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China's Belt and Road Initiative and the Rise of Yuan – Evidence from Pakistan

Jamshed Y. Uppal* **and Syeda Rabab Mudakkar****

Abstract

The Chinese yuan is poised to become an international currency and play a major role in global finance which will have significant consequences for countries, like Pakistan, which have recently seen large inflows of the Chinese capital. This paper presents empirical evidence of the evolving nature of the yuan, as reflected in the statistical distribution of the exchange rate, with a particular focus on the period after the initiation of Belt and Road Initiative (BRI) projects. We observe that the currency's empirical distribution exhibits tell-tale characteristics of a managed currency. Over time, though the yuan's statistical properties have converged towards those of other hard currencies, they still remain distinct. We find that there is a long-term trend of increasing correlations over time as indicated by the Dynamic Conditional Correlations (DCC), which is pronounced in the post BRI period. Furthermore, the yuan is increasingly being influenced by other major currencies in the recent periods, indicating increasingly integration of the currency in global foreign exchange markets. This article discusses the implications of the rise of the yuan for the management of Pakistan's foreign currency reserves and exchange rate: it should be driven by the yuan's evolving convertibility, credibility and liquidity.

Keywords: International currency, global finance, yuan, Pakistan.

JEL Classifications: F31, F39.

1. Introduction

The Chinese yuan is poised to become an international currency and play a major role in global finance, competing with other hard

* Associate Professor of Finance, Busch School of Business and Economics, Catholic University of America, Washington DC. USA. Email: uppal@cua.edu;
** Assistant Professor, Lahore School of Economics, Centre for Mathematics & Statistical Sciences. E-mail: drrabab@lahoreschool.edu.pk

currencies to serve as a reserve currency, an intervention currency and a settlement currency. China's "One-Belt-One-Road" initiative (OBOR), later renamed as the Belt and Road Initiative (BRI), feeds into and strengthens this emerging role of the renminbi (CNY)[1]. Since the China-Pakistan Economic Corridor (CPEC), a major part of BRI, is expected to considerably increase the financial flows between the two countries, the rise of the renminbi (RMB) carries significant implications for the management of Pakistan's foreign currency reserves and exchange rate. In this paper we study how the yuan has evolved over time vis-à-vis other hard currencies, and how it has been affected by CPEC projects. The analysis provides policy implications for the management of the Pakistan's foreign exchange.

The renminbi is being used increasingly in settling cross-border trade and financial transactions, areas in which the US dollar has so far held the dominant position. Park (2016) reviews the reasons behind renminbi internationalization and highlights the Chinese government's strategy. At present, around 62 percent of China's foreign exchange reserves are denominated in USD and 20 percent are in EUR, which is in line with reserves holdings of other emerging market countries (Drut et al., 2016). The People's Bank of China (PBoC) has started to diversify its FX reserves by holding other currencies with a particular emphasis on Asian currencies. Also, the yuan is becoming an increasing component of foreign exchange reserves around the world, as a growing number of central banks and sovereign wealth funds include renminbi reserves and investments. Drut et al. (2016) suggest that the yuan already serves as an anchor currency for several countries. Shu, He, and Cheng (2014) present empirical evidence of the renminbi's growing influence in the Asia-Pacific region. Their findings also suggest that China's regional influence is increasingly transmitted through financial channels. Patel (2016) finds that the yuan has become a reference currency rivaling the US dollar in East Asia within the past decade and indicates that export similarity plays a major role in increasing regional currency influence.

[1] "renminbi" and "yuan"—are used interchangeably, the former is the official currency of the People's Republic of China and the latter is the name of the unit in which renminbi transactions are denominated. Yuan also refers to the currency generally. Its international symbol is CNY (or CNH in Hong Kong; but abbreviated RMB, with the symbol ¥).

The IMF's decision to include the renminbi (RMB) in the SDR basket effective October 1, 2016 not only symbolizes worldwide recognition of Chinese yuan as an international currency, but also carries implications for international finance. This decision boosted the credibility of the yuan and global demand for the Chinese currency (Hongcai, 2015). As a result, the share of the yuan as a reserve currency held by the foreign central banks will necessarily increase. Given that a current-account deficit is unlikely for China in the short run, it is inevitable that the yuan will continue to flow abroad through capital account deficits. On the other hand, Wang (2015) argues that "the inclusion of the Chinese currency in the SDR basket may well play a facilitating role in China's financial liberalization, but it does not in itself transform the yuan into a global reserve currency."

The emergence of the yuan as an international currency is likely to have major consequences particularly for countries with large inflows of the Chinese capital, as in the case with Pakistan under CPEC. The internationalization of the yuan will challenge the capacity of these countries to steer macro-economic policies and to manage financial risks. Drut et al. (2016) argue that "the USD never had a real contender in the past, and a tripolar system (USD, EUR and CNY), more precisely a system of competing international currencies, may be unstable during some periods." This instability arises essentially due to the capacity and incentives for investors, including the central banks, to shift the composition of their international portfolios and FX reserves. Park (2016) considers the ramifications of yuan internationalization and foresees the dawn of a multi-polar monetary system, whether or not the yuan would replace the dollar as the leading reserve currency.

This article presents empirical evidence on the evolving nature of the yuan, as reflected in the statistical distribution of the exchange rate, in particular since the initiation of BRI projects. The paper is organized as follows. Section 2 traces the regulatory developments in currency management by the Chinese authorities, which have facilitated a larger role of the currency in international finance. Section 3 begins with a description of the methodology and the data used in our empirical analysis. Section 4 presents descriptive statistics and presents the findings from the empirical exercise. The final section discusses the results and

draws implications for the management of exchange rates and foreign exchange risk from Pakistan's standpoint.

2. Renminbi Internationalization

China has moved towards greater exchange rate flexibility since 1994 when the multiple exchange rates for the renminbi were unified, and the yuan became fully convertible. More significantly, in July 2005 the People's Bank of China (PBoC) announced that China would implement a managed floating exchange rate system based on a basket of currencies, instead of pegging the yuan to the US dollar. The daily trading band against the US dollar has been progressively widened since then, from ±0.3to ±0.5 percent in May 2007, to ±1 percent in April 2010 and to ±2 percent in March 2014. In November 2013 the PBoC Governor announced that the central bank would withdraw over time from regular intervention in the market. At the same time, in July 2009 the Chinese authorities started facilitating the use of renminbi outside mainland China, by removing restrictions on the use of the renminbi in current account transactions (cross-border settlements) and gradually liberalizing its use in capital account transactions. Broader sources of offshore funds have been allowed for capital transactions, e.g., overseas direct investment in the renminbi by Chinese enterprises from 2011 and relaxation of rules to make offshore lending easier for the mainland banks. Bilateral local currency swap facilities have also been set up with overseas central banks and monetary authorities, which support the international use of the renminbi and provide a contingent source of liquidity.

The use of offshore renminbi has been officially sanctioned for a wider variety of transactions, such as in the onshore interbank bond market, foreign direct investment, and the renminbi Qualified Foreign Institutional Investor (R-QFII) scheme.[2] Technical measures have also been implemented to further market development. In June 2011, spot fixing for the offshore renminbi exchange rate was launched in Hong Kong SAR. In June 2013 interbank interest rate fixing for the renminbi (CNH- HIBOR), the first offshore renminbi interest rate benchmark, was introduced. These

[2] Under the scheme, Hong Kong-based brokerage firms could offer renminbi investment products to non-Chinese residents that are invested in onshore bond and stock markets.

measures have facilitated the development of renminbi products such as syndicated loans and cross-currency swaps, and vibrant offshore renminbi markets have emerged. Renminbi offshore centers are now well established in London, Singapore and other locations. As of June 2017, the PBoC has designated 23 official renminbi clearing and settlement banks around the world. Because of the rapid internationalization of the renminbi, according to the Society for Worldwide Interbank Financial Telecommunication (SWIFT),it became the world's 8th most traded currency in 2013, rising to the 5th position by 2015. On October 1, 2016, the yuan became the first emerging market currency to be included in the IMF's special drawing rights basket, the basket of currencies used by the IMF (reserve currency).

Maziad and Kang (2012) found that foreign access to yuan-denominated assets that could act as global stores of value remained limited due to extensive restrictions on capitals flows. However, they find that "the rapid expansion of RMB [yuan] trade settlement and issuance of RMB-denominated bonds by the Chinese government and corporates in Hong Kong SAR have created some feedback channels across onshore (CNY) and offshore (CNH) RMB markets." They also find evidence of volatility spillovers between the onshore (CNY) and offshore (CNH) yuan markets. Overtime, those spillover channels would be expected to grow as the offshore market further develops.

The most recent phase in the internationalization of the yuan was set into motion with the announcement of the "One Belt One Road Initiative" (OBOR) in September 2013 by China's President Xi Jinping. In 2014, the Silk Road Fund was established followed in 2015 by the Asian Infrastructure Investment Bank (AIIB). These initiatives are intended to play a significant role in financing infrastructure projects in sixty-eight countries. OBOR projects are to lead to increasing Chinese overseas investments and also to influence the selection of the currency used in those transactions.

Internationalization of the renminbi (CNY) has far-reaching implications for economic integration between China and its partners in the Belt and Road Initiative. For example, Fan at el. (2017) argue that yuan swap agreements are beneficial for economic integration between China and the Belt and Road countries through facilitating bilateral trade. This carries implications for Pakistan's economy and its foreign exchange policies, since CPEC is a pivotal element in China's BRI.

3. Methodology and Data

a) Methodology:

The exchange rate structure of the yuan has transitioned from a fixed-rate regime to a free-floating regime. We first note from the extant empirical research, that "… there are substantial and systematic differences in the behavior of real exchange rates under these two nominal exchange rate regimes;" Mussa (1986). Genberg and Swoboda (2004) further document that the "properties of the frequency distribution of changes in exchange rates are different in countries that announce that they are following a fixed exchange rate regime compared to countries that are officially floating." More interestingly, the authors note that the properties of the tails of the distributions are different for the two foreign exchange regimes, i.e., the *de jure* fixed category contain a higher frequency of large exchange rate changes (of either sign) compared to the *de jure* float category. There is also a growing divergence between the *de facto* and *de jure* exchange rate regimes followed by the central banks - most countries now follow a *dirty float*.

Secondly, as Engel and Hakkio (1993) explain, the system of fixed but adjustable rates introduces a new kind of volatility: volatility caused by expectations of exchange rate realignments. By eliminating the market's uncertainty about the future exchange rate, a system of fixed exchange rates reduces *normal* volatility. However, when the rates are fixed but adjustable, the market knows that realignment may occur, the speculation around the magnitude and timing of the realignment will exacerbate exchange rate volatility. Therefore, between realignments the exchange rate volatility will tend to be within normal limits, but around the time of realignments it can be extreme. If the equilibrium rate continues to trend upward or downward, then the likelihood of realignment increases, as do incidences of extreme volatility. Therefore, we focus on the standard deviation and kurtosis of the distributions; the former denoting normal volatility and the later denoting extreme changes injected by realignment of the exchange rate under managed regimes. The managed regimes are characterized by relatively low standard deviation, but large kurtosis.

Huang, (2016) finds that the USD/CNY exchange rate exhibits very different patterns in different periods, differing wildly from one period to another in response to the economic reforms and changes in policies. Different statistical models seem to perform well for describing and forecasting currency dynamics in different periods. Our research focuses on the statistical distributions and the time-series properties of the yuan exchange rate, in comparison to the Pakistan rupee (PKR) exchange rate against four hard currencies, i.e., US dollar (USD), euro (EUR), British pound (GBP) and Japanese yen.

b) Study Period and Data:

The time period for the study starts after the Asian currency crisis of the late 1990's. The full sample period spans from January 1999 to August 2018, whereas the comparative analysis is conducted on three sub-periods. Period 1 spans the post-global Financial crisis from July 2009 to June 2012 when the yuan was managed under a floating exchange rate regime. The period consists of 783 daily observations with gaps. Period 2 consists of July 2012 to June 2015 when the yuan was transitioning to the free-floating regime and the central bank was gradually withdrawing from intervention in the foreign exchange market. We call it the Pre-BRI period; it consists of 782 daily observations. Period 3 spans from July 2015 to August 2018 when yuan internationalization was pushed through Belt and Road Initiative/CPEC projects. We call it the BRI period (806 daily observations). The "returns" are measured as the first log differences of the exchange rate series i.e.:

$$R_{t,EUR} = \ln((EUR/PKR)_t / (EUR/PKR)_{t-1})$$

$$R_{t,USD} = \ln((USD/PKR)_t / (USD/PKR)_{t-1})$$

$$R_{t,GBP} = \ln((GBP/PKR)_t / (GBP/PKR)_{t-1})$$

$$R_{t,JPY} = \ln((JPY/PKR)_t / (JPY/PKR)_{t-1})$$

$$R_{t,CNY} = \ln((CNY/PKR)_t / (CNY/PKR)_{t-1})$$

The purpose of converting exchange rates into geometric returns is to achieve stationarity, which is confirmed by the results of the Augmented Dickey-Fuller tests (ADF) as reported in Table-1.

Table 1: Augmented Dickey-Fuller Test (ADF)

R_t	EUR	USD	GBP	JPY	CNY
Chi-Squared-Statistic	-74.599***	-78.129***	-72.894***	-77.312***	-66.641***

Note: The null hypothesis assumes that the series has a unit root and *** indicates rejection of the null hypothesis at 1 percent level of significance.

Since the risks related to a foreign currency are reflected in the statistical distribution and time-series dynamics of the exchange rates, we examine the foreign exchange behavior estimating three different aspects: (i) Conditional Volatility (ii) Dynamic Conditional Correlation (iii) the influence of hard-currencies on the yuan.

i) Conditional Volatility

Time-varying volatility was first modelled as an Autoregressive Conditional Heteroskedasticity, ARCH (q), process (Bollerslev et al., 1992), which relates time t volatility to past squared returns up to q lags. The ARCH (q) model was later expanded to include dependencies up to p lags of past volatility. The expanded model, the Generalized Autoregressive Conditional Heteroskedasticity, the GARCH (p,q) model, has become the standard methodology to incorporate dynamic volatility in financial time series (see Poon and Granger, 2003). The auto-correlation of returns is significant in many cases and there is also a need to incorporate the Autoregressive Moving Average, ARMA (m,n), structure in the model. Our analysis of the data leads us to identify the AR(1)-GARCH(1,2) model as sufficient to capture conditional volatility for all currencies except the Chinese yuan where the AR(1)-GARCH(1,1) model seems to be appropriate. The GARCH(1,2) model is described as follows:

$$\sigma_t^2 = w + \alpha_1 \epsilon_{t-1}^2 + \alpha_2 \epsilon_{t-2}^2 + \beta_1 \sigma_{t-1}^2$$

With the necessary and sufficient conditions: $w > 0, 0 \leq \beta_1 < 1, \alpha_1 \geq 0$ and $\beta_1 \alpha_1 + \alpha_2 \geq 0$.

We first check the adequacy conditions (not reported here) over the full sample for all currencies. Next, the selected model is used to compare estimated coefficients across the post-GFC, pre-BRI and BRI time sub-periods and to compute the Dynamic Conditional Correlation, as explained below. The appropriateness of the selected model is supported by an examination of the standardized residuals for all cases. A comparison of the coefficients in the post-GFC, pre-BRI and BRI periods is conducted using the Wald chi-squared statistic by restricting the coefficients in one period in order to examine the suitability of the model in another period.

ii) *Dynamic Conditional Correlation*

A multivariate flexible GARCH model was introduced by Robert Engle in 1982 for analyzing dynamic correlations as well as volatilities. This Dynamic Conditional Correlation model (DCC) estimates the volatilities and correlations in two steps. In the first step, after applying the appropriate GARCH (p,q) models to each series, the standardized residuals from the model are extracted. In the second step, correlations are estimated between the standardized residuals with a smaller number of parameters. The specification of the correlation dynamics is extended to allow for asymmetries. In our study, the variable of interest is Chinese yuan(CNY); therefore, after extracting the standardized residuals from model of each series we compute the dynamic conditional correlation of CNY against the EUR,GBP, USD and JPY.

iii) Influence of hard currencies on the yuan

The influence of the major trading currencies on yuan is examined by ordinary least square estimation. The analysis is conducted separately for the full, post-GFC, pre-BRI and BRI periods. The appropriateness of the model is examined using residual analysis. Finally, the stability of coefficients in post-GFC, pre-BRI and BRI periods is analyzed using the Chow Breakpoint test, which tests for the presence of a structural break in the specified time period.

4. Empirical Results and Discussion

a) Descriptive Statistics

Table2 provides the descriptive statistics of the return series for the full, post-GFC, pre-BRI and BRI sample periods respectively. The average daily return for all series is positive, which reflects devaluation of PKR over the full sample period with respect to the other currencies. However, the rate of the PKR's depreciation has varied in different times, and in the pre-BRI period it has even appreciated against the EUR and JPY. Note that, since we are stating the exchange rate as rupees per unit of foreign currency, a positive change represents a loss in the value of rupee. The exchange rate returns in all five cases do not follow the normal distribution as is evident by the significant values of the Jarque-Bera statistic.

Table 2: Summary Statistics

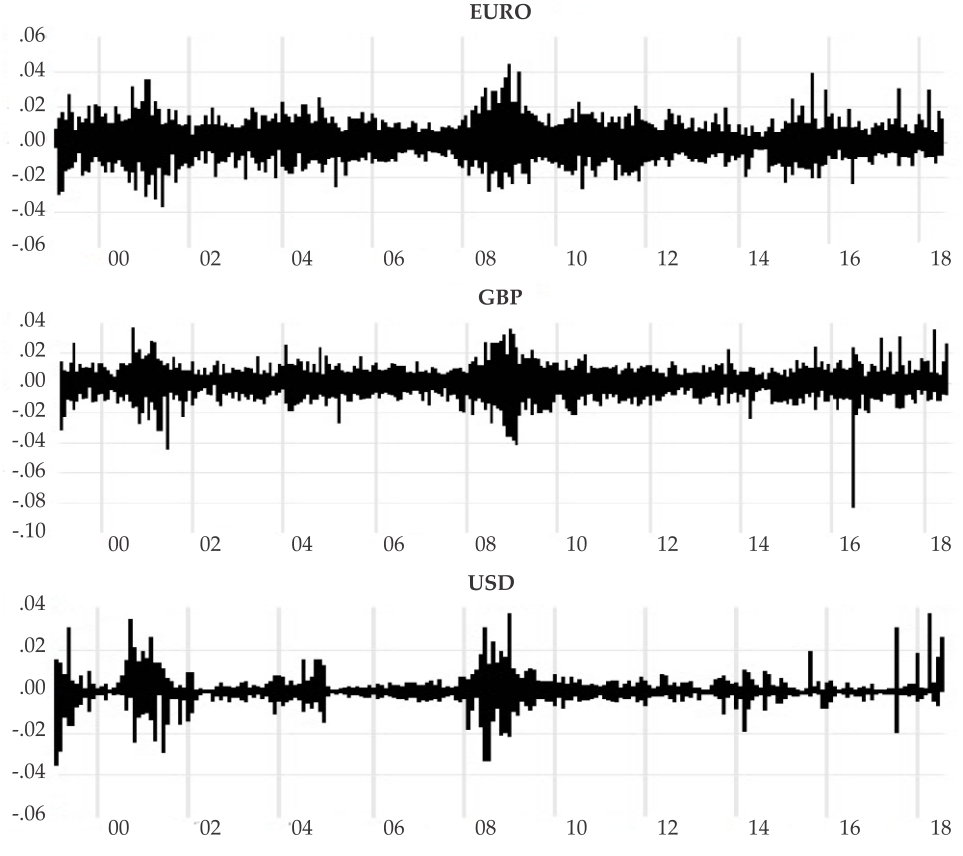
Period	FX	Mean* x1E+4	Max	Min	Std. Dev	Skewness	Kurtosis	Jarque-Bera
Full Sample	EUR	0.180	0.045	-0.050	0.007	0.109	5.977	1889**
	GBP	1.300	0.037	-0.085	0.007	-0.574	11.972	17343**
	JPY	1.800	0.083	-0.083	0.008	0.079	12.784	20299**
	USD	1.700	0.038	-0.054	0.003	0.042	41.745	318244**
	CNY	2.200	0.158	-0.158	0.006	0.027	297.271	18358249**
Post-GFC Period	EUR	1.050	0.040	-0.026	0.008	0.032	3.749	18**
	GBP	2.240	0.033	-0.042	0.008	-0.367	5.125	165**
	JPY	4.200	0.044	-0.036	0.007	-0.247	6.165	335**
	USD	1.820	0.037	-0.021	0.003	1.888	35.027	33930**
	CNY	2.800	0.014	-0.015	0.002	-0.435	8.248	923**
Pre-BRI Period	EUR	-0.701	0.025	-0.023	0.006	-0.125	4.558	81**
	GBP	0.938	0.023	-0.023	0.005	-0.233	4.627	93**
	JPY	-4.600	0.030	-0.029	0.007	-0.140	4.664	93**
	USD	0.938	0.010	-0.019	0.002	-1.724	21.036	10986**
	CNY	1.300	0.012	-0.021	0.002	-1.627	18.147	7821**
BRI Period	EUR	3.000	0.040	-0.050	0.006	0.209	12.502	3038**
	GBP	0.172	0.036	-0.084	0.007	-1.937	28.393	22159**
	JPY	0.180	0.047	-0.054	0.007	0.446	11.600	2510**
	USD	1.300	0.038	-0.054	0.004	-0.757	101.702	327252**
	CNY	1.800	0.037	-0.054	0.004	-0.735	56.163	94890**

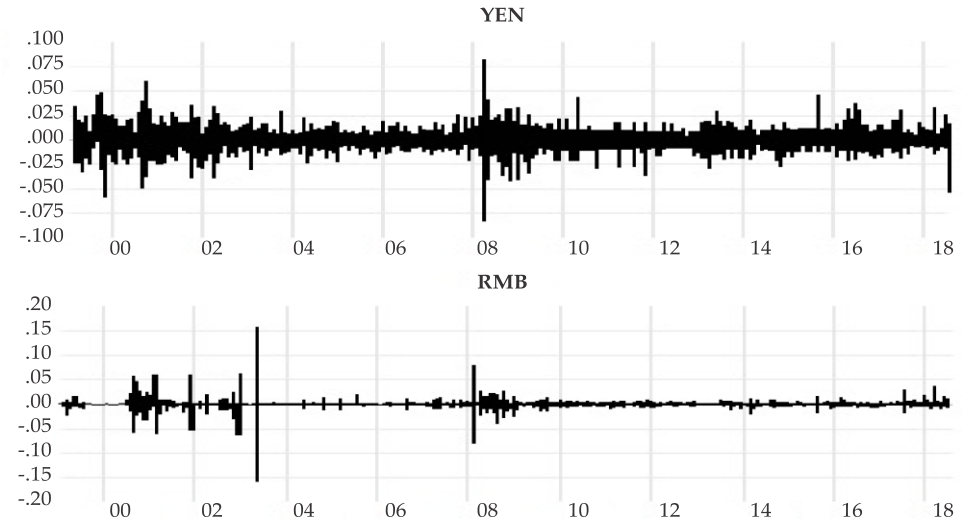
*Note: The null hypothesis of Jarque-Bera test statistic assumes that series follows a normal distribution. *** indicates the rejection of null hypothesis at 1 percent level of significance. We use EVIEWS 10.0 for the analysis.*

It is notable that the standard deviation of the daily exchange rate returns is the lowest for the yuan followed by that for the dollar; these

statistics are almost less than half of the standard deviations for the other currencies (EUR, GBP and JPY). On the other hand, while the returns series in all cases have excess kurtosis (measure > 3), which indicates the presence of outliers in daily exchange rate returns; the kurtosis statistics are the highest for the dollar and the yuan. In particular, the yuan has remarkably high kurtosis over the full sample period, which includes a period for which the currency was fully managed. This pattern is consistent with the observation that the managed exchange rates result in low standard deviation but high kurtosis. The USD/PKR exchange rate fits this pattern as well due to the rate being managed from the Pakistani side, while CNY/PKR exchange rate fits this pattern due to FX management on the part of the Chinese.

Figure 1: Daily Exchange Rate Returns against Pakistani Rupee (PKR)





From Table 2 we also observe that the kurtosis measures increased substantially for all currencies during the BRI sub-period as compared to the previous two sub-periods. The highest value of kurtosis indicates the frequent presence of abnormal daily exchange rate returns. This could be due to a number of extreme adjustments in the PKR exchange rate during the BRI period but may also indicate frequent adjustments in the exchange rate on the part of the Chinese authorities.

b) Empirical Results

i) Dynamics of Volatility

The next step is to estimate the dynamics of the conditional mean and volatility of the exchange rate series, as per the models laid out in the previous section. Figure 1 shows the daily returns for the five exchange rate return series. The graph indicates that large changes tend to be followed by large changes of either sign and small changes tend to be followed by small changes. It implies that the returns are not independent and identically distributed (i.i.d.), and the volatility clustering phenomenon is present in the data, which is also verfied by the correlogram of squared returns (not shown here). This suggests that GARCH models need to be employed to incorporate dynamic volatility.

We report the results of the estimation in Table 3. As explained in the section 3b(i), our preliminary checks on the data lead us to identify the

AR(1)-GARCH (1,2) as the model to sufficiently capture conditional volatility for all currencies except for the yuan (CNY), in which case the AR(1)-GARCH (1,1) model seems appropriate. The Durbin-Watson statistic value (reported in Appendix) lies in the acceptable range in all cases. Although the significant Jarque-Bera statistic and kurtosis estimates indicate departure from normality and the presence of heavy tails in all cases (reported in Appendix), the insignificant p-values of the Autoregressive Conditional Heteroscedasticity-Lagrange Multiplier (ARCH-LM) statistic imply that extracted residuals from suggested models are i.i.d. This means that the suggested volatility models are appropriate and can be used for further analysis. The results are reported in Table 4.

Our estimation of the GARCH models validates our initial assumption and shows that the dynamic volatility process followed by the CNY is quite different from the other hard currencies. It suggests that in the case of the yuan, exchange rate volatility subsides quicker than is the case with the other currencies, and hints at active management of the exchange rate. Comparing the volatility dynamics of the five exchange rate returns, the results imply that, in general, the ambient volatility is highest in the case of the yuan against the Pakistani rupee and the least in the case of USD as indicated by the estimated constant for the full sample period. There are a few exceptions to this observation, for example, in case of EUR in the BRI period, and EUR and JPY in the post-GFC period.

When comparing the pre-BRI and the BRI period, we observe an increase in the ambient volatility during the BRI period for all currencies. The dependence of average returns on its immediate past is highly significant (p-value <0.001) in all cases for the full sample period, but the coefficient on the average daily return is significant only for the USD and the yuan during the pre-BRI and the BRI periods. This result could be due to the increase in circulation of the yuan during the BRI period.

The significant value of the first two coefficients of the ARCH effect indicates that the previous two days' shocks have impacts on the current volatility of exchange rate returns for the full sample period in all currencies, except for the yuan, in which case the coefficient is significant for lag 1 only. The impact of the immediate shock on the current volatility is the highest for the yuan, followed by the USD during the full sample period. Comparing the pre-BRI period, the impact of the last lag on

current volatility is the highest for the USD. However, in the BRI period, the increase in ARCH lag 1 effect is highest for the yuan, followed by the USD. This indicates an increased impact of the yuan on the Pakistani rupee during the BRI period.

Figure 2 presents the conditional standard deviations obtained from the fitted GARCH model for the five exchange rates. It appears that the yuan's conditional standard deviation has followed a different pattern than the other four exchange rates. In the case of the USD, the model indicates that although there are spikes during 2000-2002, 2008-2010 and post-2017, the exchange rate seems to fair better in reverting back to its average variation of around 0.003 (less than EUR). In the case of the yen, we observe fluctuations in volatility throughout the period. On the other hand, in the yuan's case, the average variation is very low, around 0.0005 throughout the sample period. However, the standard deviation seems to shift abruptly with sharp spikes; for example, during 2003 the conditional variation shows a spike of 0.11 and in 2008 approximately of 0.05.

Table 3: Coefficients Extracted from GARCH Analysis

Period	FX	Mean Equation		Variance Equation			
		μ	φ_1	w	a_1	a_2	b_1
		Mean	**1st Lag**	**Constant**	**(ARCH)**	**(ARCH)**	**(GARCH)**
Full Sample	EURO	20.000**	-0.054***	0.020***	0.056***	-0.030	0.970***
	GBP	20.000**	-0.045***	0.029***	0.132***	-0.101***	0.963***
	JPY	9.210	-0.083	0.064	0.104	-0.068	0.955
	USD	9.290***	-0.253***	0.005***	0.378***	-0.354***	0.971***
	CNY	24.000***	-0.142***	1.140***	0.441***		0.249***
Post-GFC Period	EURO	14.000	-0.035	4.390	0.133**	0.044	0.179
	GBP	10.000	-0.072**	0.070***	-0.057**	0.062**	0.976***
	JPY	45.000	-0.057	3.550**	0.034	0.076**	0.252
	USD	10.000	-0.218***	0.017***	0.179***	-0.093*	0.883***
	CNY	31.000***	-0.140***	0.243***	0.124***		0.469***
Pre-BRI Period	EURO	-0.795	-0.046	0.041***	0.118***	-0.080	0.949***
	GBP	10.000	-0.007	0.081	0.112***	-0.073**	0.927***
	JPY	-30.000	-0.106***	0.074***	0.134***	-0.094**	0.942***
	USD	10.000***	-0.092**	0.005***	0.483***	-0.315***	0.858***
	CNY	26.000***	-0.047	0.089***	0.325***		0.516***
BRI Period	EURO	26.000	0.019	3.500***	0.068***	0.217***	-0.171
	GBP	-2.520	-0.061	0.409**	0.404***	-0.318***	0.854***
	JPY	30.000	-0.041	0.369***	0.122***	-0.073**	0.884***
	USD	38.000***	-0.213***	0.299**	0.580***	-0.309**	0.510**
	CNY	22.000**	-0.085*	0.907***	0.668***		0.018

Note: *** and *** indicates significance at 5 and 1 percent level of significance respectively.*

Figure 2: Dynamic Volatility of Exchange Rate return against Pakistani Rupee (PKR)

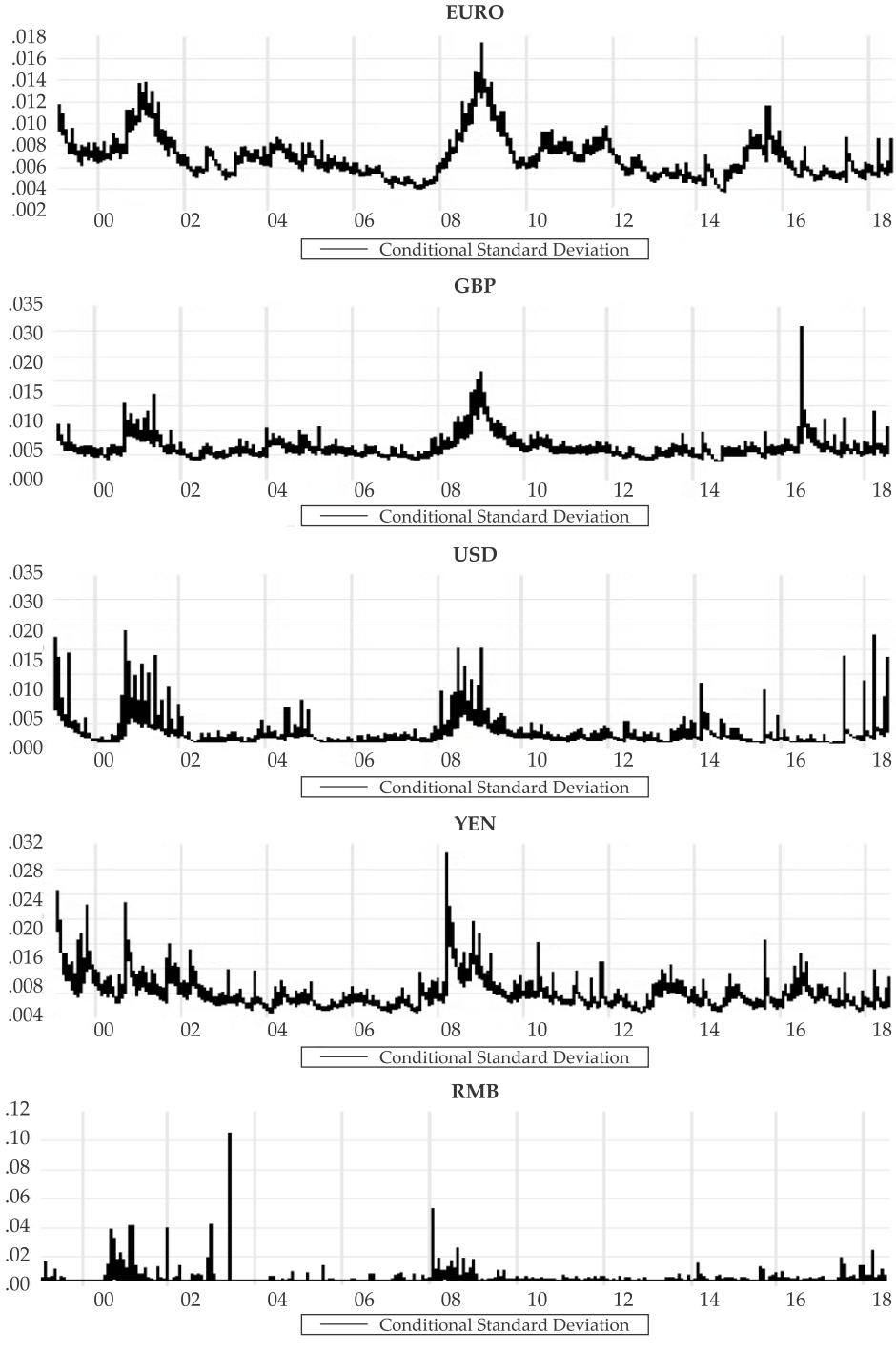


Table 4: ARCH LM residual test

Period	Full Sample	Post GFC	Pre-BRI	BRI
EUR	0.2055	2.5651	0.0443	0.0536
GBP	0.0077	0.0407	0.0069	0.1034
USD	0.0005	0.0115	0.3637	0.0001
JPY	0.0681	0.0307	0.0083	0.0196
CNY	0.0018	0.5006	0.2380	0.0317

Note: *F-statistic values are reported in the cells which test the null hypothesis that the residuals extracted from the fitted models are independent identically distributed (i.i.d.).*

Next, we run Wald tests to examine the stability of coefficients across post-global Financial Crisis, and across the pre-BRI and the BRI period to make comparisons. The results are reported in Table5. We impose the restriction of coefficients being equal in both periods for all cases. We find that, for all currencies, the Wald test statistics reject the null hypothesis that GARCH model coefficients are equal across the periods. This indicates that the estimated coefficients during the pre-BRI period cannot be used during the BRI period. The results underscore the differences in volatility structure during the post-global Financial Crisis period, the pre-BRI-period and the BRI period.

Table 5: Wald Chi Squared Test

	EUR	GBP	USD	JPY	CNY
Post-GFC and Pre-BRI	60.0328***	32.175***	8.997**	6.3330**	40.3507***
Pre-BRI and BRI	10383.4***	331.4364***	38861.16***	108.1362***	109.9875***
Post-GFC and BRI	21841.94***	284.4242***	1529.18***	5.2591**	1169.24***

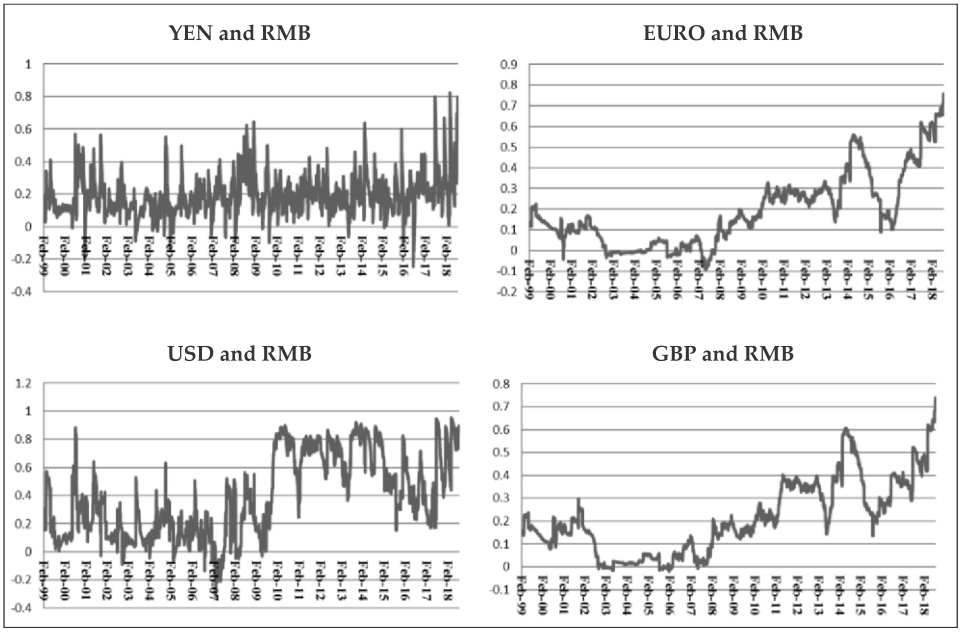
Note: *Chi-squared statistic values are reported in the cells which test the null hypothesis of structural stability of model in one period compared to another period. ** and *** indicate significance, and rejection of null hypothesis at 5 and 1 percent level of significance respectively*

ii) Dynamic Conditional Correlation

Once the univariate GARCH model is fitted, we employ multivariate GARCH models to compute time-varying correlations of the yuan with the other currencies. In the case of yen and yuan, we observe a low positive correlation in the range of 0.2, although there are occasional jumps (as in 2000) when the currency pair correlation jumps to 0.6. Interestingly, in the BRI period we observe that the yen and yuan exhibit strong positive correlations upto 0.8.

In the case of the EUR and CNY, during the 2001-2003 period the currency pairs show decreasing correlation, followed by almost no correlation during the 2003-2007 period. In the following period, 2008-2014, the currency pair correlations steadily increase to 0.60. Then, there is a period of decline in correlations which drop to approximately0.1 in 2014-2015. Finally, during the BRI period the correlations between EUR and CNY are positive and increasing. It points to the emergence of the yuan in the BRI period as an international player, significantly affecting exchange rate movements of the EUR/PKR rate. The correlation behavior of the yuan with GBP is similar to that with the EUR. Until 2003, the correlations are decreasing, reaching almost zero during 2003-2006 but increasing afterwards, until 2014. During 2014-2016, the correlation decreased abruptly but then steadily increased to 0.70 in 2018. This indicates that during the BRI period, the yuan seems to be affecting the GBP/PKR exchange rate. The dynamic conditional correlation between the USD and CNY follows a different pattern. The graph indicates that currency pair correlations exhibit considerable fluctuations throughout the sample period. Interestingly, whenever the correlation exhibits a positive jump, it seems to be followed by a reversion downwards. The phenomenon could also be an indication of the corrective action of China's central bank on the yuan exchange rate. During 2001, there is a positive spike in the pair's correlation to 0.9, but the correlation falls back to about 0.2 in 2002. Similar behavior continues until 2006 with upward and downward spikes. In 2007 we observe a negative correlation between the currency pairs of -0.3, and throughout the Global Financial Crisis (2007-09) period, wide fluctuations in the correlation ranging from 0 to 0.6 are seen. Interestingly after 2009, we observe a structural upward shift in the correlation to a maximum of 0.8 which lasts until 2015. However, in the BRI period, the currency pair-correlations again exhibit an unstable pattern, ranging from 0.2 to 0.95. The increase in correlation post-GFC could be an indication that the yuan is being used increasingly in Pakistan for settling cross-border trade and financial transactions, along with the US dollar.

Figure 3: Dynamic Conditional Correlation



iii) Influence of hard currencies on yuan

Next, we examine how the exchange rate of the Chinese yuan (CNY) is being influenced by major currencies as is explained in section 3b (3). In these models, residuals extracted from the fitted GARCH models are employed in multiple-regressions, with the CNY residuals as the dependent variable. The results of the OLS estimations are reported in Table 5.

During the full sample period, we observe that all hard currencies except EUR have a significant impact on the exchange rate of CNY against PKR. The impact of USD is the highest followed by YEN and GBP respectively. However, only 12.7 percent of the variation of the yuan is explained by three major trading currencies during 1999-2018. Considering the sub-periods, post-global Financial Crisis period (2009-2012), 24.7 percent of the variation in the CNY/PKR rate is explained by USD and YEN only. The impact of USD is the highest followed by YEN, whereas the impact of all other currencies is insignificant. Comparing the pre-BRI and the BRI period results, we observe that during pre-BRI period almost 82 percent of the variation of the CNY is explained by the

USD only (indicated by the only significant coefficient). During the BRI period the impact of USD on CNY remains significant but it is somewhat reduced (coefficient value is 0.8318); however, the coefficients of GBP, EURO and YEN are now also significant. The four currencies together explain 73.3 percent of the variation in the yuan during this period. This points to China's increasing regional influence, which seems to be transmitted through foreign exchange markets after 2015. The values of the Durbin-Watson statistic are tenable in all cases which speak to the appropriateness of the model.

Table 6: Multiple Regression Analysis (Dependent variable CNY)

Independent Variables	Full Sample	Post GFC	Pre-BRI	BRI
Constant	0.0001*	0.0002**	3.55E-05	-0.00011
	(1.6504)	(2.5223)	(0.9524)	(-1.4110)
EUR	-0.0198	0.01256	0.0019	0.0501***
	(-1.3161)	(0.9509)	(0.2112)	(2.6548)
GBP	0.0408**	0.00052	-0.0044	0.0651***
	(2.5268)	(0.0359)	(-0.4019)	(4.6881)
USD	0.3839***	0.3516***	0.9964***	0.8318***
	(14.9547)	(12.3342)	(50.6109)	(30.5486)
JPY	0.1451***	0.05173***	0.0077	0.0352**
	(15.4149)	(4.9095)	(1.2760)	(2.5674)
Adjusted R Sq.	0.1267	0.2466	0.8176	0.7327
No. of observations	5088	783	782	806
Durbin Watson	2.811	2.4503	2.011	1.922

Note: The t-statistic value which tests the significance of the coefficients is reported in parenthesis. *,** and *** indicates the rejection of null hypothesis at 10 percent, 5 percent and 1 percent level of significance.

An important feature of any regression analysis is the stability of its parameters across the given time regime to detect any structural change. The Chow test is commonly used to test for structural change in model parameters where the disturbance term is assumed to be the same in both periods.

Table 7: Chow Breakpoint Test

	Null Hypothesis	F-Statistic	Decision
Post GFC Model Comparison	The impact of major currencies on yuan is the same during regimes 2/1/1999-6/30/2009 and 7/1/2009-8/1/2018.	42.3493***	Rejected
Pre-BRI Model Comparison	The impact of major currencies on yuan is the same during regimes 2/1/1999-6/29/2012 and 7/2/2012-8/1/2018.	31.6946***	Rejected
Pre and BRI Model Comparison	The impact of major currencies on yuan is the same during regimes 7/2/2012-6/30/2015 and 7/2/2015-8/1/2018.	10.8357***	Rejected

Note: *, ** and *** indicate the rejection of null hypothesis at 10 percent, 5 percent and 1 percent level of significance.

We run Chow-Breakpoint tests to examine the possibility of structural breaks in the parameters of the OLS models in Table 5. We run the analysis for the three cases. The first one is the post-GFC period where a structural break is introduced in the middle of 2009. The next one is the pre-BRI time period where a structural break is proposed in the middle of 2012. Our third case examines the data period three years prior to and three years following the announcement of the BRI; a structural break is proposed during the middle of 2015. In the first case the value of the F-statistic is significant, which leads us to reject the null hypothesis of the model's structural stability, and to conclude that the estimated parameters of the model are not same during the two sub-periods, i.e., 1999-2009 and 2009-2018. A similar result of structural instability holds for periods before mid-2012 and afterwards. Finally, the Chow Breakpoint tests highlight structural changes in the pre-BRI and the BRI periods.

5. Conclusion and Implications

Our study looks into how the yuan exchange rate has evolved over time vis-à-vis other hard currencies. Comparing the distributions, we observe that the yuan's daily returns are characterized by a relatively low standard deviation, but high kurtosis compared to the other hard currencies, which should be a tell-tale sign of a managed currency. The highest incidence of extreme returns is observed during the fixed exchange rate regime, but more recently the yuan's extreme movements seems to have been attenuated. The currency still exhibits comparatively

lower standard deviation and higher kurtosis. It seems that though the yuan's empirical distribution has moved closer to those of other international currencies, it remains distinct.

We examine the time-varying correlation of the Chinese yuan with other currencies by extracting Dynamic Conditional Correlation (DCC) series. We observe that there is a long-term trend of increasing correlations over the period. However, this long-term trend seems to be mostly driven by higher correlations in the Belt-and-Road-Initiative (BRI) period. We find that around 2015 there is a marked increase in the DCCs vis-a-vis the dollar. With respect to EUR and GBP, the DCCs increased steadily from around 0.20 to around 0.60-0.70in the post-GFC period. In case of the Japanese yen, the DCCs increased from around 0.10 to about 0.80 during the BRI period. However, the DCC's are still seen to be fluctuating within a wide range and appear to be rather unstable, and it remains to be seen if the higher levels of correlations would be sustained.

We also examine how the yuan exchange rate is being influenced by the other major currencies. During the full sample period, we observe that less than 13 percent of the variation in the CNY is explained by the four major trading currencies. In the recent sub-periods (pre-BRI and BRI) this explanatory power has increased to 73-82 percent, and, in addition to the US dollar, the euro, British pound and the Japanese yen are also exerting statistically significant influence on the Chinese currency. This indicates that yuan is increasingly being integrated into global foreign exchange markets, and the Chinese economy's influence on the other major economies is transmitted through the foreign exchange markets, particularly after 2015.

Our results point to the growing role of the renminbi and suggest that China's economic influence now comes increasingly through the foreign exchange market. It follows that global exports and overall growth will be affected by changes in the yuan's exchange rate by altering their relative competitiveness. Similarly, changes in China's monetary policy may lead to fluctuations in the economy's external demand. The continuing growth of the renminbi's influence in the global markets will depend on the progress in China's capital account liberalization and to the extent that convertibility of China's currency is achieved. The renminbi's influence will also increase as cross-border

trade settlements become more prevalent and channels of outward and inward flows widen, increasing both the supply and the demand for renminbi. Financial institutions may also be attracted by the growing depth of the renminbi market and shift their operations to this market, providing a further boost.

Since, the China-Pakistan Economic Corridor (CPEC) is a significant event in Chinese-Pakistani economic relations, the rise of yuan carries significant implications for the management of Pakistan's foreign currency reserves and exchange rate. With the IMF's decision to include the renminbi in the SDR basket, there is an expectation that the share of the yuan as a reserve currency held by the foreign central banks will necessarily increase. However, the IMF's decision does not in itself make the yuan an international reserve currency. As Wang (2015) notes, inclusion of a currency in a country's foreign exchange reserve portfolio by a government should depend on a number of factors such as the currency's convertibility, credibility and liquidity.

The peculiarities of the statistical distribution of the yuan noted by our analysis are likely to reflect the currency's convertibility, credibility and liquidity. With regard to each of these economic considerations there are certain concerns. First, there are indications that despite China's liberalization of its currency, many mechanisms of capital controls remain intact through licensing, quota allocation and other forms of intervention (Wildau, 2015).

Second, for the yuan to be an international reserve currency there will also have to be greater confidence in Chinese economic and political institutions such as an independent central bank and a competent judicial system. International investors and institutions would need assurance that their holding of renminbis not at risk from arbitrary actions of the government.

Thirdly, for a currency to be liquid in the international context, it has to be first widely held by international investors and institutions. For that to happen, the country has to have overall balance of payment deficits; on the contrary, China has run persistent current as well as capital account surpluses. To increase international yuan liquidity, China would need to lend, invest and provide aid denominated in renminbi. The Belt and Road

Initiative with its massive size will help to promote holding of renminbi abroad. However, China has also been trying to reduce its very large holdings of dollar-denominated assets, which has resulted in most of its outbound investment being in US dollars.

It is likely that, given the advantages of being an international reserve currency, the Chinese authorities would continue to implement financial reforms and the strategy of internationalizing the yuan. However, as there are disadvantages to it as well, the Chinese are likely to proceed with caution which means that it may take some time for the renminbi to become an international reserve currency. Given China's growing share of the global economy and the increasing internationalization of its currency, adding the renminbi to the Pakistan's reserve basket seems logical. It will contribute to a movement away from the current heavy reliance on the US dollar and will help minimize the fluctuations in the Pakistani rupee value against the major currencies.

As Liao and McDowell (2016) conclude, "the decision to invest in RMB is not simply an economic choice. It is also a political act that signals and symbolizes a state's preferences for a diminution of American global influence and support for a revised order." Considering the developing relationship between Pakistan and China, it seems that over time Pakistan will hold a larger portion of renminbi in its reserve portfolio. However, it would be prudent to base such decisions on economic considerations, particularly as Pakistan is still highly dependent on the inflow of US dollars and frequent recourse to IMF stabilization packages.

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Appendix

TableA1: Durbin Watson Statistic Value for Full Sample Period

	EUR	GBP	USD	YEN	CNY
Durbin-Watson Statistic	1.9838	1.9560	1.7057	2.0017	2.4270

The value of statistic reported in the cells tests the null hypothesis that there exists no serial correlation. Value closer to 2 considered in acceptable range.

TableA2: Summary Statistics of Residuals

	$Res_{t,(Euro/PKR)}$			
	Full Period	**Post GFC**	**Pre-BRI**	**BRI**
Skewness	0.1281	0.0705	-0.1642	0.3253
Kurtosis	4.8307	4.0839	4.6453	10.2241
Jarque-Bera	337***	39***	92***	1767***
	$Res_{t,(USD/PKR)}$			
Skewness	4.1269	-0.1993	-0.0697	5.9998
Kurtosis	90.5311	4.1775	9.2751	107.21
Jarque-Bera	1638474***	50***	1284***	369540***
	$Res_{t,(RMB/PKR)}$			
Skewness	-13.363	-0.2753	-0.1586	2.968
Kurtosis	573.339	8.2911	7.2944	47.6349
Jarque-Bera	69098814***	923***	604***	68090***
	$Res_{t,(GBP/PKR)}$			
Skewness	-0.2620	-0.1927	-0.1634	-0.5142
Kurtosis	7.6149	2.9719	4.8388	14.0477
Jarque-Bera	2132***	4.8708	113***	4134***
	$Res_{t,(YEN/PKR)}$			
Skewness	0.2368	-0.1329	-0.1551	0.5584
Kurtosis	7.734	6.1632	4.3104	11.094
Jarque-Bera	4797***	329***	59***	2242***