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Can Trade and Remittances Flows Survive COVID-19 in Africa? Evidence from Symmetric Volatility Model

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Abstract: In this study, volatility in trade and remittances flows to Africa during the COVID-19 pandemic for the period 2004M1 to 2020M11 was modeled. The study evaluated the volatility using the symmetric GARCH (1, 1) univariate volatility model. Results revealed that a shock to exports during the COVID-19 pandemic was temporary and its recovery was quick. On the other hand, a shock to remittances was more enduring and persistent; and its variance reverted slowly. The study recommended that policies to promote export, especially of COVID-19 protective gears be implemented while efforts should be made to lower the cost of receiving remittances.

Keywords: trade, imports, exports, remittances, symmetric, asymmetric, GARCH

JEL Code: F14, F24, C5

1. Introduction

Africa, like every other continent in the world, has rigorously been trying to contain the adverse effects of the currently ravaging Corona Virus disease (COVID-19) pandemic. The internet-enhanced globalization of the world economy has brought countries more economically together (Stuart, 2020), with the resultant accelerated movements of humans and other resources across regions and continents, makes it possible for the Virus to spread in unimaginable quantum within the shortest period of time, irrespective of distance. Therefore, the incidence of the pandemic in any part of the world resonates almost instantaneously to the other part. As of mid-2020, the novel coronavirus had infected more than 8.7 million people and caused more than 460,000 deaths (Solis, 2020). The world economy experiences an unprecedented severe downturn in cross-border exchanges and remittances (World Bank, 2020), consequent upon the COVID-19-induced negative supply and demand shocks, with international trade and investment flows anticipated to drop by 30% and 40%, respectively; and rising unemployment rates in many countries (Solis, 2020).

Correspondingly, remittance flows to East Asia and Pacific region are anticipated to decrease by US$131 billion or 11% in 2020, while global remittance flows are to shrink to 14% by 2021, and then flows to Africa and other low and middle-income countries are predicted to decline by 7% to US$508 billion in 2020 and 7.5% to US$470 billion in 2021

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from the 2019 amount of US$548 billion record high (World Bank, 2020). Declining economic growth, employment levels in migration-destination countries, and worsening weak oil prices and depreciation of remittance-source countries' currencies vis-à-vis the US dollar are among the factors responsible for the projected decreases in remittance flows. According to the World Bank, the Middle East and North Africa would each experience 8% decline in remittance flows in 2020 and 2021 respectively, while Sub-Sahara Africa would experience 9% decline to US$44 billion in 2020 and further 6% in 2021. The scenario becomes more worrisome in the light of the World Bank's prediction that all major remittance-recipient countries would experience decline, and that remittance flows to Kenya, which hitherto remained positive, are likely to eventually decline in 2021. Worse still, both the migrants' destination and source countries are negatively affected by the COVID-19 pandemic, with the potential attendant worsened food insecurity and poverty conditions in the countries.

The literature documents that the predominant global trade flows between China and the US, and other variants of global trade patterns evolve as countries develop sector specializations to gain comparative trade advantage (Stuart, 2020). Perhaps, the COVID-19 pandemic has reduced the volume of international trade as governments tighten economic security by restricting trade and investment flows and, thus, providing some leverage for the US-China trade tussle. This has the potential to place the African Continent in a disadvantageous trade position relative to other continents and regions of the world and, thus, a challenge for the African Continental Free Trade Area (AfCFTA). However, the huge opportunities inherent in the fast-evolving global digital trade infrastructure present a leeway for Africa's trade environment, even in this era of the COVID-19 pandemic.

During the period of 2015-2017, total trade flows from Africa to other countries of the world averaged US$760 billion in comparison with Oceania's US$481 billion, Europe's US$4,109 billion, US$5,140 from America and US$6,801 from Asia (UNCTAD, 2019). Similarly, Africa experienced high shares in the world exports that ranged from 80% to 19% from 2000 to 2017; thus, placing the Continent in the second position after Oceania in terms of export dependence. Further, the statistics on inter-African country trade during 2015-2017 periods showed 2% for the African Continent compared to 47% for America, 61% for Asia, 67% for Europe and 7 percent for the Oceania (ibid). These show that Africa is less inter-country trade dependent than the other continents in the world. Furthermore, the COVID-19 pandemic caused the closure of factories and general lockdown with resultant shrinkage in demand for African exports, which are mostly primary products. Given these scenarios, it becomes pertinent to inquire about the survival potentials of African trade in this era of COVID-19 pandemic.

Among the consequences of the Corona Virus pandemic are the unprecedented public health challenge and the shutting down of a significant proportion of the world economy in the effort to curb the spread of the COVID-19 disease (WTO, 2020). The pandemic has brought with it an unprecedented rise in the demand for medical and allied products, as well as concerted efforts to fight the disease. All countries depend on international trade and global value chains to source these products (WTO, 2020). This seems to be a potential source of threat to the survival of African trade in the COVID-19 era since the Continent neither produces nor exports a significant amount of medical and allied products.

Some countries and regions have responded to the ravaging negative effects of the COVID-19 pandemic on various aspects of human activities, including cross-border exchange transactions, by either imposing or increasing trade prohibitions and restrictions. Thus, the adverse effect of the COVID-19 pandemic challenge may worsen as a result of the increasing number of trade impediments being implemented by some WTO members and non-member countries in the wake of the COVID-19 pandemic. In particular, export protections and prohibitions have been the favored response option occasioned by the pandemic. Moreover, available statistics indicate that the prohibitions and restrictions are selective in terms of product specificity (see Appendix 1). Also, this scenario portends a source of potential threat to African trade since the primary products exports of Africa fall into the trade prohibition and restriction policies of WTO members and non-members, especially the more advanced and industrialized economies.

This paper tested the potentials of trade and remittance flows in the COVID-19 era in Africa. Exploring recent data, the paper evaluated the volatility of trade and remittances flows in Africa including the COVID-19 pandemic era. The findings show that shocks in the midst of the COVID-19 pandemic to exports are temporary. This finding is in consonance with the graphical analysis presented in Figure (2). Also, shocks due to the COVID-19 pandemic will have a more enduring and persistent effect as its variance reverts slowly for remittances. Consequently, the implication is the need to articulate and implement policy thrusts that could engender diversification of the exports base of the African Continent. There is also the need for the monetary policy authorities in the Continent to reduce the cost of remittances and incentivise remitting migrants.

The paper is structured into five sections. Following this introduction is section two in which the data characteristics were laid out. The methodology deployed in the paper is discussed in section three. Section four presents the results and discussion, while the conclusion and recommendations are articulated in section five.

2. Summary of empirical literature

COVID-19 and its impact on various aspects of human endeavors are still evolving phenomena. In this subsection, we present a brief summary of the empirical literature on the COVID-19 in the contexts of trade and remittances.

In Obayelu et al. (2020), it was found, through leading indicators, that keeping trade open in the face of the COVID-19 pandemic will help mitigate its negative effects, as against the trade restrictions that followed the announcement of a global pandemic. The same view is shared by Agarwal and Mulenga (2020) where it was posited that given that African countries depended on foreign trade in the form of importation, the restrictive trade policies of the rest of the world coupled with the less diversified nature of the economies in Africa, the impact of the COVID-19 on Africa will likely be severe.

The adverse effect of the COVID-19 pandemic on Europe may further negatively affect the recovery of African trade given that the supply chain of Europe is tied to Africa (Banga et al., 2020). Gillson (2020) posits that trade in health services be given attention in the face of the global pandemic as countries struggle to contain the surge in hospitals and health care facilities, thus advocating for more trade openness and not less, even as African countries are encouraged by Brenton and Chemutai (2020) to keep trade open so as to access medicines and food in the face of the pandemic, while reducing taxes and duties on imported products as a way of responding to the COVID-19 shock to trade. In the midst of the doom and gloom, Mold and Mveyange (2020) found that trade in East Africa, especially exports enjoyed significant improvement in the first quarter of 2020.

Several studies have been carried out on the potential effects of the COVID-19 pandemic on the African continent in terms of the flow of capital and inward remittances. Drawing lessons from the Global Financial Crisis, Akpa, et al. (2020) concluded that the COVID-19 pandemic will not have an adverse negative effect on inward remittances to Africa, a finding that is contested by Bisong et al. (2020) where it was projected that inward remittances into Africa were likely to fall given that the effect of lockdowns in host countries may constrain the earning potential of migrants upon whom recipient households and individuals in the receiving countries depend. However, Kalantaryan and McMahon (2020) recognised that the adverse effect the COVID-19 pandemic will have on remittances inflows into Africa; but its negative effect will not be evenly spread among the economies on the Continent, with greater impact on the more remittance dependent economies and households.

In the light of the foregoing literature, our study differs from the rest in that it seeks to investigate how well trade and inward remittances-both representing exchanges beyond the domestic borders-will survive a COVID-19 pandemic shock using a volatility model. While most of the reviewed literature followed a stylized facts approach to evaluating the effects of the pandemic on trade and remittances, or use lower frequency data, this study uses high-frequency data within the period the pandemic's first wave was at its height.

3. Methodology

3.1 *Data characteristics*

This study utilized monthly secondary data from month one 2004 (2004M1) to month eleven 2020 (2020M11), giving a total of 202 observations. Thus, the data spanned the period of 17 years, 2004 to 2020, including when the COVID-19 pandemic was declared in January up to November 2020. Trade data for South Africa were sourced from the OECD (2021) database and seasonally adjusted in billions of US dollars. Remittances data for Kenya (in millions of US dollars) were sourced from the Central Bank of Kenya (CBK) (2020) database.

3.2 *Univariate volatility models for the empirical analysis*

In modeling the volatility in export and remittances, several measures are considered-both symmetric and asymmetric. The superior between the symmetric and asymmetric models is selected based on the SIC. After confirming, through the pre-estimation test, the existence of serial correlation and ARCH effects in the exports and remittances series, we show through the post-estimation diagnostics that the preferred volatility model has captured the serial correlation and ARCH effects. The post-estimation analysis is performed on the preferred model using the ARCH-LM and Ljung-Box Q-test for serial correlation (see Appendix 4). The symmetric models considered in this study are ARCH (5) and GARCH (1, 1). The asymmetric models tested for suitability are EGARCH (1, 1) and TGARCH (1, 1) (see appendices 2 and 3). The ARCH equation is presented in equation (1)

$$r_t = \mu + \varepsilon_t, t = 1, \ldots, T$$

$$\varepsilon_t \sim iidN(0, \sigma^2) \tag{1}$$

where r_t is the time series, μ is the mean of the time series, ε_t is the residuals.

$$\sigma^2 = \partial_0 + \partial_1 \mu_t^2 - 1 \tag{2}$$

The specification in equation (1) is the mean equation while equation (2) represents the variance equation.

The ARCH model developed by Engle (1982) had been criticized as being more of a moving average than an autoregressive model. Thus, Bollerslove (1986) developed the GARCH model to better capture the volatility in the series. A general GARCH (p, q) model can be expressed thus according to Sekati et al. (2020):

$$\rho_t^2 = c + \in_{t-i}^2 + \rho_{t-j}^2 \tag{3}$$

In equation (3), ρ_{t-j}^2 (the GARCH term) is the variance, $\in_{t-i}^2$ (the ARCH term) is the squared error at time $t - j$, t is the time while j is the number of lags, c is the intercept. The GARCH model is proposed in line with Benlagha and Chargui (2017, p.5) because the prediction error of conditional variance is a function of time, "system parameters, exogenous and lagged endogenous variables, and past prediction errors."

To capture possible asymmetry in the volatility of the series, we specify exponential GARCH (EGARCH) and threshold GARCH (TGARCH) or GJR-GARCH models respectively.

The EGARCH model is thus specified:

$$\ln(\rho_t^2) = \varphi + \tau \left| \frac{\mu_t}{\sqrt{\rho_{t-1}^2}} \right| + \pi \frac{\mu_{t-1}}{\sqrt{\rho_{t-1}^2}} + \vartheta \ln(\rho_{t-1}^2) \tag{4}$$

In equation (4), τ represents the effects on the conditional variance of the conditional shock while π is the asymmetric effect and ϑ evaluates the persistence of shocks to the variance.

The TGARCH (1, 1) or GJR-GARCH (1, 1) model is specified in line with Zakoian (1994) because it allows the volatility in the variables of interest to react to different signs of the lagged error term. However, as earlier stated, the choice of the most appropriate model will be made based on the one with the lowest SIC. The TGARCH model is specified thus:

$$\rho_t^2 = \varphi + \omega_1 u_{t-1}^2 + \delta_1 \rho_{t-1}^2 + \vartheta u_{t-1}^2 l_{t-1}. \tag{5}$$

According to Salisu (n.d.), in equation (5), if $\vartheta > 0$ then positive shocks will lead to higher volatility than negative shocks will be; if $\vartheta = 0$, the model is symmetrical.

4. Results and discussion

4.1 *Descriptive statistics of imports, exports and remittances*

Table 1 shows the statistical features of the variables selected for this study-imports, exports and remittances. In the three variables, there seem to be large variations given the significant differences in their minimum and maximum values. This is also confirmed from the standard deviation obtained for the series. It is observed that both import and export are negatively skewed, while the skewness of remittances is positive which means extreme right tail. The kurtosis indicates that all the series are platykurtic, given that they are less than 3. The Jarque-Bera (JB) statistic that uses information from the skewness and kurtosis shows that all the series are not normally distributed.

Table 1. Descriptive statistics

	Import	Export	Remittance
Mean	6.8101	6.715	107650.800
Median	7.000	7.230	95624.980
Maximum	9.430	9.590	295317.000
Minimum	2.950	2.920	25154.000
Std. Dev.	1.466	1.544	72247.100
Skewness	-0.421	-0.500	0.816
Kurtosis	2.334	2.314	2.597
Jarque-Bera	9.763	12.453	23.932
Probability	0.008	0.002	0.000
Observations	203	203	203

Source: Authors' computation (2021)

4.2 *Dynamics in the imports, exports and remittances*

Figure 1 illustrates the dynamics in the imports, exports and remittances. The figure shows instability in all series, especially in export and import. Exports and imports particularly show evidence of volatility clustering, that is, periods of high volatility followed by calm. The trend analysis shows mildly fluctuating upward movement in remittances (including around the end of 2019 and throughout 2020 being the period around when the world entered the COVID-19 pandemic). Import and export, which follow each other very closely, experienced upward slightly increasing amounts until 2008 when a sharp decline is noticed, perhaps due to the global financial crisis of that period. The two series recovered but plateaued from 2010 to 2017, after which they recovered but declined in 2019 before rising sharply in 2020.

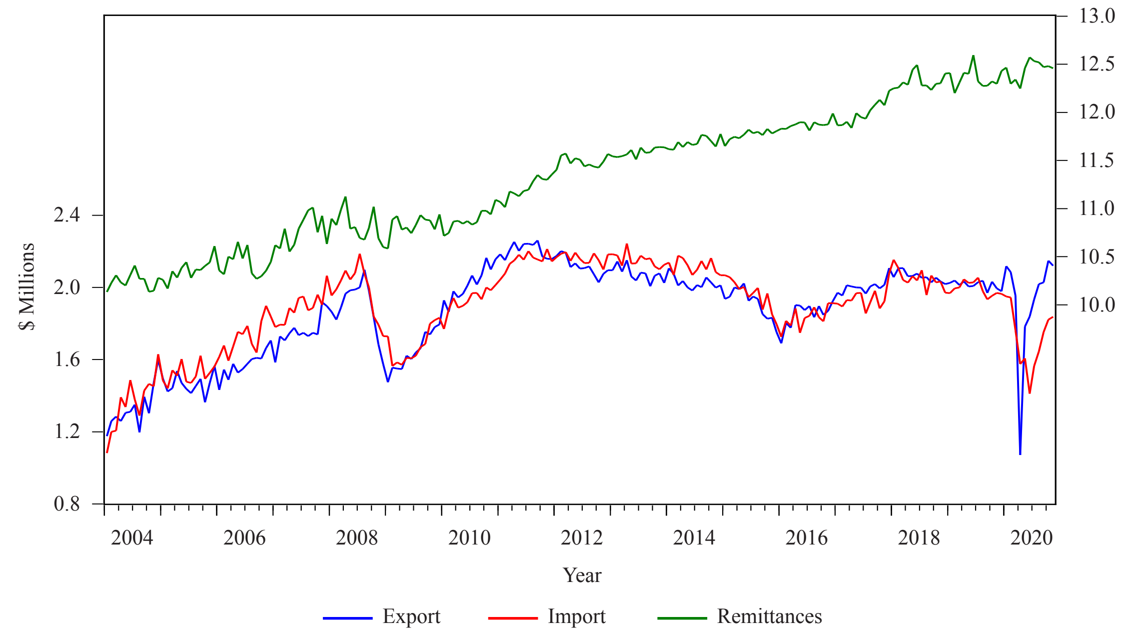

Figure 1. Trend analysis of Exports, Imports and Remittances (2004M1 to 2020M12)
Source: Authors' computation (2021) based on data from CBK (2020) and OECD (2021)

4.3 *Stationarity tests*

The stationarity of the variables were tested based on the Augmented Dickey-Fuller (ADF) (1979) and Phillip Perron (PP) (1988) tests and their results are presented in Table 2.

Table 2. Unit root test results

	Level					
	Augmented Dickey-Fuller (ADF)			Phillip Perron (PP)		
	Constant	Constant & Trend	None	Constant	Constant & Trend	None
EXP	-2.783*	-3.068	0.477	-3.101**	-3.619**	0.749
IMP	-3.603***	-3.269*	0.408	-3.562***	-3.144*	0.394
REM	-0.476	-5.084***	3.638	-0.797	-6.560***	4.946
	First Difference					
EXP	-19.501***	-19.483***	-19.496***	-21.305***	-21.648***	-21.141***
IMP	-17.511***	-17.663***	-17.510***	-17.5115***	-17.663***	-17.507***
REM	-11.947***	-11.915***	-11.017***	-42.0215***	-41.865***	-18.928***

Note: ***, ** and * imply significance at 1%, 5% and 10% respectively.
Source: Authors' computation (2021).

The stationarity and level of integration of the variables were tested based on the Augmented Dickey-Fuller (ADF) (1979) and Phillip Perron (PP) (1988) tests. The results presented in Table 3 show that the variables are stationary at level. That is, the is order of integration is *I*(0).

Table 3. Summary of unit root test results

	Augmented Dickey-Fuller (ADF)			Phillip Perron (PP)		
	Level	First Difference	I(d)	Level	First Difference	I(d)
EXP	-2.783[a]*	-	I(0)	-3.101[a]**	-	I(0)
IMP	-3.603[a]***	-	I(0)	-3.562[a]***	-	I(0)
REM	-5.084[b]***	-	I(0)	-6.560[b]***	-	I(0)

Note: ***, ** and * imply statistical significance at 1%, 5% and 10% levels respectively. Also, 'a' denotes model with constant, 'b' is for model with constant and trend and 'c' is the model without constant and trend
Source: Authors' computation (2021)

4.4 *Formal tests for univariate volatility models*

Before proceeding to model univariate volatility, we tested for the presence of serial correlation (which is captured by the mean equation of a GARCH model) and the heteroscedasticity test for ARCH effect (which is captured by the variance equation) (Salisu, 2016).

The tests are done on the AR(1) process of each of the series as presented in equation (6)

$$r_t = c + r_{t-1} + \varepsilon_t, t = 1, \ldots T \qquad (6)$$

where r_t is the time series, c is the constant, r_{t-1} is the one-period lag of the time series and ε_t is the residual.

Test 1: Serial Correlation test.

Table 4. Ljung-Box Q test Q-stat test for serial correlation in import

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*|. |	*|. |	1	-0.187	-0.187	7.1312	0.008
.|* |	.|. |	2	0.075	0.042	8.2972	0.016
.|. |	.|. |	3	0.006	0.028	8.3041	0.040
.|. |	.|. |	4	0.055	0.060	8.9290	0.063
.|. |	.|. |	5	0.029	0.049	9.1089	0.105
.|. |	.|. |	6	0.039	0.048	9.4311	0.151
*|. |	*|. |	7	-0.078	-0.073	10.716	0.151
.|. |	.|. |	8	0.017	-0.021	10.779	0.215
.|* |	.|* |	9	0.089	0.094	12.452	0.189
.|. |	.|. |	10	-0.048	-0.018	12.943	0.227
.|. |	.|. |	11	-0.003	-0.022	12.944	0.297
*|. |	*|. |	12	-0.120	-0.127	16.050	0.189

Source: Authors' computation (2021)

Table 5. Ljung-Box Q test Q-stat test for serial correlation in export

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
**|. |	**|. |	1	-0.263	-0.263	14.152	0.000
.|. |	.|. |	2	0.036	-0.035	14.426	0.001
.|. |	.|. |	3	-0.015	-0.015	14.471	0.002
.|. |	.|. |	4	0.028	0.023	14.636	0.006
.|. |	.|* |	5	0.064	0.084	15.498	0.008
*|. |	.|. |	6	-0.066	-0.030	16.427	0.012
.|. |	.|. |	7	0.057	0.034	17.107	0.017
.|. |	.|. |	8	-0.013	0.010	17.145	0.029
.|. |	.|. |	9	0.063	0.062	17.985	0.035
.|. |	.|. |	10	-0.013	0.019	18.024	0.055
.|. |	.|. |	11	0.047	0.056	18.501	0.071
.|. |	.|. |	12	0.020	0.042	18.587	0.099

Source: Authors' computation (2021)

Table 6. Ljung-Box Q test Q-stat test for serial correlation in remittances

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
**|. |	**|. |	1	-0.314	-0.314	20.157	0.000
.|. |	*|. |	2	-0.008	-0.118	20.169	0.000
*|. |	*|. |	3	-0.095	-0.151	22.020	0.000
*|. |	**|. |	4	-0.156	-0.275	27.058	0.000
.|* |	*|. |	5	0.115	-0.072	29.831	0.000
.|* |	.|* |	6	0.104	0.083	32.100	0.000
.|. |	.|* |	7	0.060	0.111	32.849	0.000
.|. |	.|. |	8	-0.015	0.066	32.898	0.000
*|. |	.|. |	9	-0.080	0.014	34.274	0.000
.|. |	.|. |	10	-0.009	0.040	34.292	0.000
*|. |	*|. |	11	-0.098	-0.107	36.380	0.000
.|. |	*|. |	12	0.058	-0.083	37.099	0.000

Source: Authors' computation (2021)

Test 2: Heteroscedasticity (ARCH) Effect Test.

Table 7. ARCH-LM test for presence of heteroscedasticity in imports, exports and remittances

	Imports	Exports	Remittances
F-test	0.834	4.254***	3.392***
nR^2	10.165	42.533***	35.530***

Note: ***, ** and * imply significance at 1%, 5% and 10% respectively
Source: Authors' computation (2021)

From the results presented in Table 4, it is noticed that the probability values of the Ljung-Box Q-test for serial correlation in imports show that the null hypothesis of no serial correlation is accepted. This implies that there is no volatility in import amounts during the period covered in this study. However, this finding comes with a caveat that, perhaps, increased importation of medical and allied products by the African countries in response to the menace of COVID-19 pandemic sustained the import amounts of the African countries in the period of the COVID-19 pandemic. So, Kenya and South Africa as well as other African countries are not exemptions to the WTO's (2020) assertion that the COVID-19 pandemic stimulated unprecedented rise in global demand for medical and related products. In tables 5 and 6, it is noticed that the probability values of the Ljung-Box Q-test for serial correlation in exports and remittances show that the null hypothesis of no serial correlation in the series is rejected. This clearly shows that Kenya and South Africa and, by extension, the African Continent, experience volatilities in both exports and remittances during the period under study. The volatility in exports amounts may be explained in the context that Kenya and South Africa as well as other countries on the Continent do not export a significant amounts of medical and allied products. Rather, the aggregate exports of the countries are dominated by primary produces. The observed volatility in remittances is likely due to the widespread of the negative impact of the pandemic across the globe, which adversely affects the incomes of Africans in diaspora and reduces their capacities to remit funds to their African countries of origin. This is not with prejudice to the available 2020 remittance data which indicate that remittances to Kenya remained relatively consistent when compared to other African countries, even in the heat of the pandemic.

Table 7 presents that ARCH-LM test result for the presence of heteroscedasticity in the three series-imports, exports and remittances. The probability values of the z-stat for the three series indicate that both the F-stat and the nR^2 for import are not significant, indicating that import has no ARCH effect. The other two series-exports and remittances show the presence of ARCH effect.

Given the result of the serial correlation and ARCH tests, it is not appropriate to model import with the univariate framework since the underlying assumptions have been violated. Therefore, we go ahead to build a univariate model for exports and remittances.

Tables 8 and 9 present the result of the symmetric GARCH (1, 1) for exports and remittances respectively. The results of the symmetric ARCH (5) and asymmetric EGARCH (1, 1) and TGARCH (1, 1) volatility models are in the appendix 2 and 3 (Tables 10 and 11), respectively. Using the SIC for model selection, it is found that in the GARCH (1, 1), the export and remittances equation has the smallest SIC. Thus, the GARCH (1, 1) model (the symmetric model) outperforms the ARCH (5) model and the two asymmetric models of EGARCH (1, 1) and TGARCH (1, 1). Therefore, the symmetric GARCH (1, 1) model is the best fit when modeling trade and remittance volatility in Africa and is hereby reported.

In the export equation, it is observed that adding the ARCH and GARCH effects of the GARCH (1, 1) model gives 0.75 which is less than one. This indicates that shocks have a temporary effect on exports. Looking at Figure 2, it becomes obvious that following the shock due to the COVID-19 pandemic in early 2020, export dipped but recovered almost instantaneously. Thus, the volatility modeling in this study has shown COVID-19 induces temporary shock on exports. This may be due to the easing off of economic lockdowns, and the subsequent resumption of primary produce exports by the African countries.

In the remittances equation, it is observed that adding the ARCH and GARCH effects of the GARCH (1, 1) model gives 0.99, which is very close to one and, thus, indicating that though the shock related to COVID-19 induces temporary effect on remittances, the variance process reverts slowly. The economic implication of this is that there is more persistence in remittances than trade. This underscores the view that migrants see themselves as the extension of their families back in their home countries.

Table 8. Univariate GARCH (1, 1) model for export

Export Equation				
GARCH (1, 1)				
Mean Equation				
C	0.088	0.028	3.084	0.002
LNEP_(-1)	0.957	0.015	64.387	0.000
Variance Equation				
C	0.002	0.001	2.848	0.004
RESID(-1)^2	0.475	0.206	2.302	0.021
GARCH(-1)	0.273	0.155	1.761	0.078
R-squared	0.846			
Adjusted R-squared	0.845			
Observation	202			
AIC	-2.643			
SIC	-2.544			
HQC	-2.603			

Source: Authors' computation (2021)

Table 9. Univariate GARCH (1, 1) model for remittances

Remittance Equation				
GARCH (1, 1)				
Mean Equation				
C	0.158	0.094	1.686	0.092
LNREM(-1)	0.987	0.008	121.271	0.000
Variance Equation				
C	0.000	0.000	0.872	0.383
RESID(-1)^2	0.126	0.066	1.917	0.055
GARCH(-1)	0.859	0.074	11.657	0.000
R-squared	0.977			
Adjusted R-squared	0.977			
Observation	202			
AIC	-1.809			
SIC	-1.711			
HQC	-1.769			

Source: Authors' computation (2021)

4.5 *Post-estimation test results*

Table 12 (see Appendix 4) shows that the volatility model captures the serial correlation in exports while Table 13 shows that the volatility model also captures the serial correlation in remittances. In Table 14, it is shown, using the ARCH-LM test, that the volatility model used in this study has captured the heteroscedasticity in exports and remittances.

5. Conclusion and recommendations

This study modeled volatility in trade and remittances flows in Africa in the midst of the COVID-19 pandemic using the symmetrical GARCH (1, 1) univariate volatility models. The initial serial correlation and ARCH effect tests carried out on the variables of interest-imports, exports and remittances-showed that imports had neither serial correlation nor contained ARCH effect (heteroscedasticity), thus imports were dropped from the univariate volatility analysis. When compared to asymmetric EGARCH (1, 1) and TGARCH (1, 1) univariate volatility models (whose results are presented in the appendix) the best performing volatility model is the GARCH (1, 1) model, given that it had the lowest SIC.

Results from the GARCH (1, 1) model revealed that shocks in the midst of the COVID-19 pandemic to exports are temporary, in consonance with the graphical analysis presented in Figure 2. On remittances, results revealed that shocks due to the COVID-19 pandemic will have a more enduring and persistent effect as its variance reverts slowly.

Furthermore, post-estimation tests were carried out to determine if the preferred model captured the volatility in the model. Findings from the Ljung-Box Q test for serial correlation on exports and remittances showed that the serial correlation observed in this series in the pre-estimation analysis had been captured. The ARCH-LM test for revealed that the preferred model captured the heteroscedasticity in exports and remittances.

The study recommends that policy for open trade, especially exports be supported on the continent. Attention should be paid by policymakers to the tradeable sectors of the economy, especially in the production of simple COVID-19 protective items identified in Figure 1 (see Appendix 1) for which countries have been imposing export restrictions. Such export restrictions may indicate low domestic production and supplies. On the other hand, policies to make remittances cheaper should be implemented as larger remittances inflows will make up for what may be lost to outflows as the COVID-19 pandemic cause the flight of capital from some African countries.

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Appendix 1

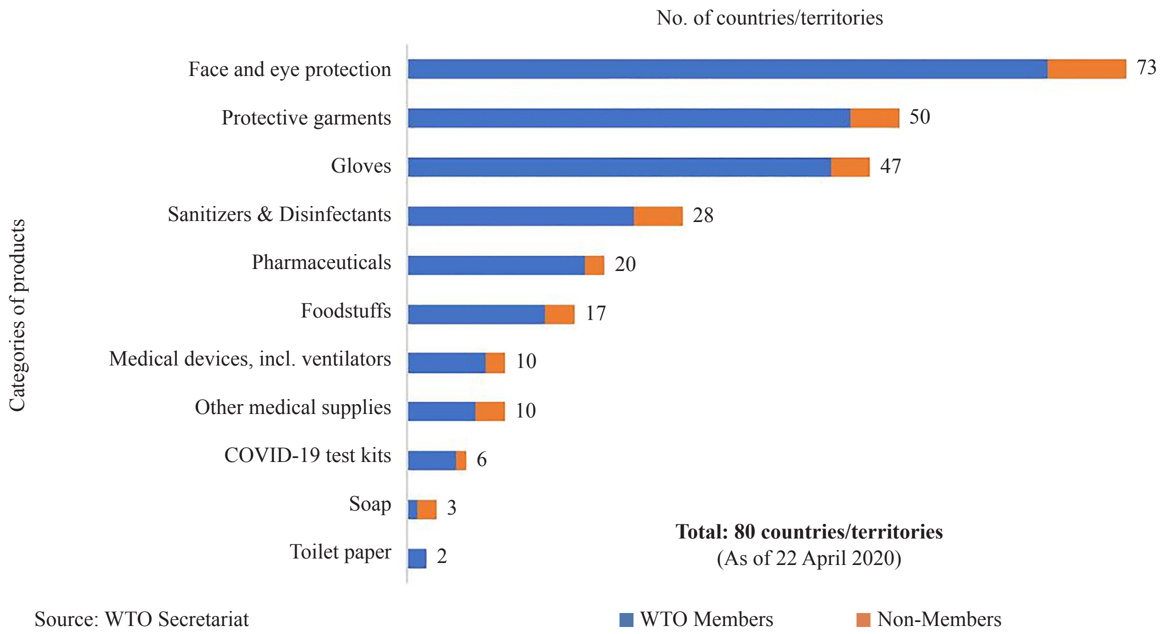

Figure 2. Countries/regions imposing export restrictions and prohibitions
Source: https://www.wto.org/english/tratop_e/covid19_e/export_prohibitions_report_e.pdf

Appendix 2

Table 10. Univariate ARCH (5), EGARCH (1, 1) and TGARCH (1, 1) models for export

Export Equation				
		ARCH (5)		
Variables	Coefficient	Std. Error	z-Statistic	Prob.
		Mean Equation		
C	0.0801	0.028	2.875	0.004
LNEP_(-1)	0.962	0.015	65.512	0.000
		Variance Equation		
C	0.003	0.001	3.932	0.000
$RESID(-1)^2$	0.508	0.239	2.123	0.034
$RESID(-2)^2$	0.055	0.149	0.369	0.712
$RESID(-3)^2$	0.064	0.124	0.513	0.608
$RESID(-4)^2$	-0.033	0.066	-0.495	0.621
$RESID(-5)^2$	0.011	0.027	0.398	0.691
R-squared	0.845			
Adjusted R-squared	0.844			
Observation				
AIC	-2.632			
SIC	-2.484			
HQC	-2.572			
		EGARCH (1, 1)		
		Mean Equation		
C	0.093	0.030	3.074	0.002
LNEP_(-1)	0.953	0.016	60.750	0.000
		Variance Equation		
C(3)	-2.286	0.890	-2.570	0.010
C(4)	0.506	0.207	2.448	0.014
C(5)	-0.182	0.163	-1.1108	0.267
C(6)	0.644	0.151	4.263	0.000
R-squared	0.846			
Adjusted R-squared	0.845			
Observations	202			
AIC	-2.637			
SIC	-2.522			
HQC	-2.590			
		TGARCH (1, 1)		
		Mean Equation		
C	0.083	0.030	2.805	0.005
LNEP_(-1)	0.958	0.015	62.190	0.000
		Variance Equation		
C	0.002	0.001	2.487	0.013
$RESID(-1)^2$	0.177	0.232	0.763	0.445
$RESID(-1)^2 \times (RESID(-1) < 0)$	0.587	0.456	1.286	0.198
GARCH(-1)	0.161	0.238	0.676	0.499
R-squared	0.846			
Adjusted R-squared	0.845			
Observations	202			
AIC	-2.644			
SIC	-2.523			
HQC	-2.598			

Source: Authors' computation (2021)

Appendix 3

Table 11. Univariate ARCH (5), EGARCH (1, 1) and TGARCH (1, 1) models for remittances

Remittances Equation				
		ARCH (5)		
Variables	Coefficient	Std. Error	z-Statistic	Prob.
		Mean Equation		
C	0.151	0.089	1.686	0.092
LNREM(-1)	0.988	0.008	126.403	0.000
		Variance Equation		
C	0.002803	0.001	2.187	0.029
$RESID(-1)^2$	0.250	0.119	2.099	0.036
$RESID(-2)^2$	0.361	0.189	1.908	0.056
$RESID(-3)^2$	-0.023	0.055	-0.418	0.676
$RESID(-4)^2$	0.099	0.113	0.873	0.383
$RESID(-5)^2$	0.180	0.146	1.234	0.217
R-squared	0.977			
Adjusted R-squared	0.977			
Observation	202			
AIC	-1.766			
SIC	-1.618			
HQC	-1.706			
		EGARCH (1, 1)		
		Mean Equation		
C	0.111	0.077	1.456	0.145
LNREM(-1)	0.992	0.007	148.698	0.000
		Variance Equation		
C(3)	-0.333	0.201	-1.652	0.098
C(4)	0.228	0.103	2.2150	0.027
C(5)	0.196	0.103	1.907	0.056
C(6)	0.966	0.031	31.005	0.000
R-squared	0.977			
Adjusted R-squared	0.977			
Observations	202			
AIC	-1.821			
SIC	-1.707			
HQC	-1.774			
		TGARCH (1, 1)		
		Mean Equation		
C	0.107	0.082	1.305	0.192
LNREM(-1)	0.992129	0.007	139.202	0.000
		Variance Equation		
C	0.000	0.000	0.904	0.366
$RESID(-1)^2$	0.322	0.172	1.875	0.061
$RESID(-1)^2 \times (RESID(-1) < 0)$	-0.279	0.197	-1.417	0.156
GARCH(-1)	0.823	0.091	8.994	0.000
R-squared	0.977			
Adjusted R-squared	0.977			
Observations	202			
AIC	-1.812			
SIC	-1.697			
HQC	-1.766			

Source: Authors' computation (2021)

Appendix 4

Post estimation test results.

Table 12. Ljung-Box Q test Q-stat test for serial correlation in exports

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
*|. |	*|. |	1	-0.139	-0.139	3.944	0.047
.|. |	.|. |	2	-0.001	-0.021	3.945	0.139
.|. |	.|. |	3	-0.031	-0.035	4.150	0.246
.|. |	.|. |	4	-0.021	-0.031	4.241	0.374
.|. |	.|. |	5	0.045	0.038	4.669	0.458
.|. |	.|. |	6	-0.053	-0.044	5.254	0.512
.|. |	.|. |	7	0.003	-0.011	5.255	0.629
.|. |	.|. |	8	0.010	0.010	5.278	0.728
.|* |	.|* |	9	0.103	0.107	7.564	0.579
*|. |	*|. |	10	-0.098	-0.075	9.644	0.472
.|* |	.|. |	11	0.080	0.067	11.031	0.441
.|. |	.|. |	12	-0.001	0.022	11.032	0.526

*Probabilities may not be valid for this equation specification
Source: Authors' computation (2021)

Table 13. Ljung-Box Q test Q-stat test for serial correlation in remittances

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
.|. |	.|. |	1	-0.008	-0.008	0.014	0.905
.|. |	.|. |	2	0.003	0.003	0.016	0.992
*|. |	*|. |	3	-0.159	-0.159	5.269	0.153
.|. |	.|. |	4	-0.056	-0.061	5.932	0.204
.|* |	.|* |	5	0.115	0.117	8.693	0.122
.|. |	*|. |	6	-0.042	-0.067	9.059	0.170
.|* |	.|* |	7	0.169	0.154	15.081	0.035
*|. |	.|. |	8	-0.075	-0.042	16.262	0.039
.|. |	.|. |	9	0.006	-0.001	16.269	0.061
.|. |	.|. |	10	-0.011	0.025	16.292	0.092
.|* |	.|* |	11	0.086	0.101	17.904	0.084
.|. |	*|. |	12	-0.016	-0.066	17.961	0.117

*Probabilities may not be valid for this equation specification
Source: Authors' computation (2021)

Table 14. ARCH-LM test for presence of heteroscedasticity in imports, exports and remittances

	Exports	Remittances
F-test	0.142	1.553
nR^2	1.817	18.096

Source: Authors' computation (2021)