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Exchange Rate Volatility and COVID–19 Infection Cases in Uganda: Evidence from GARCH Analysis

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Abstract: The analysis of exchange rate volatility has been conducted due to its diverse policy implications for financial markets and international trade. Uganda shifted away from fixed exchange rate regimes towards more flexible exchange rate regimes to facilitate the efficient absorption of external shocks to the domestic economy. However, this current regime is marred with exchange rate volatility due to the imbalance in demand and supply for foreign currency as a result of economic shocks and crisis like the COVID-19. On March 18, 2020, Uganda started implementing several policy measures as a response to curtail the spread of COVID-19. However, because of the profound uncertainty due to the threat of COVID 19 pandemic, this study examines the impact of COVID 19 on exchange rate volatility in Uganda using secondary data over a period of 74 days spanning between March 21st March when the first COVID-19 case was declared to June 2nd, 2020 when the country started easing the nationwide lockdown. Using the Generalized Autoregressive Conditional Heteroskedasticity, GARCH (1,1) model, the study finds that the increasing number of COVID–19 cases over the estimation period in Uganda had no significant effect on exchange rate volatility in Uganda. This results can be explained by the reduced uncertainty among economic agents because of the lockdown measures instituted to curtail the spread of the COVID-19. Therefore, the country should still implement the policy measures constituted to reduce the spread of COVID-19 and reduce economic uncertainty and increase investor confidence.

1. Introduction

The analysis of exchange rate volatility has become increasingly critical among academics and policymakers especially in the era of increased globalization and of floating exchange rate regimes that are occasioned with fluctuations in bilateral exchange rates. As a result, the exchange rate volatility has detrimental effects on international trade flow, capital flow and economic growth (Hakkio, 1984; De Grauwe, 1988; Asseery & Peel, 1991). On the other hand, it is crucial for policy makers to understand exchange rate movements to support the development and conduct of monetary policy (Longmore & Robinson, 2004). In this regard, the analysis of exchange rate volatility has received enormous attention from researchers, stakeholders, and policymakers to understand and develop monetary policies to address the adverse effects of exchange rate volatility on key macroeconomic indicators.

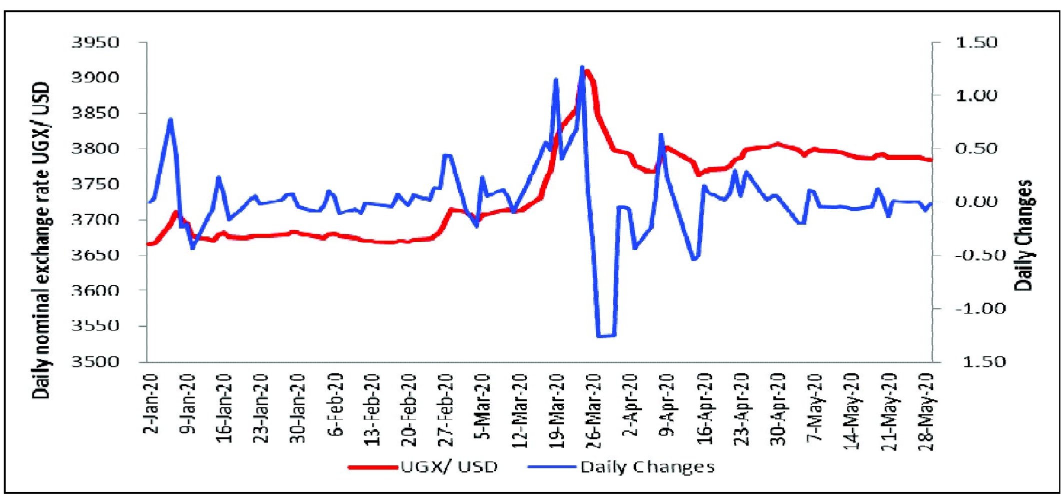
The COVID-19 (caused by SARS-CoV-2) that started in Wuhan, China, in December 2019 and rapidly spread to almost every country has been a global public health and economic threat. As such, the COVID-19 was declared a pandemic by the World Health Organization (WHO) on 11th March 2020 (WHO, 2020). The governments globally implemented various public health measures to stem the tide and flatten the curve of the disease transmission given that at the time there was limited knowledge on the efficacy and effectiveness of the medicines to treat the virus. Besides, there was no accredited vaccine to prevent COVID-19. Therefore, the countries adopted non-pharmaceutical interventions (NPIs) to curtail the spread of the virus and prevent the associated deaths (WHO, 2020).

In Uganda, the first case of COVID-19 of a traveler from the United Arab Emirates was confirmed on 21st March 2020. In this regard, the government of Uganda instituted several lockdown measures that included the suspension of public gatherings including places of worship, pubs, weddings, music shows, rallies and cultural meetings on March 18th; suspension of public transport on 25th March; declaration of nationwide curfew on 30th March, among others in order to curb the spread of the COVID-19. However, the country started easing the lockdown restrictions from May 19th, 2020, after 63 days of the lockdown. Further opening up of the country was announced on June 4th, 2020 with the government permitting public transport to operate. As a result, the country's COVID-19 cases were 870 confirmed cases as at end June 2020, and 37,808 cases as at 12th January 2021.

Notwithstanding the relatively low number of COVID-19 cases at this time in Uganda, the effects of the pandemic on the economy were expected to be significant particularly for key macroeconomic variables like the exchange rate (Adam et al., 2020) because they fluctuate highly in the short run as they respond to uncertainty generated by political events, monetary policies, and changes in current and future expectations (Krugman & Obstfeld, 2009). In light of COVID-19, when the virus first hits a country, economic growth expectations are downgraded in fear that so that it reads fear that some parts of the economy might need to be shut down.

In Uganda, as the country prepared to declare a national lockdown as a measure to control the spread of the coronavirus, a number of foreign business people withdrew billions of shillings from their businesses and to safer economic havens. Between February 28th, 2020 and March 27th, 2020, offshore holdings of Government securities declined by Uganda Shillings 251 billion (Adam *et al.,* 2020). Consequently, the Uganda shilling, which had been relatively stable with a bias towards an appreciation since January 2019, depreciated against the US dollar by 6.3 percent during the same period. The shilling depreciated further in March 2020 because of the speculative tendencies in the domestic foreign exchange market that were instigated by economic agents due to the decline in supply of foreign exchange and foreseen worsening of the country's external position. Nevertheless, the Shilling stabilized in April and May 2020 as depicted in Figure 1.1. Figure 1.1 shows exchange rate movements in Uganda during the COVID-19 period.

Figure 1.1: Exchange Rate Developments in Uganda



Source: Adam *et al.,* (2020)

Within the literature, there exists extensive research investigating exchange rate volatility. Bala and Asemota (2013) used the monthly exchange rate return series for the naira (Nigerian currency) against the US dollar ($) and other currencies to examine the exchange rate volatility using GARCH models. On the other hand, Rofael and Hosni (2015) estimates exchange rate volatility in Egypt using ARCH model. Several factors have been highlighted to impact exchange rate volatility (Coudert et al. (2011); Omrane & Savaºer (2017). In Uganda, the existing studies have focused on examining either the determinants of exchange rate volatility or investigated the relationship between exchange rate volatility and key macroeconomic variables. Tusiime (2017) examines the determinants of real exchange rate volatility in Uganda between 2000 to 2014; Katusiime (2019) examines the spillover effects between foreign exchange rate volatility and commodity price volatility; Katusiime *et al.,* (2016) examine the nexus between exchange rate volatility and economic growth in Uganda. To the best of our knowledge, there is no study in Uganda that examines the relationship between exchange rate volatility and COVID–19 cases in Uganda.

Nevertheless, few studies on the nexus between exchange rate volatility and COVID-19 cases have been undertaken on India and United States. Banerjee et al., (2020) uses the Vector Auto Regressive (VAR) model to explore the existence of causal relationships and directions among the growth rate of confirmed COVID–19 cases and exchange rate in India during the pre and post-lockdown phases. The study finds a positive relationship between the growth rate of confirmed COVID-19 cases and the growth rate of exchange rate. Further, Benzid & Chebbi (2020) uses the GARCH (1,1) model to examine the impact of COVID-19 cases and related deaths in the US on exchange rate volatility and finds that an increase of the number of cases and the deaths in the US has a positive impact on the exchange rate.

While the determination of exchange rate volatility is an important issue for both policymakers and economic agents involved in the financial market (Bauwens & Sucarrat, 2006), the literature has shown no study examines the relationship between exchange rate volatility and COVID-19 in Uganda. Yet, this information is relevant to policy makers to guide the design and conduct of monetary policy especially at the time when the COVID-19 cases in Uganda are on an increasing trend and possible second lockdown expected in the future. Therefore, this study contributes to this growing body of literature by examining the relationship between exchange rate volatility and COVID-19 cases in Uganda.

2. Exchange Rate Management in Uganda

The experience in exchange rate management in Uganda has shown that government involvement in fixing the exchange rate resulted in serious macroeconomic distortions that were harmful to the country's economic growth. As a result, the government implemented several reforms that were hoped to correct the external imbalances and remove the market distortions that ensued. The macroeconomic policy options entailed the adoption of the managed float exchange rate regime and the liberalization of the external trade and payments regime. However, the full impact of these policies was for a moment as inflation increased due to increased monetary growth that resulted from the slackness in monetary and fiscal management. In the same realm, the effectiveness of these policies was undermined by the foreign exchange shortfalls in the official channels as demand shifted from the parallel to the official market.

In this regard, the government through the Central Bank introduced the dual exchange rate system in 1982 with the lower priced window (W1) for financing priority imports and higher-priced window (W2) to both simulate non-traditional exports and to efficiently allocate the available foreign exchange. Like the first monetary policies, the dual exchange rate regime was as well short-lived as its effectiveness was impeded by rent seeking behavior leading to amalgamation of the two windows in 1984. The dual exchange rate system however collapsed in 1984 after the IMF/World Bank cut-off lending to Uganda after failing to comply with the programme benchmarks.

In 1987, the government introduced exchange rate reforms and the liberalization of the trade and payments regime that focused on improving the allocation of foreign exchange. These reforms included:

- Open General License (OGL) introduced in August 1988 that aimed to improve foreign exchange allocation to sectors like industries and other priority sectors of the economy with greater multiplier effect;
- Special Import Programme 1, [SIP 1], introduced in November 1988 that aimed to reduce the excess demand of foreign exchange at the overvalued official rate and the premium on the official exchange rate in the parallel market;
- Discrete devaluations aimed at reducing over-valuation of currency were started in December 1988;

- o Elimination of surrender requirements for exports and introduction of the dual licensing system for non-coffee exporter in January 1989;
- o Special Import Programme II, [SIP II], introduced in July 1989 that aimed to limit monetary expansion as commercial banks were restricted from lending.
- o Maintain the real effective exchange rate constant so as to achieve export sector competitiveness. The nominal exchange rate was adjusted on a monthly basis in order to maintain the real effective exchange rate constant.

The government undertook liberalization of the foreign exchange market in 1990. This commenced with the introduction of new foreign exchange regime that removed foreign exchange restrictions and introduced foreign exchange bureaus. The legalization of the parallel exchange market gave way to the introduction of a weekly Dutch auction of donor funds at Bank of Uganda, further reducing the foreign exchange premium. As a result of these policy reforms, the Interbank Foreign Exchange Market (IFEM) was introduced in 1993 leading to the complete liberalization of foreign exchange and payment systems with the liberalization of the capital account in July 1997. Until this moment, there has been unrestricted capital flow in Uganda, freedom to hold foreign exchange denominated accounts in the domestic banking system by both residents and non-residents, and for residents to hold foreign exchange denominated accounts and instruments outside the country. Uganda's exchange rate regime is now categorized as a floating exchange rate regime. However, the Bank of Uganda does intervene in the foreign exchange market in order to pursue a limited number of objectives, which principally include: intervening on the purchase and sale side to avoid destabilizing short-run movements in the exchange rate and securing adequate net official international reserves without influencing the direction of the exchange rate. Against this background it is evident that the Government of Uganda has over the years implemented reforms aimed at realigning and stabilizing the foreign exchange market. Thus given the reforms implemented by government and the role played by the exchange rate market in the economic growth process of a country, it is worthwhile to investigate how shocks such as COVID-19 would affect the exchange rate volatility in Uganda.

3. Methodology

3.1. Empirical Model – GARCH Model

The modelling and analysis of financial time series like the exchange rate is different from that of the normal time series because such series involve volatility clustering, leptokurtic distribution, and leverage effect. During a financial shock or crisis like the COVID 19 pandemic, the leverage effect (or the asymmetric quality of financial time series data) is heightened, and therefore impossible to model and analyze the volatility of say the exchange rate series by normal means, rather, by time varying volatility models such as the ARCH (Autoregressive Conditional Heteroskedastic) or GARCH (Generalized Autoregressive Conditional Heteroskedastic) type models. (Rastogi, 2014; Yousef, 2020). Against this backdrop, conditionally heteroscedastic models are advocated for to model exchange rate volatility (Dhamija and Bhalla, 2010).

The approach of analyzing financial time series by considering the time varying nature of volatility using the conditionally heteroscedastic models was first proposed by Engle (1982). However, the ARCH models had limitations of overfitting and breach of the non negativity constraint, and as such other GARCH type models (GARCH, EGARCH, GJR GARCH, and TGARCH) were developed by Bollerslev (1986); Glosten, Jagannathan, and Runkle (1993); Franses and Dick (1996). These models have therefore become prominent in modeling volatility in financial time series.

Despite the great variety of different GARCH models, this study focuses on the GARCH (1,1) model to analyze the effect of the number of COVID-19 cases on the exchange rate volatility in Uganda. As the starting point for a volatility analysis, the GARCH (1,1) model is the prominent model in the GARCH-type models and it is computationally convenient and widely compared to other ARCH-type models. The GARCH (1,1) model is expressed by the conditional mean equation (eq.2.1) and the conditional variance equation (eq.2.2):

$$(Vol_t)_i = \alpha_0 + \alpha_1\, Covid_t + \varepsilon_t;\ \ \varepsilon_t \sim N(0, \sigma_t^2) \tag{2.1}$$

$$\sigma_t^2 = h_t = \beta_0 + \beta_1 h_{t-1} + \beta_2 u_{t-1}^2 \tag{2.2}$$

Where: (Vol_t is the volatility of exchange rate: (Vol (UGX/USD); and $Covid_t$ is the number of cases (daily COVID-19 cases) at time t, which are equal to $\ln(1 + X_t)$, where ln is the natural logarithm function, ε_t are the innovations. σ_t^2 is the conditional variance, where $\beta_0 > 0$, $\beta_1 > 0$ and $\beta_2 > 0$. Importantly, a higher value of β_1 (the GARCH coefficient) indicates that it takes a long period for the shocks conditional variance to dissolve or die off. This therefore suggests the persistence of the volatility. On the other hand, if the sum of the ARCH and GARCH effects ($\beta_2 + \beta_1$) is close to 1, or relatively high, then a shock at time *t* will persist. Lastly, if $\beta_1 + \beta_2 < 1$, the model ensures positive conditional variance stationarity.

Prior to the modelling of the exchange rate volatility, we conduct unit root tests to check for the unit root properties of the variables becauses many economic and financial time series tend to exhibit trending behavior or non-stationarity in the mean, and therefore using the series in the analysis when they contain unit roots may lead towards spurious regressions (Granger and Newbold, 1974). Therefore, for reliable results it is critical to test for stationarity. In this regard, we used the Augmented Dickey–Fuller test (ADF) to test the null hypothesis of a unit root against the alternative hypothesis of stationarity.

3.2. Variables and Data

The key variables of the study are the exchange rate series obtained from Bank of Uganda and the daily COVID-19 cases for the period of 21th March to 30th November 2020 obtained from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University[1]. All data covers the period from 21st March 2020 when Uganda recorded its first COVID– 9 case, to 2nd June 2020 when the country eased the nationwide lockdown. This period is important because it covers a period of high economic uncertainty and great expectation formation by economic agents that are expected to impact on exchange rate volatility.

4. Results and Discussions

4.1. Descriptive Statistics

Table 4.1 presents descriptive statistics for exchange rate and daily COVID-19 cases in Uganda. Over the estimation period, there are 74 observations with the exchange rate having a maximum value of 3909 and the highest number of COVID-19 infection cases recorded during the study period was 84. The results show that the exchange rate is more volatile compared to COVID-19 cases because its values are farther away from the mean as shown by the results of the standard deviations. Since the kurtosis for both variables is greater than 3, then the dataset has heavier tails than a normal distribution. Furthermore, the results show that the series are non-symmetrical since the skewness is greater than zero, and therefore indicating that the size of the right-handed tail of the series is larger than the left-handed tail.

Table 4.1: Descriptive Statistics

Variable	*Exchange Rate*	*COVID-19 Cases*
N	74	74
Mean	3,793	8
Minimum	3,752	1
Maximum	3909.15	84
Standard Deviation	28.81	13.83
Skewness	2.36484	2.9632
Kurtosis	9.7266	14.2749

Source: Author's Computation

4.2. Pairwise Correlation

The results of the pairwise correlation matrix between the daily exchange rate series and the daily number of COVID–19 cases is presented in Table 4.2. The results show a negative and insignificant relationship between exchange rate movements and COVID-19 cases. However, it is imperative to further probe the relationship between exchange rate volatiity and COVID-19 cases using formal statistical and econometric procedures.

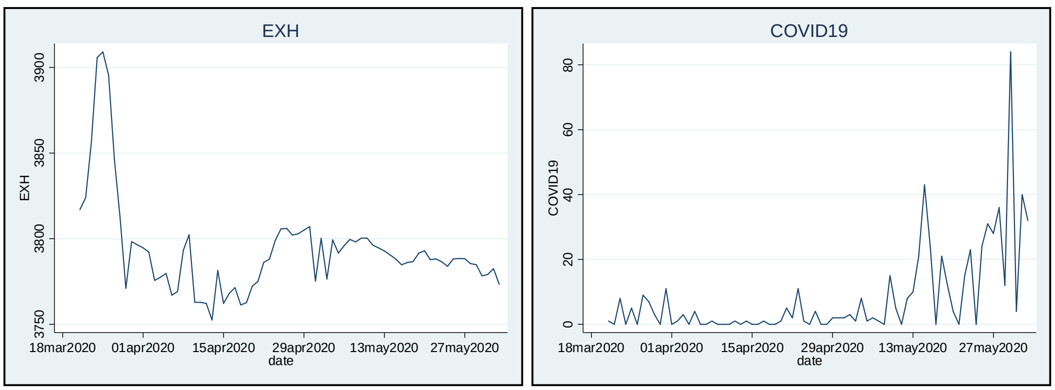
Table 4.2: Pairwise Correlation

Variable	*Exchange Rate*	*COVID-19 Cases*
Exchange Rate	1.000	
COVID-19 Cases	-0.0878 (0.4567)	1.000

To further understand the nature of the timeseries with the motive to ascertain the volatility of the exchange rate series and number of COVID-19 cases, the time plot of the two variables is presented in Figure 4.1. Between February 28, 2020 and March 27, 2020, offshore holdings of Government securities declined by Shs 251 billion (Adam et al., 2020). Consequently, the Uganda shilling, which had been relatively stable with a bias towards an appreciation since January 2019, depreciated against the US dollar by 6.3 percent during the same period. The shillings depreciated further in March 2020 because of the speculative tendencies in the domestic foreign exchange market that were instigated by economic agents due to the decline in supply of foreign exchange and foreseen worsening of the country's external position.

Nevertheless, the Shilling stabilized in April and May 2020 (See Figure 1.1). Between March and April, Uganda maintained reltively low number of COVID-19 cases mainly due to lockdown policy measures adopted to curtail the spread of COVID-19. However, starting May 2020, spikes of the COVID-19 cases are shown in figure 4.1.

Figure 4.1: Time plot of Exchange rate and COVID 19 infection cases over the study period



Source: Author's

4.3. Unit Root Tests

We tested for the presence of a unit root using ADF and the presence of heteroskedasticity in the exchange rate series using ARCH effect as a pre requisite for using the volatility modeling approach. The results of the unit root tests at Levels and first difference; and ARCH LM test are shown in Table 4.3. The results show that the exchange rate series is not stationary at levels, however, after the first difference it becomes stationary at 1 percent level of significance. The COVID-19 series is

Table 4.3: Unit Root Tests and ARCH-LM Test

Variable	*ADF in Levels*		*ADF in First Difference*		*ARCH Effects*
	Test Statistic	*5% CV*	*Test Statistic*	*5% CV*	*LM*
Exchange Rate	-2.370 (0.1502)	-2.912	-7.702***	-2.912	48.009***
COVID-19 Cases	-5.865***	-2.912	-18.893***	-2.912	

Note: *** indicates significance at 1% level. CV implies critical values and LM stands for Lagrange multiplier.

stationary at 1 percent level of signifiacnce both at levels and first difference. Using the ARCH LM test, we conclude that the exchange rate series is highly volatile since the null hypothesis of no ARCH effect is rejected at 5% level of significance. In this regard, we proceed with the use of GARCH model.

4.4. GARCH Model

Table 4.4 presents the emprircal results of the mean and conditional equations of the standard GARCH (1,1) model with daily number of COVID 19 cases as the conditional variance regressor. The results show that both the ARCH effect and the GARCH effect are significant at 1% level of significance. The results show that the coefficient of COVID-19 is insiginficant implying that the daily increases in COVID-19 cases in Uganda had no effect on the exchange rate volatility. Thus despite the pandemic, in the shortrun investors did not scramble to adjust their portfolios to reflect the potential damage of the virus to the country's exchange rate. This result is however contrary to that obtained by Banerjee et al., (2020) and Benzid & Chebbi (2020) who explored the existence of causal relationships and directions among the growth rate of confirmed COVID–19 cases and exchange rate.

Table 4.4: Results of GARCH (1,1) with COVID 19 infcetion cases

	Coefficient	*p value*
COVID-19	0.0849	0.875
β_2 (ARCH Effect)	0.9023***	0.006
β (GARCH Effect)	0.2689***	0.001

Note: *** and ** indicate 1% and 5% level of significance.

Nevertheless, the results of this present study could be firstly explained by the fact that during the period under estimation, there was reduced demand for foreign exchange due to low imports and a slowdown in economic activity. During this period, the major 5 sources of Uganda's imports that account for over 59 percent of the country's toatl imports - Kenya, China, India, Saudi Arabia, and United Arab Emirates had rising COVID-19 cases and therefore closed their borders to international trade. As a result, the electrical apparatus imports from China declined by UGX 30.1 billion in value in February 2020 compared to February 2019. This trend was exacerbated in March, 2020 when Uganda closed her borders. Mugume & Opolot (2019) assert that exchange rate instability in a developing country like Uganda is largely due to trade-related flows and seasonality of some major exports like coffee and other inflows. Secondly, there was reduced fear and uncertainity in the country to guarrantee the transfer of foreign currency outside the economy as the country gains better control of the virus with only 84 confirmed cases at the time and no COVID-19 related deaths.

The results further reveal that both recent and past news have a significant impact on exchange rate volatility. The sum of the ARCH [β_2(ARCH effect)] and GARCH [β_1(GARCH effect)] effects is close to unity which signifies that the current shocks to the exchange rate triggered by COVID 19 may not die off quickly but rather persist for a while considering that the duration of the pandemic is unknown. Since our analysis is based on the short run dynamics, a study that examines the long-run relatonship between COVID-19 cases might reveal a positive and significant relationship in the long-run.

5. Conclusion and Policy Recomendation

The study examines the relationship between exchange rate volatility and COVID-19 cases in Uganda over the period March 22nd 2020 when the first COVID-19 case was declared to 2nd June 2020 when the country started to ease the lockdown. The study sets to investigate whether the increasing number of COVID-19 cases in Uganda over this period have an impact on exchange rate volality. The study employs the GARCH (1,1) on daily data and the results show that the increasing number of COVID-19 cases in Uganda had no significant impact on exchange rate volality. The results can be explained by the reduced uncertainity among economic agents because of the lockdown measures implemented by the government to reduce the spread of the virus. Therefore, the country should continue to implement measures that reduce economic uncertainity and foster investor confidence thereby reducing the effect of the pandemic on exchange rate volatilty.

Note

1. The data are available at: The data are available at: *https://github.com/CSSEGISandData/COVID-19/tree/master/csse_covid_19_data/csse_covid_19_time_series.*

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