts in the field of international trade, financial markets, exchange rate policies, macro-economic functions and domestic and foreign money and banking markets where the currency Yuan will have to face keen competition with other dominant key currencies although the steps of RMB internationalisation will force to rethink the policy makers of International Monetary Fund about multi-polar functions of international monetary system.

On the basis of the phenomenon, this paper has attempted to focus the major impacts of the macroeconomic indicators like, GDP, inflation rate, foreign exchange reserves, export and import of China on the exchange rate of Yuan per SDR because new weights of the SDR basket has been started since October,2016 due to inclusion of Yuan so that the international exchange rates of Yuan with US Dollar, Euro, and Pound Sterling have been adjusted daily in the international market of SDR value which has real consequences in the international payments too.

2. LITERATURE REVIEW

There are huge researches on the RMB internationalization, its impacts, roles and requirements but less examination had been done about the role of macroeconomic determinants on the Yuan-SDR exchange rate through econometric analysis. Yet, some relevant studies have been incorporated here as literatures.

Zhang (2015) raised some important issues to succeed the RMB internationalisation process , e.g.,[i] reform exchange rate, interest rate and capital account liberalisation,[ii] make domestic financial market more deep, broad and liquid,[iii] PBOC should adopt monetary policy to control inflation, promote structural reform, use open market operation to hike bond yield, determine short term interest rate where new price based monetary policy should be emphasised,[iv] in creating domestic structural reform, China must accelerate GDP growth rate, to increase the ratio of household income to national income to stimulate domestic consumption, privatise the monopoly of SOEs in many service sectors, [v] to carry forward the reforms on legal, political and administrative systems to boost long-term confidence in the RMB.

Germain and Schwartz (2017) studied that China is successful on international negotiation on social cost of RMB internationalization and remarked that the American dollar would remain unchallenged as the global economy's pre-eminent international currency for the foreseeable future.

Brummer (2017) also stated the systemic risk factors of Yuan internationalization like inadequate liquidity, unequal competition, transmission belts of risk to even non-renminbi markets, disorderly outflow of capital, and stress on renminbi markets which need the policies of macroeconomic liberalization and reform, well-regulated onshore investment opportunities and capital account convertibility.

Wu and Tang (2018) admitted that internationalisation of RMB was positively related to international share of GDP, export, import and economic freedom and negatively related with inflation and volatility of REER respectively during 1997-2017.

Xia (2018) reminds that there many adverse impacts of RMB international on Chinese economy such as [i] reduction of controlling base money and regulate domestic economy, [ii] increase pressure on rising interest rate in home economy, [iii] harm on stability of price level.

Lim (2020) thought that RMB internationalization would allow China to a systematic management of monetary stimulus where China would enhance domestic economic growth through expanding currency supply, and its state capitalism seeks to co-exist uneasily with the demands of global economic integration although China would never supersede US supremacy over Dollar domination amid the process of fixed exchange rate mechanism and associated with the risks of state-monopolized credit creation.

Ding, Cui, and Zhang (2020) generated a genetic programming method for RMB volatility forecasting model due to the effect of RMB internationalization to help the monetary policy formulation and currency trading strategies.

Kurien and Geoxavier (2020) stated that China wanted to establish the RMB as [i] global trade currency, [ii] global investment currency, [iii] global reserve currency which intended China to set up Cross-Border Interbank Payment System, China Europe International Exchange, and planned to deregulate capital market to sign bilateral Currency Swap Arrangements, to invite foreign banks into China's interbank foreign exchange markets.

Chow (2021) reported that RMB cross border trade settlement in volume and in percentage of total China trade have been increasing after entering into SDR basket although they fell down during covid-19 but recovered later on. The offshore RMB deposits in Hong Kong, Taiwan, UK and Singapore have been slowly increasing with a break in covid period and the RMB share as a global payment currency has been enhancing slowly and stood at 2% in mid-2020.International trade shares with ASEAN, EU and USA have been rising steadily in last 6 years. The progress of RMB internationalization can ensure Yuan convertibility and the Yuan appreciation could expand offshore liquidity

while capital flows is still maintaining an incentive of current account surplus when capital controls helped RMB dominated outbound investment.

Lu and Tansuchat (2021) applied ARCH and GARCH model during $2010m_8$-$2021m_1$ and found that forex reserve is not significantly affected by Chinese on-shore and off-shore market exchange rate since their fluctuations were high and their contagion effect of volatility have been significantly strengthened. Author concluded that [i]there was positive bidirectional volatility contagion effect between on-shore and off-shore exchange markets of RMB, [ii] rising forex reserve enhances the volatility of exchange rate, [iii] forex reserves have two-way contagion effect with on-shore and off-shore exchange rate.

3. OBJECTIVES OF THE PAPER

The economists, researchers, political leaders, media and some spokesmen remarked on the issue of RMB entry into the SDR basket in IMF. Their expressions might produce puzzles among the general masses. The paper attempted to justify the impact of Chinese macroeconomic indicators such as export, import, foreign exchange reserves, inflation rate and GDP respectively on the Yuan per SDR exchange rate after inclusion of Yuan into the SDR basket. The study of the trend and cyclical behaviour of the Yuan-SDR exchange rate from $2017m_1$ to $2021m_7$ is the other area of research which can also help its impact on the economy. The purpose of the study will enable to formulate policies that might control the actual potentialities of the economy.

3.1. Methodology and Sources of Data

In this paper, semi-log linear and nonlinear regression model were applied for obtaining growth rate or linear trend and nonlinear trend of the macro indicators and Yuan per SDR whose residual test for stability was found from the CUSUM of squares. Decomposition into the trends, cycles and seasonal variation of Yuan SDR exchange rate from $2017m_1$ to $2021m_7$ was done by applying the Hamilton (2018) regression filter model. Its seasonality was tested by using autocorrelation and partial autocorrelation functions. The automatic ARIMA (p,d,q) model was fitted into the Hamilton regression filter residual for showing AR and MA properties and convergences which was also fitted to the forecasting model for $2023m_5$ following (Box & Jenkins, 1976) model. Augmented Dickey and Fuller (1979) model was used to show unit root of each variable. The cointegration and vector error correction were done for getting short run and long run causalities and cointegrating relations with the variables of export, import, consumer price index, GDP index, and foreign exchange reserves of China, and Yuan per SDR respectively by applying (Johansen, 1988) model where impulse response functions were used to verify response to one standard deviation innovations of the variables. The Wald (1943) test was applied to find out the short run causalities.

The monthly data during $2017m_1$ -$2021m_7$ on Yuan per SDR and foreign exchange reserves excluding gold were collected from the Peoples Bank of China (https://www.pbc.gov.cn) and monthly data on export, import, consumer price index, GDP index during the same period were collected from https://www.fred.stlouisfed.org.

4. RESULTS AND OBSERVATIONS-I

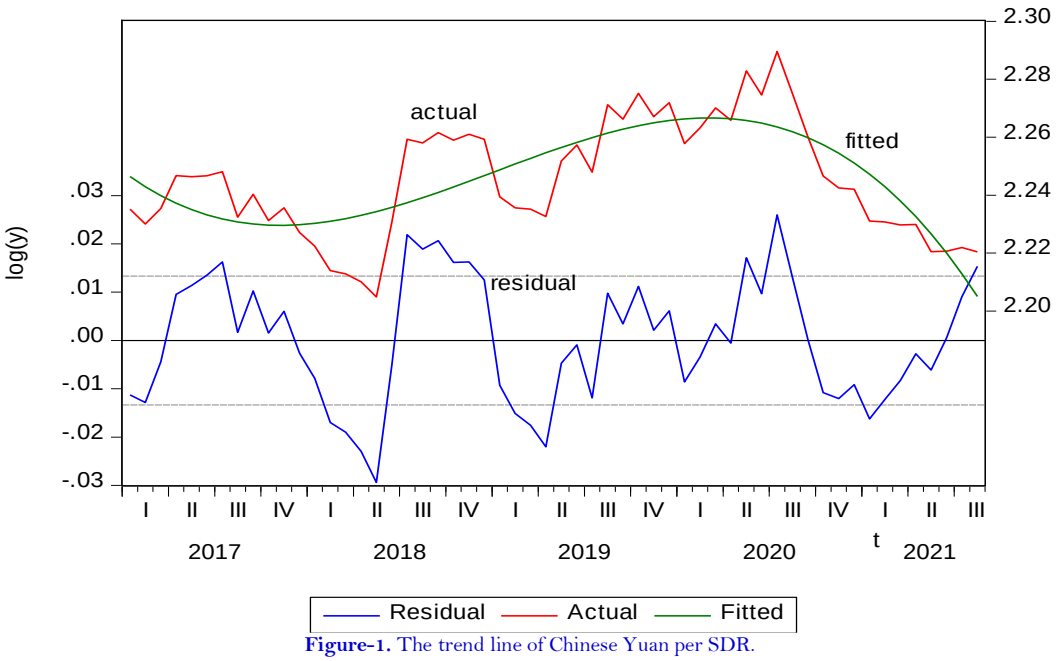


Figure-1. The trend line of Chinese Yuan per SDR.

[1]Behaviour of Yuan per SDR Exchange Rate

The non-linear trend line in the cubic form of Chinese Yuan per SDR from $2017m_1$ to $2021m_8$ is estimated below where its first phase has been declining in comparison to increasing in the second phase followed by decreasing in the third phase and all the coefficients of the estimated equation are significant at 5% level.

$Log(y)=2.2504-0.004285t+0.000255t^2-3.44e^{-06}t^3+u_i$

(294.42)* (-3.722)* (5.452)* (-6.38)*

R^2=0.57, F=23.91*, DW=0.603, AIC=-5.72, SC=-5.58, *=significant at 5% level, y=Yuan per SDR, t=period of time, i.e., month.

The shape of the estimated non-linear trend line of Yuan per SDR is inverse S which is shown in the Figure 1, where one downswing and one upswing trend have been observed but in the actual exchange rate of Yuan per SDR there are many ups and downs of the rates.

The CUSUM of squares line of the trend line passes through the ±5% significant level which clarifies its stability and it is seen in the Figure 2 distinctly.

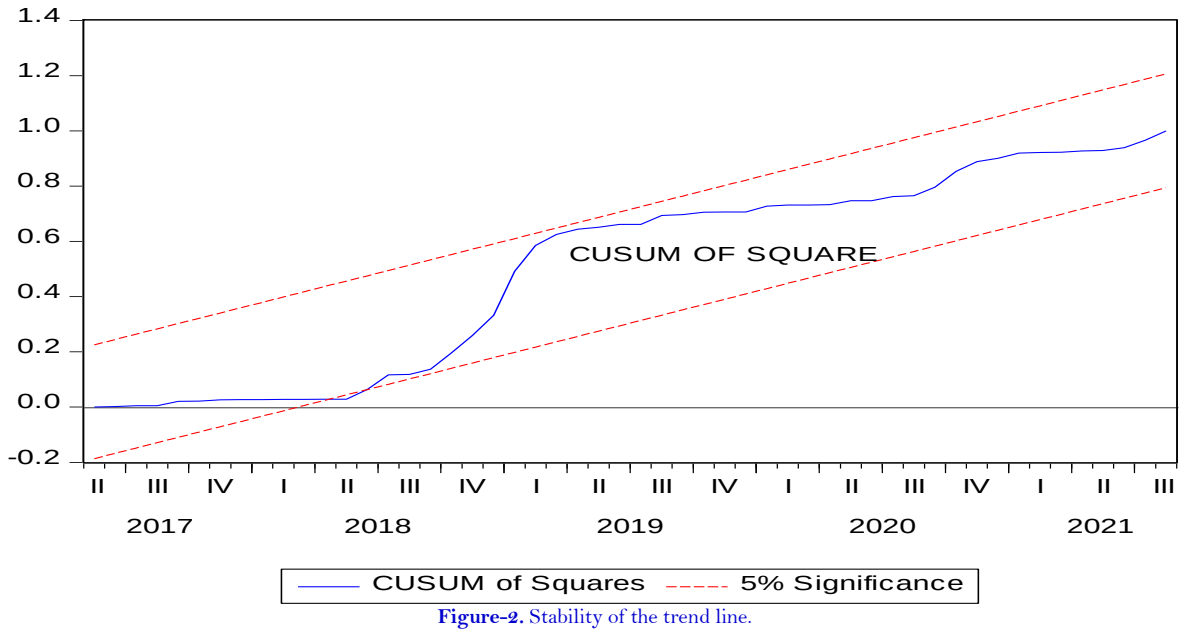


Figure-2. Stability of the trend line.

Through the regression filter of Hamilton (2018) model the exchange rate of Yuan per SDR from $2017m_1$ to $2021m_8$ has been decomposed into the trend, the cycle and the seasonal variation. The estimated equation is given below.

$$Log(y)_t=4.487-0.459log(y)_{t-24}+0.268log(y)_{t-25}-0.254log(y)_{t-26}-0.552log(y)_{t-27}+v_t$$

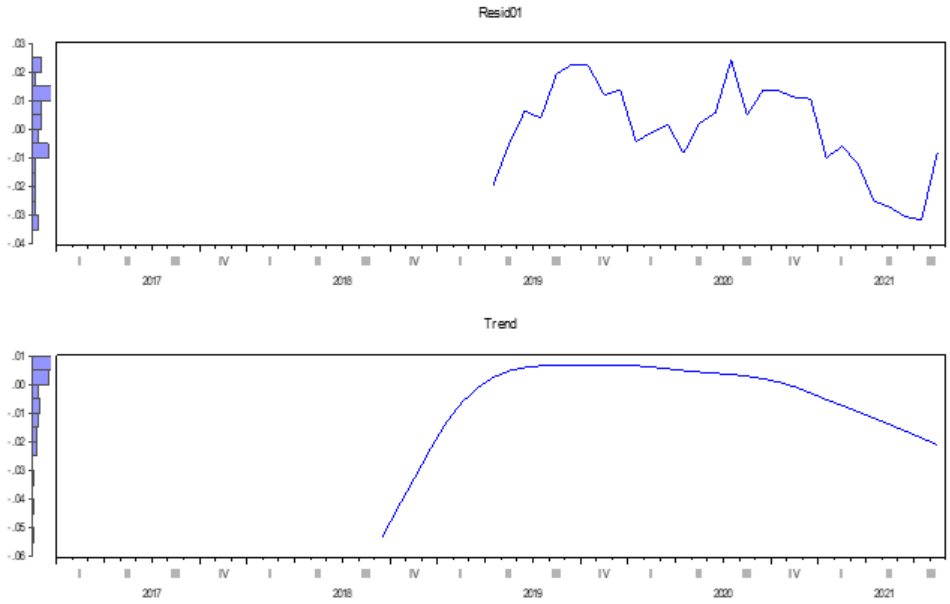
(7.97)* (-1.50) (0.60) (-0.53) (-1.56)

R^2=0.417, F=4.30*, AIC=-5.12, SC=-4.89, DW=0.45, n=29(adjusted 2019m4-2021m8), *=significant at 5% level.

Here, v_t represents the regression filter residual which can be decomposed into cycle, trend and seasonal variation through the STL method.

$$V_t= Log(y)_t-[4.487-0.459log(y)_{t-24}+0.268log(y)_{t-25}-0.254log(y)_{t-26}-0.552log(y)_{t-27}]$$

In Figure 3, the panel 1 showed the cycles of the exchange rate where seven peaks and seven troughs have been found. In panel 2, the cyclical trend clearly has one peak where it is inverse U type. The seasonal variation is plotted in panel 3 where four upswings and five downswings were found including small fluctuations.



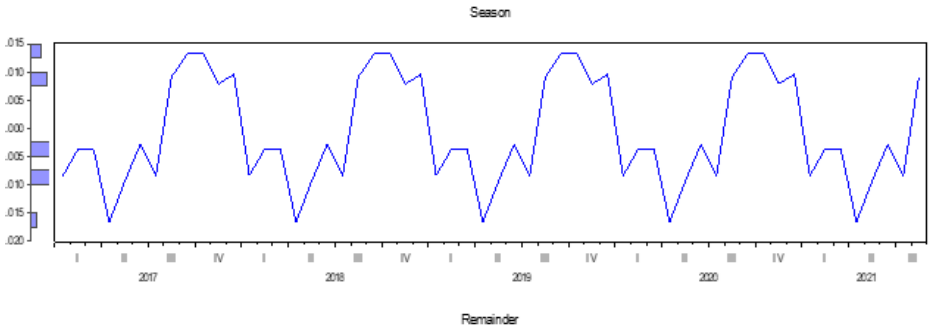
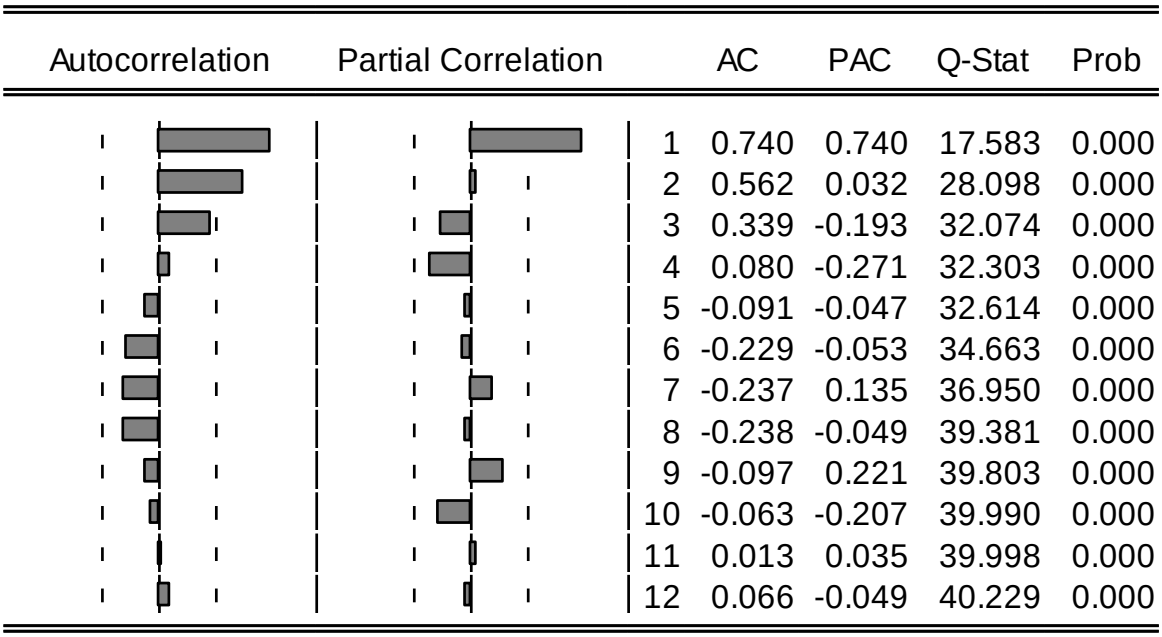


Figure-3. Decomposition of exchange rate of Yuan per SDR.

In Figure 4, the seasonality is verified by the autocorrelation and partial autocorrelation functions of the Hamilton regression filter residuals where autocorrelation functions have been declining and tend to negative showing increasing and declining patterns and finally reached positive values at lag 11. The partial autocorrelation functions contain one spike and then fluctuated into positive and negative values where Q stat are significant. (n=29).



	AC	PAC	Q-Stat	Prob
1	0.740	0.740	17.583	0.000
2	0.562	0.032	28.098	0.000
3	0.339	-0.193	32.074	0.000
4	0.080	-0.271	32.303	0.000
5	-0.091	-0.047	32.614	0.000
6	-0.229	-0.053	34.663	0.000
7	-0.237	0.135	36.950	0.000
8	-0.238	-0.049	39.381	0.000
9	-0.097	0.221	39.803	0.000
10	-0.063	-0.207	39.990	0.000
11	0.013	0.035	39.998	0.000
12	0.066	-0.049	40.229	0.000

Figure-4. AC and PAC of the residuals.

Automatically selected ARIMA (2,0,2) model usually passed through the Hamilton's regression filter residuals where AIC is the minimum i.e.-5.7648.

Using ARMA maximum likelihood (OPG-BHHH) methodology, the estimated ARIMA (2,0,2) is shown below where convergence achieved after 20 iterations.

V_t=-0.0023+0.4907v_{t-2}+ε_t+0.346ε_{t-2}+0.000133σ^2_t

(-0.41) (1.75) (1.05) (2.81)*

R^2=0.46, F=7.148*, AIC=-5.76, SC=-5.57, DW=1.10, AR roots=±0.70, MA roots=-0.00±0.59i, n=29, *=significant at 5% level.

The values of coefficients and roots of AR and MA are less than one so that the model is convergent and stable approaching towards equilibrium. Again, the t value the coefficient of σ^2_t is significant which implies that the volatility is found to be minimum.

The ARIMA (2,0,2) model if forecasted up to 2023m5, then the forecast line behaves cyclically with reducing its amplitude and ultimately moves towards equilibrium which is depicted in Figure 5.

4.1. Result and Observations-II

[1] Cointegration and Vector Error Correction among Macro Indicators and Yuan-SDR Exchange Rate

The long run linear trends of macro indicators are found to be significant except for GDP index of China from 2017m1 to 2021m6 where Chinese export and import growth rates assured 0.527% and 0.48% per month and the growth rates of CPI and foreign exchange reserves are shown as 0.191% and 0.078% per month respectively. In Table 1, the growth rates, values of R^2, DW and t were given for verification.

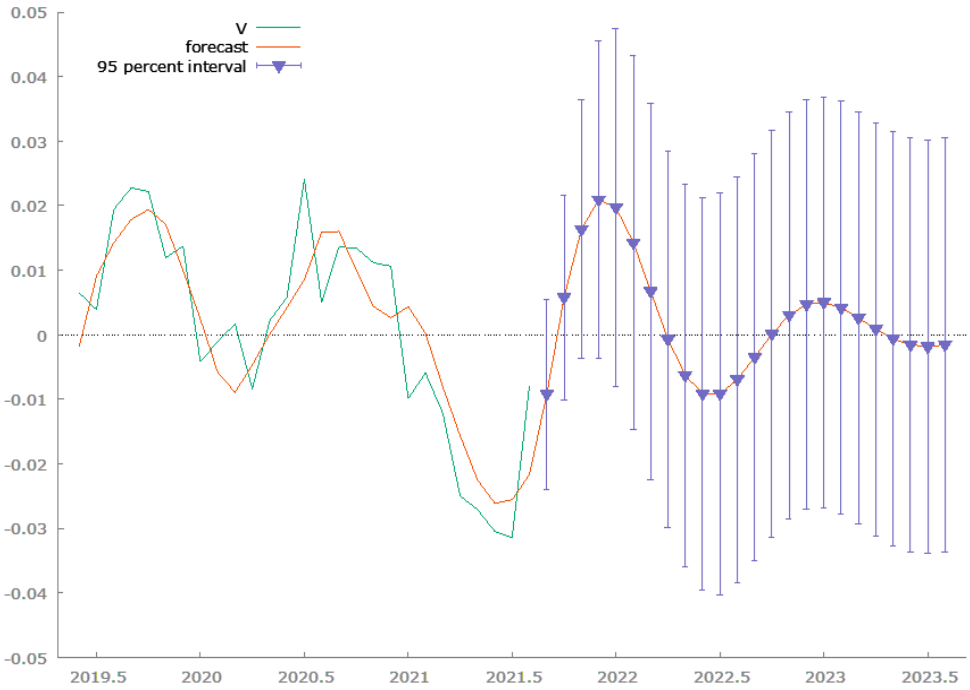


Figure-5. Forecast from ARIMA (2,0,2).

Table-1. Growth rates of macro indicators.

Indicators	Growth rate per month	R^2	t value	DW	Sig/nonsig
Chinese export(x_1)	0.527%	0.31	4.92	1.41	sig
Chinese import(x_2)	0.48%	0.439	6.38	0.46	sig
Chinese CPI(x_3)	0.191%	0.91	24.09	0.41	sig
GDP index(x_4)	$-2.23e^{-05}$%	0.00022	-0.107	1.28	nonsig
Foreign exchange reserves excluding gold(x_5)	0.078%	0.525	7.662	0.277	sig

Note: n=54.

But, the better significant and relevant observations were found from the nonlinear trend lines of those macro fundamentals of China because in the long run they are usually cyclical. Chinese export(x_1) is initially upswing followed by downswing and upswing. The similar behaviours were observed in the cases of import, GDP index and foreign exchange reserves but the CPI is initially declining followed by upswing and downswing during the survey period. All the t values of the coefficients of the phases are significant at 5% level (marked by *) showing high values of R^2, F and DW.

[a] Trend line of export

$\text{Log}(x_1)=5.133+0.0298t-0.00136t^2+1.87e^{-05}t^3+u_i$

(84.52)*(3.15)* (-3.43)* (3.92)*

$R^2=0.53$, F=18.81*, DW=2.048, n=54,

[b] Trend line of import

$\text{Log}(x_2)=4.8701+0.0412t-0.00175t^2+2.23e^{-05}t^3+u_i$

(156.02)*(8.46)* (-8.59)* (9.11)*

$R^2=0.79$, F=66.02*, DW=1.23, n=54

[c] Trend line of CPI

$\text{Log}(x_3)=4.638-0.00050t+0.00011t^2-1.52e^{-06}t^3+u_i$

(1004.67)*(-0.69) (3.91)* (-4.18)*

$R^2=0.94$, F=264.22*, DW=0.56, n=54

[d] Trend line of GDP index

$\text{Log}(x_4)=4.587+0.0044t-0.00025t^2+3.56e^{-06}t^3+u_i$

(394.04)* (2.42)* (-3.34)* (3.89)*

$R^2=0.327$, F=8.12*, DW=1.90, n=54

[e] Trend line of foreign exchange reserves

$\text{Log}(x_5)=8.004+0.00504t-0.000209t^2+2.65e^{-06}t^3+u_i$

(1696.73)* (6.97)* (-6.99)* (7.56)*

$R^2=0.79$, F=64.62*, DW=0.59, n=54

Since the macroeconomic indicators and the Yuan per SDR are cyclical then the variables are obviously nonstationary and contain unit root which were verified by using the ADF test statistic and they were accepted as null hypothesis H0=contain unit root and then the first difference series were verified as no unit root all of which have been arranged in the Table 2 below.

Table-2. Unit root test (constant and linear trend).

Variables	ADF t statistic	Prob	Critical Value5%	H0= has a unit root
x_1	-2.6015	0.28	-3.49	accepted
dx_1	-8.406	0.00	-3.50	rejected
x_2	-0.584019	0.9758	-3.49	accepted
dx_2	-10.42212	0.00	-3.49	rejected
x_3	-3.339181	0.0713	-3.49	rejected
dx_3	-5.539374	0.0002	-3.49	rejected
x_4	-4.556519	0.0031	-3.49	rejected
dx_4	-8.061538	0.00	-3.50	rejected
x_5	-1.943954	0.6179	-3.50	accepted
dx_5	-6.864723	0.0000	-3.49	rejected
y	-1.592335	0.7833	-3.49	accepted
dy	-7.605006	0.0000	-3.49	rejected

Note: n=54.

Assuming all the macroeconomic indicators and the Yuan per SDR series contain intercept and linear deterministic trend, then the Unrestricted Cointegration Rank Test among the first difference series of the macro indicators and Yuan per SDR of China during $2017m_1$-$2021m_6$ confirmed that there is one significant cointegrating equation according Trace Statistic. These are shown below in Table 3. So, there is long run association among the macro indicators and Yuan-SDR rate.

Table-3. Cointegration test.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.516355	120.4344	117.7082	0.0332
At most 1	0.436545	82.66143	88.80380	0.1278
At most 2	0.362488	52.83071	63.87610	0.2971
At most 3	0.286952	29.42127	42.91525	0.5367
At most 4	0.155963	11.83452	25.87211	0.8233
At most 5	0.056376	3.017434	12.51798	0.8745
		Max-Eigen Statistic		
None	0.516355	37.77297	44.49720	0.2235
At most 1	0.436545	29.83073	38.33101	0.3367
At most 2	0.362488	23.40944	32.11832	0.3890
At most 3	0.286952	17.58676	25.82321	0.4095
At most 4	0.155963	8.817082	19.38704	0.7431
At most 5	0.056376	3.017434	12.51798	0.8745

Note: * denotes rejection of the hypothesis at the 0.05 level, **denotes (MacKinnon, Haug, & Michelis, 1999) p-values, n=52

The estimated VECM has been done assuming intercept and linear deterministic trend by Maximum Likelihood Method during 2017m04 -2021m06.All the estimated equations of the VECM have been arranged in the Table 4 below where t values of all coefficients are shown in the box brackets in which the marked by star(*) in the superscripts explained significant at 5% level.Since the macroeconomic indicators and Yuan-SDR exchange rate are cointegrated then the estimated VECM suggests that the increment of Yuan per SDR is positively related with the increment of Chinese export in both the lags but not vice versa. The increment of export is positively related with the change of CPI in lag one, the changes of GDP index and foreign exchange reserves for both the lags. The increment of CPI is negatively related with change of export in lag 2 and positively related with the increment of GDP index and foreign exchange reserves of the second periods. The increment of GDP index is positively related with the changes in import of first year and foreign exchange reserves of the second year. All other incremental relationships revealed insignificant.

From the VECM, it was found that the Yuan per SDR has significant long run causalities from the Chinese export, import, consumer price index, GDP index and the foreign exchange reserves excluding gold from $2017m_1$ to $2021m_6$ where the causality between import and Yuan-SDR exchange rate showed negative but other causalities were found positive. All the t statistic of the coefficients were significant and coefficient of y_{t-1} is negative and significant which implies that the cointegrating equation has been converging towards equilibrium at the speed of adjustment of 11.83% per month significantly. The trend line has ensured negative pattern which represents that yuan-SDR rate has been approaching towards favourable position of Chinese economy.

The Cointegrating equation is estimated below and is depicted in Figure 6.

$$Z_{t-1}=-0.1183y_{t-1}+0.0147x_{1t-1}-0.0236x_{2t-1}+0.2059x_{3t-1}+0.1903x_{4t-1}+0.00584x_{5t-1}-0.0567t-66.397$$
$$(-2.86)^*\quad (2.18)^*\quad (-4.12)^*\quad (2.89)^*\quad (2.23)^*\quad (3.19)^*\quad (-3.56)^*$$

Table-4. Estimated VECM.

Error Correction:	d(y)	d(x_1)	d(x_2)	d(x_3)	d(x_4)	d(x_5)
CointEq1	-0.118445	-35.78264	12.81625	0.265329	-2.387169	7.422570
	[-2.83848]*	[-3.94303]*	[3.13414]*	[0.99526]	[-2.70375]*	[0.82697]
d(y_{t-1})	-0.061818	25.32922	-6.098334	1.024884	2.974284	-43.88689
	[-0.45119]	[0.85007]	[-0.45420]	[1.17085]	[1.02598]	[-1.48917]
d(y_{t-2})	0.189196	-30.81657	-2.143518	0.278529	-0.371577	-11.92040
	[1.30605]	[-0.97817]	[-0.15099]	[0.30095]	[-0.12123]	[-0.38256]
d(x_{1t-1})	0.001949	-0.535543	-0.133222	-0.012134	0.027677	-0.067577
	[2.17083]*	[-2.74254]*	[-1.51404]	[-2.11517]*	[1.45683]	[-0.34989]
d(x_{1t-2})	0.002275	-0.335475	-0.036420	-0.006996	0.003372	-0.049547
	[2.62408]*	[-1.77914]*	[-0.42864]	[-1.26301]	[0.18379]	[-0.26567]
d(x_{2t-1})	0.000455	0.637199	-0.260526	0.004351	0.052700	-0.219380
	[0.30954]	[1.99249]*	[-1.80789]*	[0.46317]	[1.69379]*	[-0.69358]
d(x_{2t-2})	0.002003	0.288005	-0.082441	-0.012515	0.037220	-0.016575
	[1.30611]	[0.86349]	[-0.54853]	[-1.27726]	[1.14700]	[-0.05025]
d(x_{3t-1})	0.022373	4.255503	-2.680576	0.418908	-1.254790	-12.48090
	[0.76373]	[0.66798]	[-0.93377]	[2.23833]*	[-2.02445]*	[-1.98077]
d(x_{3t-2})	-0.051903	13.86255	-2.185877	0.050129	1.015980	-10.45832
	[-1.66601]	[2.04604]*	[-0.71597]	[0.25186]	[1.54128]	[-1.56067]
d(x_{4t-1})	-0.000855	9.415717	-1.566472	0.139610	-0.373733	-0.058135
	[-0.06826]	[3.45708]*	[-1.27638]	[1.74489]*	[-1.41040]	[-0.02158]
d(x_{4t-2})	-0.003883	7.063854	-0.815068	0.030581	0.091520	-1.505641
	[-0.32885]	[2.75111]*	[-0.70447]	[0.40542]	[0.36636]	[-0.59288]
d(x_{5t-1})	-0.001247	0.300953	-0.070481	0.014957	0.006517	-0.074321
	[-1.51996]	[1.68667]*	[-0.87660]	[2.85337]*	[0.37540]	[-0.42114]
d(x_{5t-2})	-0.000725	0.612712	0.146678	0.001669	0.030904	-0.079485
	[-0.86773]	[3.37107]*	[1.79092]*	[0.31266]	[1.74765]*	[-0.44215]
C	-0.001203	-6.158764	3.107198	0.071488	-0.224870	9.113573
	[-0.07551]	[-1.77810]*	[1.99081]	[0.70258]	[-0.66730]	[2.66028]*
R-squared	0.458375	0.674420	0.459898	0.477095	0.616853	0.384546
F-statistic	2.408685*	5.895632*	2.423504*	2.596812*	4.582203*	1.778327*
Log likelihood	60.99945	-213.4873	-172.8324	-33.58232	-94.65511	-212.9264
Akaike AIC	-1.843116	8.921072	7.326762	1.865973	4.260985	8.899073
Schwarz SC	-1.312811	9.451377	7.857067	2.396278	4.791290	9.429379

Note: n=51(after adjustment).

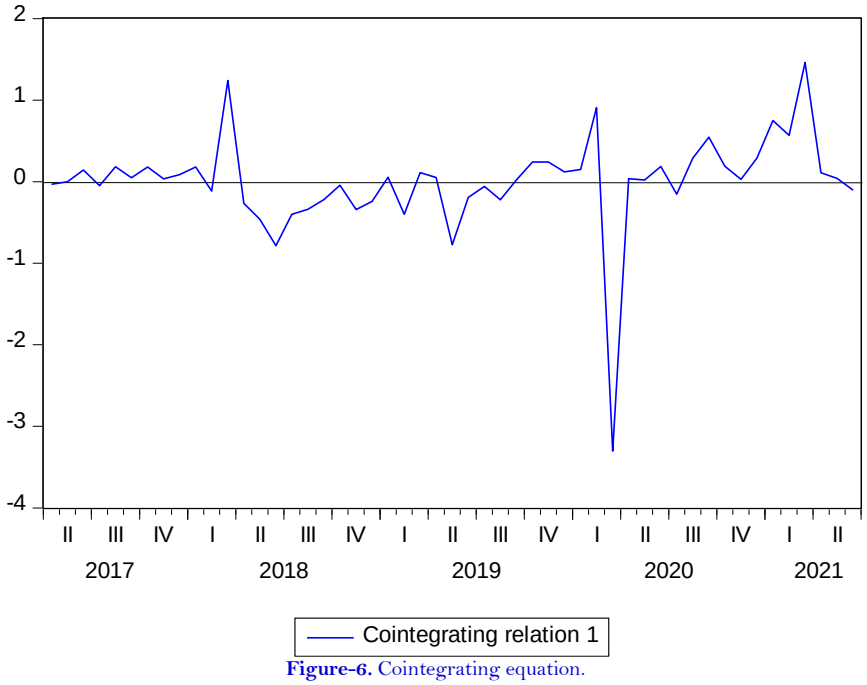


Figure-6. Cointegrating equation.

The System equation is estimated by the Method of Least Squares through Gauss-Newton / Marquardt steps and using the Wald Test during 2017m04 - 2021m07 after adjustment, the short run causalities have been arranged

in the Table 5 below. It is found that Yuan per SDR has significant causality with Chinese export which has also created short run causalities from CPI, GDP index and foreign exchange reserves respectively. Moreover, GDP index has bidirectional short run causality with CPI which has also ensured causality with foreign exchange reserves in the short run.

Table-5. Short run causality.

Causality from …… to ……	Chi-Square(2)	prob	F value	prob	H0=no causality
Causality from export to yuan per SDR	7.523953	0.0232	3.7619(2,38)	0.0323	rejected
Causality from CPI to export	5.253236	0.0723	2.6266(2,37)	0.0808	Rejected 10% level
Causality from GDP index to export	12.633	0.0018	6.3166(2,37)	0.0044	rejected
Causality from forex to export	14.116	0.0009	7.0582(2,37)	0.0025	rejected
Causality from GDP index to CPI	8.2253	0.016	4.1126(2, 37)	0.0244	rejected
Causality from CPI to GDP index	5.5699	0.061	2.784(2, 37)	0.074	Rejected at 10%
Causality from CPI to forex reserves	7.990	0.018	3.995(2, 38	0.026	rejected

Note: H0=null hypothesis, n=51(after adjustment).

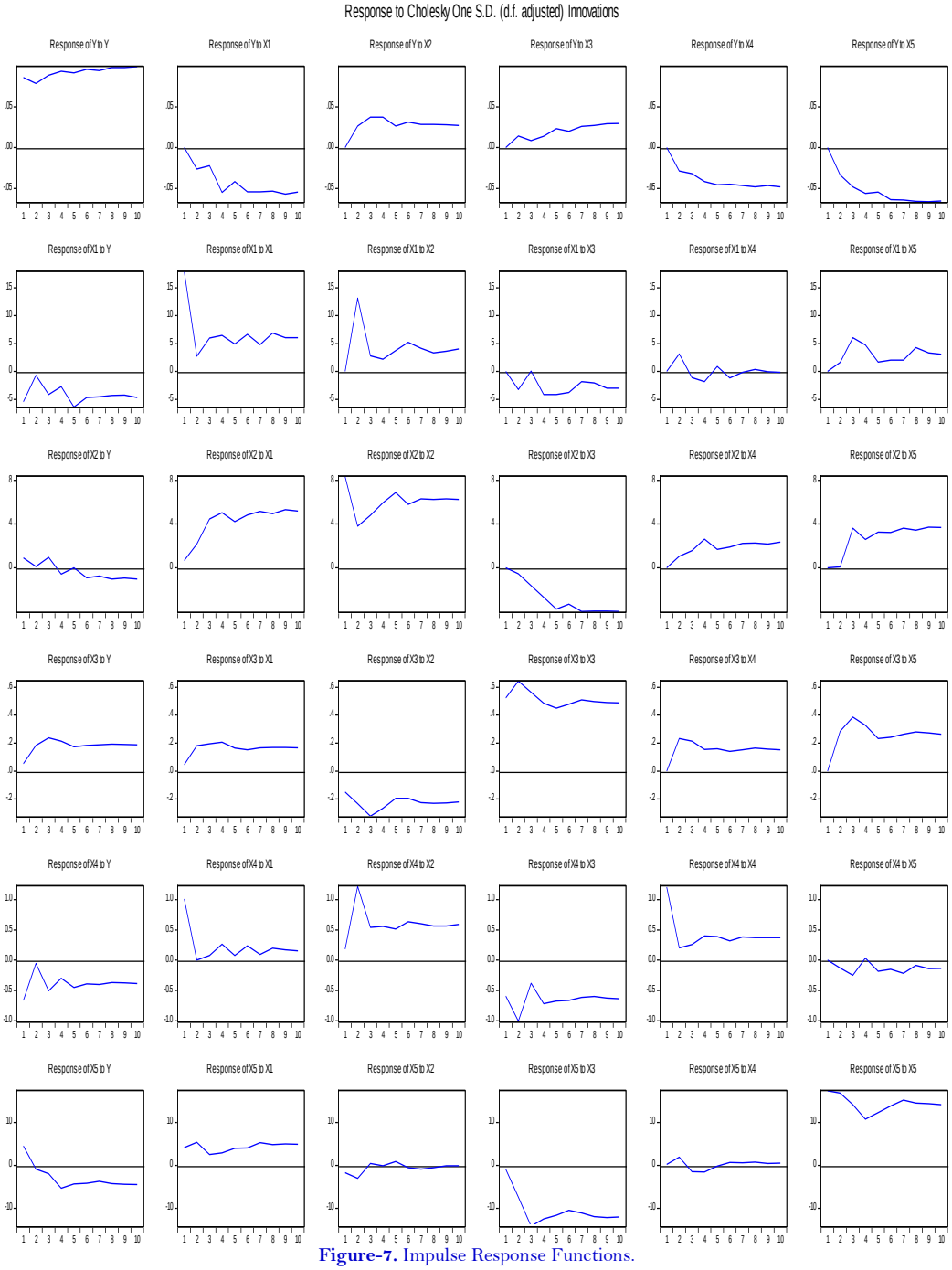


Figure-7. Impulse Response Functions.

The impulse response functions measured by Cholesky one standard deviation innovations suggest that the response of import to yuan per SDR has reached equilibrium at 1.5 years, 3years and 4.5years and then moved away. The response of foreign exchange reserves to Yuan per SDR reached equilibrium at 1.5 years then diverged. The response of GDP index to export reached equilibrium at 1.5 years and then moved away. The response of foreign exchange reserves to import reached equilibrium after 2 years,3.5 years,4.5 years and 8 years respectively and then turned around the equilibrium. The response of export to CPI reached equilibrium at 2.5 years and then diverged. The response of export to GDP index attained equilibrium after 2years,4 years, at 5 years and 6.5 years successively then passed around the equilibrium. The response of foreign exchange reserves to GDP index attained equilibrium after 2 years and 4.5 years and then moved around the equilibrium. The response of GDP index to foreign exchange reserves approached towards equilibrium at 3.5 years and then diverged. All the impulse response functions have been shown in the Figure 7.

The VECM contains 18 roots in which the number of unit root is one,number of complex roots are fourteen and the number of real roots are three which are less than one.So that the model is nonstationary and stable. The values of roots are given in the Table 6.

Table-6. Values of roots.

Roots	Modulus
1.000000	1.000000
1.000000 - 5.09e-16i	1.000000
1.000000 + 5.09e-16i	1.000000
1.000000 - 4.30e-16i	1.000000
1.000000 + 4.30e-16i	1.000000
-0.600563 + 0.374097i	0.707548
-0.600563 - 0.374097i	0.707548
0.682639	0.682639
-0.670252	0.670252
0.207899 - 0.622517i	0.656315
0.207899 + 0.622517i	0.656315
-0.352895 - 0.513036i	0.622688
-0.352895 + 0.513036i	0.622688
0.341485 - 0.387162i	0.516243
0.341485 + 0.387162i	0.516243
-0.051625 + 0.497082i	0.499755
-0.051625 - 0.497082i	0.499755
-0.293350	0.293350

Since all the roots lie on or inside the unit circle, then the model is said to be a stable one.The unit circle containing roots has been depicted in Figure 8.

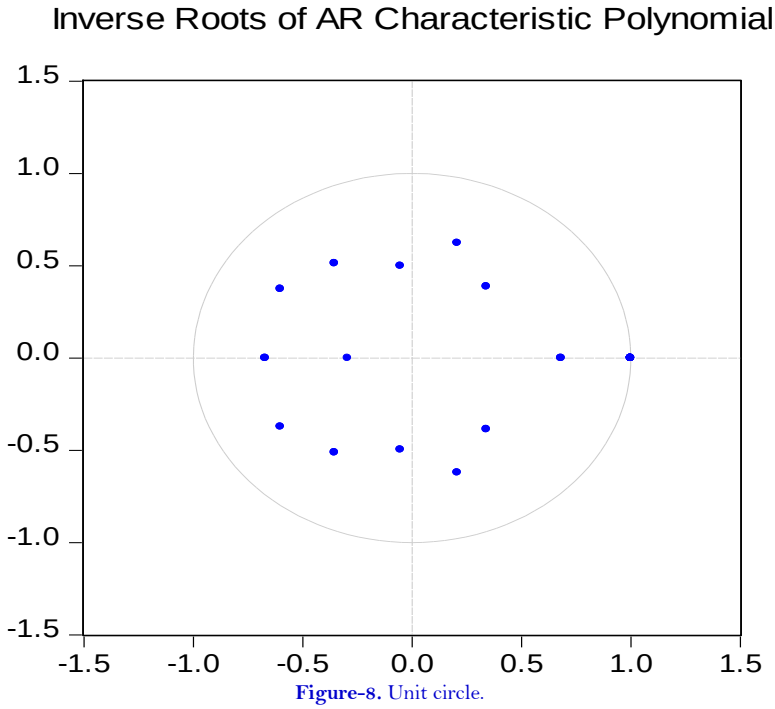


Figure-8. Unit circle.

Once again, the residual test for VECM contains autocorrelation problem which are shown by both the vertical positive and negative bars with ±2 SD bounds among the variables which are clearly visible in the Figure 9 below.

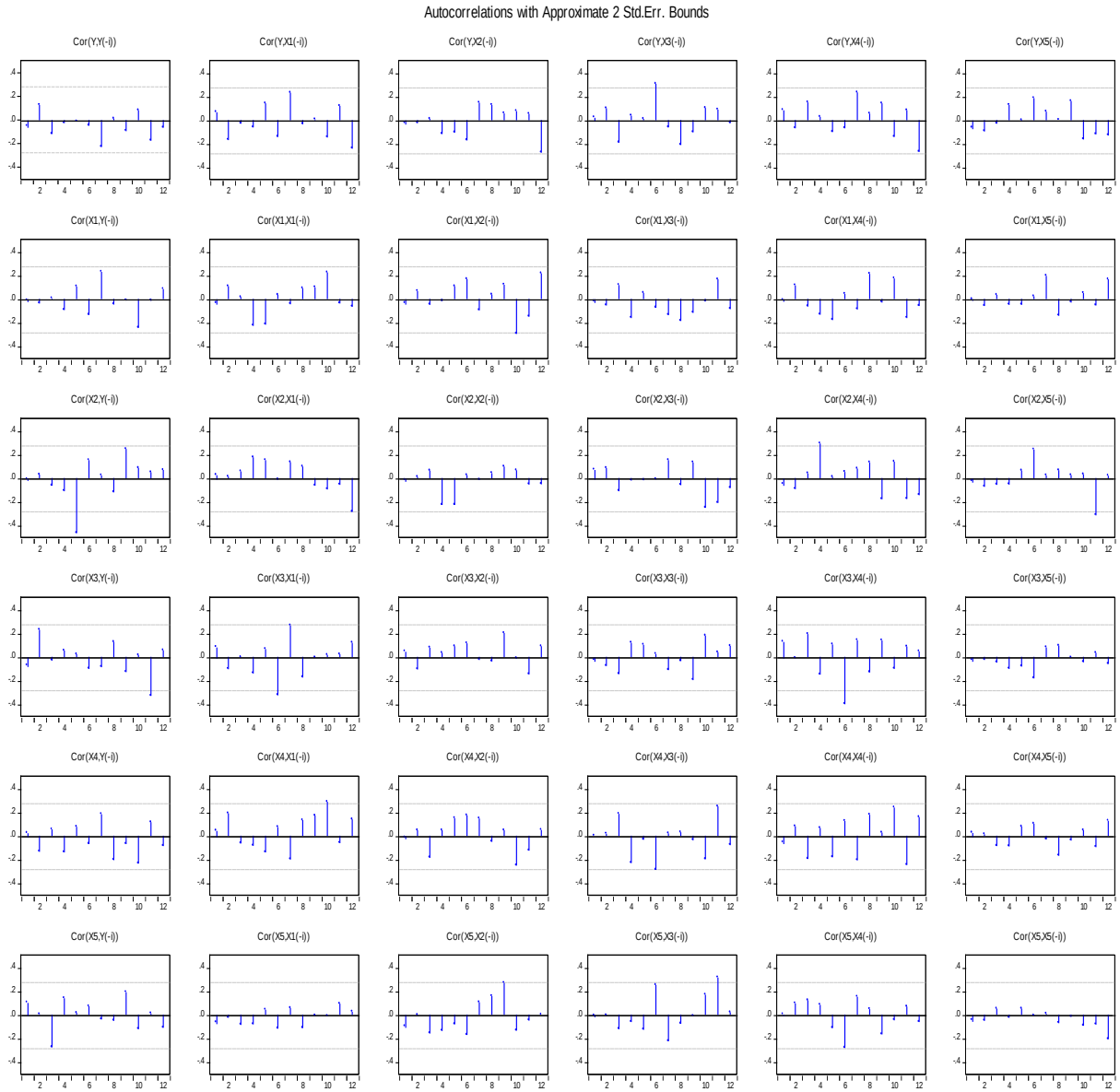


Figure-9. Problem of autocorrelation.

5. LIMITATIONS AND FUTURE SCOPE OF RESEARCH

The paper suffers from a few limitations too. The data on foreign direct investment was not incorporated as the influencing variable due to non-availability of monthly data. With the same reason,the data on the interest rate, money supply and bond yields were not included which had hindered the additional scope of analysis. Therefore, the paper has ample scope for future research in these areas.

6. POLICY IMPLICATIONS

According to the observations of the model, the long-term policy measures require to control inflation rate which needs monetary and fiscal policies and other related policies demand boosting for macro-fundamentals in the course of depreciation of RMB phases. Even, in the appreciation phases capital control are required. In the short run, boosting of export, GDP and domestic price stability must be appropriate policies to ensure short run causalities.

The other general policies which are indirectly related with the model have been incorporated from the opinions of the economists.

Eichengreen and Kawai (2014) suggested that the PBOC should be more independent, raising accountability and transparency of policy making, and democratizing the political regime.

Ryan (2017) emphasized on the policies of transition from export led investment driven economy to a consumption-based service-oriented economy which will challenge the steering of macroeconomic and structural policies otherwise RMB would be undermined.

Subacchi and Oxenford (2017) recommended that China should take lead in developing yield curve for long run bonds in off-shore market to facilitate effective bond financing of infrastructure.

Wang (2018) suggested some important policies in explaining the risk of RMB internationalization process with a high speed in the course of hegemonic problem such as [i] to adopt flexible exchange rate, [ii] to form laws and regulations to control financial risks contagion, [iii] need better regional cooperation which requires multilateral financial institution that can control capital account liberalisation efficiently to attain financial stability.

Kwan (2018) examined that irrespective of Chinese economic power, it should adopt trinity reform policies such as, [i] liberalisation of capital account transactions, [ii]stable exchange rate policy against US dollar, [iii] accelerating high growth rate. Although, author admitted that USA is still economic super power having its currency as the most acceptable key currency for international transactions in which China has to compete against Euro zone and USA.

Chen and Cheng (2019) also prescribed that China may encourage RMB cross border trade settlement and investment and strengthen monetary and financial co-operation in countries along the Belt and Road Initiative.

Zhang (2020) emphasized on capital market development through the policies of [i] relaxing China's capital outflows[ii] establishing a comprehensive standardized system for technical regulation and [iii] reforming financial institutions to attract foreign investment.

7. CONCLUSIONS

The paper concludes that the trendline of Yuan per SDR is significantly non-linear with three phases during $2017m_1$-$2021m_6$ in which the decomposition of trend and cycle showed one peak in the trend and seven peaks and troughs in the cycle. It is seasonally fluctuated and its ARIMA(2,0,2) process is convergent towards equilibrium reducing variability within 2023m5.The exchange rate of Yuan per SDR is cointegrated with export, import, inflation rate, GDP and foreign exchange reserves from $2017m_1$ to $2021m_6$.The VECM suggested that the incremental change in Yuan SDR is positively related with the increment of export and it has significant long run causalities from export, import, inflation rate, GDP and foreign exchange reserves respectively in which its cointegrating equation converged towards equilibrium with the speed of adjustment of 11.83% per month. Even, there is significant short run causality between Yuan SDR rate and export. The responses of import and foreign exchange reserves to Yuan per SDR had significant economic implication where the former is convergent and the latter is divergent. The VECM appers to be nonstationary and stable showing autocorrelation problem.

Funding: This study received no specific financial support.
Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
Acknowledgment: In preparing this paper, Author indebted to all sources of references, the authority of the journal and other well-wishers.

REFERENCES

Bhowmik, D. (2003). *Essays on international money*. New Delhi: Deep and Deep Publications Pvt. Ltd.

Box, G. E. P., & Jenkins, G. M. (1976). *Time series analysis, forecasting and control*. San Francisco: Holden Day.

Brummer, C. (2017). The renminbi and systemic risk. *Journal of International Economic Law*, *20*(3), 447–507. Available at: https://doi.org/10.1093/jiel/jgx026.

Chen, X., & Cheng, X. (2019). The challenge and path choice of RMB internationalization in belt and road initiative undefineds construction. *Journal of Applied Science and Engineering Innovation*, *6*(1), 39-42.

Chow, N. (2021). Understanding China: RMB internationalisation 2.0. DBS Treasurers. Retrieved from: https://www.dbs.com/in/treasures/templatedata/article/generic/data/en/GR/012021/210122_insights_china.xml.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366a), 427-431. Available at: https://doi.org/10.1080/01621459.1979.10482531.

Ding, S., Cui, T., & Zhang, Y. (2020). Incorporating the RMB internationalization effect into its exchange rate volatility forecasting. *The North American Journal of Economics and Finance*, *54*, 101103. Available at: https://doi.org/10.1016/j.najef.2019.101103.

Eichengreen, B., & Kawai, M. (2014). Issues for renminbi internationalization: An overview. ADBI Working Paper No. 454.

Frankel, J. (2012). Internationalization of the RMB and historical precedents. *Journal of Economic Integration*, *27*(3), 329-365.

Germain, R., & Schwartz, H. M. (2017). The political economy of currency internationalisation: The case of the RMB. *Review of International Studies*, *43*(4), 765-787. Available at: https://doi.org/10.1017/S0260210517000109.

Hamilton, J. D. (2018). Why you should never use the Hodrick-Prescott filter. *Review of Economics and Statistics*, *100*(5), 831-843. Available at: https://econweb.ucsd.edu/~jhamilto/hp.pdf.

Horesh, N. (2011). The people's or the world's: RMB internationalisation in longer historic perspective. *Economics Research International*. Available at: https://doi.org/10.1155/2011/161074.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2-3), 231-254. Available at: https://doi.org/10.1016/0165-1889(88)90041-3.

Kurien, J., & Geoxavier, B. Y. (2020). The political economy of international finance: A revised roadmap for renminbi internationalization. *Yale Journal of International Affairs. Retrieved April*, *5*(2021), 163-181.

Kwan, C. H. (2018). Issues facing Renminbi internationalization: Observations from Chinese, regional and global perspectives. *Public Policy Review*, *14*(5), 871-900.

Lim, K. F. (2020). RMB internationalisation as an extension of Chinese state capitalism.Developing Economics[Blog post]. Retrieved from: https://developingeconomics.org/2020/04/27/rmb-internationalisation-as-an-extension-of-chinese-state-capitalism/.

Lu, X., & Tansuchat, R. (2021). *The conflicting developments of RMB internationalisation: Contagion effect and dynamic conditional correlation.* Paper presented at the The 7th international conference on Time Series and Forecasting, Gran Canaria, Spain.

MacKinnon, J. G., Haug, A. A., & Michelis, L. (1999). Numerical distribution functions of likelihood ratio tests for cointegration. *Journal of applied Econometrics*, *14*(5), 563-577. Available at: https://doi.org/10.1002/(sici)1099-1255(199909/10)14:5%3C563::aid-jae530%3E3.0.co;2-r.

Maddison, A. (2007). *Contours of the world economy.* NewYork: Oxford University Press.

Ryan, J. (2017). Geopolitical influences on the future of Renminbi. Security Policy Brief -82.EGMONT Royal Institute for International Relation. Retrieved from: http://aei.pitt.edu/86887/1/SPB82.pdf.

Subacchi, P., & Oxenford, M. (2017). The 'Belt and Road' initiative and the London market-the next steps in renminbi internationalization. Research Paper. The Royal Institute of International Affair. Retrieved from: http://www.obela.org/system/files/RENMINBI%202%5B601%5D_0.pdf.

Wald, A. (1943). Tests of statistical hypotheses concerning several parameters when the number of observations is large. *Transactions of the American Mathematical society*, *54*(3), 426-482. Available at: https://doi.org/10.1090/s0002-9947-1943-0012401-3.

Wang, Y. (2018). *A study of the internationalization of the chinese renminbi—to access its risks.* Master Thesis. Aalborg University, China and International Relations.

Wu, T., & Tang, R. (2018). *Research on the influencing factors of RMB internationalization in the process of the belt and road initiative.* Paper presented at the Proceedings of the 2018 2nd International Conference on Management, Education and Social Science.(Series:Advances in Social Science, Education and Humanities Research,176).

Xia, S. (2018). Path Selection of Renminbi (RMB) Internationalization under "The Belt and Road"(B & R) Initiative. *American Journal of Industrial and Business Management*, *8*(03), 667-685.

Zhang, M. (2015). Internationalization of the Renminbi: Developments, problems and influences. Paper No-2,Centre for International Governance Innovation. New Thinking and the New G 20 Series.

Zhang, X. (2020). *Analysis on the obstacles for China to become a financial superpower.* Paper presented at the E3S Web of Conferences 214, 02008.