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The Impact Of The Covid-19 Pandemic On Exports In Africa: An Approach Based On Fractional Integration

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ORIGINAL ARTICLE

The Impact of the COVID-19 Pandemic on Exports in Africa: An Approach Based on Fractional Integration

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Abstract

This paper examines the influence of the COVID-19 pandemic on exports in Africa. Fractional integration methods were applied to monthly African exports from 26 African countries from January 2011 to December 2020. We observe that the order of integration is found to be statistically smaller than 1 in all except a single country, Angola. For the rest of the African countries, shocks are transitory, showing mean reversion though with a large degree of heterogeneity across the countries, ranging from low levels of persistence with short memory behaviour in Sao Tome and Principle, the Seychelles and Kenya to high levels of persistence in the Democratic Republic of Congo.

JEL classification: C22, G15, M21

Keywords: Africa, Exports, Persistence, Fractional integration

1. Introduction

The rapid spread of COVID-19 and the policy measures taken by governments to contain it have had serious consequences for the global economy. Many productive activities have been disrupted. The data in Fig. 1 shows the massive decline in world GDP growth during 2020 from the perspective of other organizations such as United Nations ECLAC (2020).

All regions of the world were negatively affected, but Table 1 shows there seems to be a high concentration of the most affected countries in sub-Saharan Africa.

According to the World Trade Organization (2021), from 2015 to 2022, world merchandise trade volume experienced a linear increase (from an index of 100−120), except for an enormous decrease for almost a year (the 2019−2020 COVID effect). After this decline, the numbers turned more positive again in the second half of 2020 and forecasts suggest that world trade will resume its 2011 to 2019 trend in the latter half of 2022 (to reach the aforementioned 120, and maybe even improve on it).

This situation, where a pandemic affects commerce and economies, can be found in previous years, as SARS was widespread in Asia from 2002 to 2003. As Tanaka (2021) mentioned, many countries were impacted, all of which were in Asia (China, Hong Kong, Macao, Taiwan, Kuwait, Malaysia, Mongolia, Philippines, Republic of Korea, Russia, Singapore, Thailand, Viet Nam). The reduction in consumer spending on hotels and restaurants marked those economies. In this case, the shock was related to the demand side. The effect of the pandemic can also be found when observing transaction-level trade data for Chinese firms, because these regions with local transmission of SARS experienced lower import and export growth.

The COVID-19 pandemic hit African economies hard. The International Monetary Fund (2021) predicts that despite a more buoyant external environment, sub-Saharan Africa will be the world's slowest growing region in 2021. This decline will be

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mainly because of African economies that rely heavily on exports of commodities whose prices have crashed and have other structural challenges such as limited diversification. These challenges associated with COVID-19 will affect Africa's participation in trade and value chains and reduce foreign financing flows (Espitia et al., 2020). Given that Africa has low intra-regional trade, trade with the rest of the world is critical. There are eight regional economic communities in Africa, yet the share of intra-regional African trade remains low at around 14.8 percent in 2017. This is a very different situation to the one China had with SARS (2002–2003), whose overall macroeconomic impact on the country was noticeable only as a slowing down of growth in the third quarter, and this impact dissipated over the year (Beutels et al., 2009). But in this case, the pandemic was less global, less strong and in a better developed economic area. Before COVID-19, Africa's trade had been increasing progressively. In the period 2015–2017, total trade from Africa to the rest of the world averaged US$ 760 billion. From 2000 to 2017 Africa's exports to the rest of the world as a share of its total trade ranged from 80 to 90 percent. Africa is therefore the region with the second highest export dependence in the world after Oceania (United Nations Conference on Trade and Development, 2019).

Abbreviations

AJBM	African Journal of Business Management
AEP	Asian Economic Papers
AEPR	Asian Economic Policy Review
B	Biometrika
ERSS	Energy Research and Social Science
EMPH	Ethics, Medicine and Public Health
FBR	FIIB Business Review
GHJ	Global Health Journal
GH	Global Health
JE	Journal of Econometrics
JEB	Journal of Economics and Business
JFE	Journal of Financial Econometrics
JGH	Journal of Global Health
JIA	Journal of Integrative Agriculture
JTSA	Journal of Time Series Analysis
IER	International Economic Review
IJFE	International Journal of Finance and Economics
SIR	Social Indicators Research
SAJE	South African Journal of Economics
TWE	The World Economy
TMIH	Tropical Medicine and International Health
TE	Tourism Economics

The situation in the African continent is not more positive or retrievable due to government measures. The different governments were giving mostly fiscal/financial and short-term economic stimulus packages, with medium to long term measures often

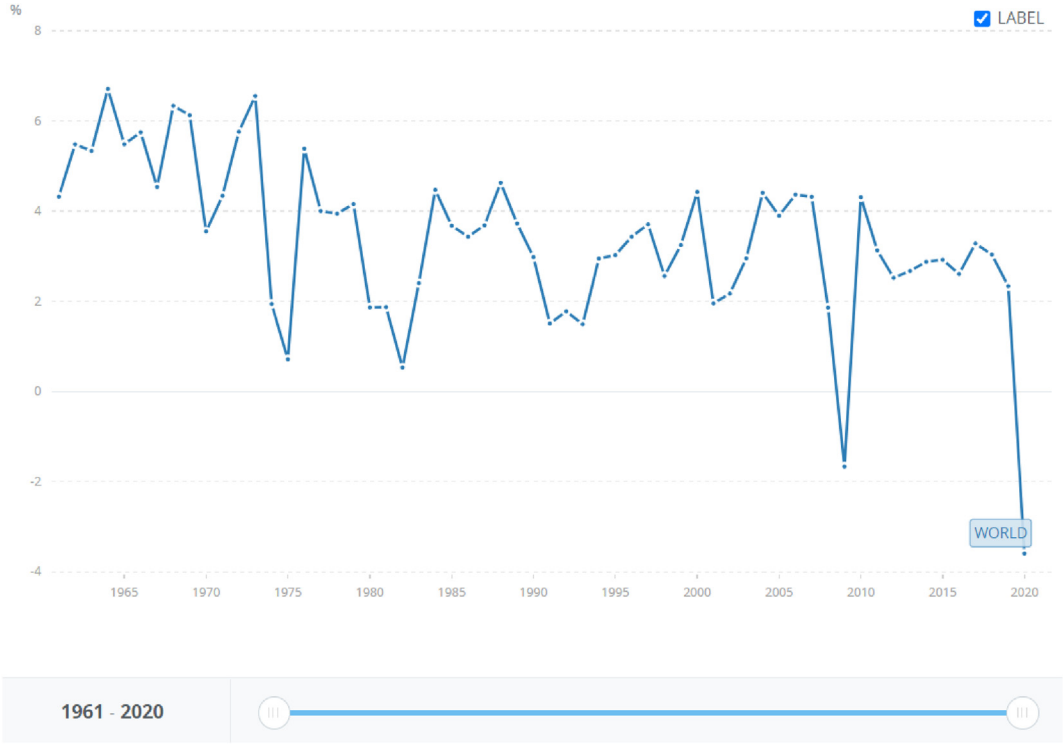


Fig. 1. Graphic for GDP Growth (annual %) (The World Bank, 2021). Source: World Bank national accounts data, and OECD National Accounts data files.

Table 1. GDP growth (annual %).

Region	2018	2019	2020
Africa Eastern and Southern	2,48	2,08	−2,94
Africa Western and Central	2,95	3,19	−0,88
Middle East & North Africa	1,48	1,16	−3,99
Sub-Saharan Africa	2,69	2,58	−2,01
Middle East & North Africa (IDA & IBRD countries)	0,59	0,55	−3,40
Sub-Saharan Africa (IDA & IBRD countries)	2,69	2,58	−2,01
North America	2,98	2,14	−3,55
European Union	2,07	1,82	−5,96

broad without being specific to the energy sector (Akrofi & Antwi, 2020). As energy is the motor of a country, the help measures were not enough to compensate for the pandemic's effects. Another highly impacted sector was animal production, due to food security and safety concerns, where measures have not facilitated farmers' participation in government regulations on enforcing biosecurity, health standards, disease monitoring, and surveillance practices (Ejeromedoghene et al., 2020). Africa remains a continent with huge potential, but it is far from reaching its full potential and the pandemic has not helped by showing the weakness of its health systems and its high levels of poverty (Akintunde et al., 2021).

The main objective of this study is to determine if COVID-19 has had any influence on exports in Africa, using a panel of 26 countries for the period from January 2011 to December 2020. We choose this sample period both due to data availability for the African countries in question and to ensure that the period adequately captures the dominant period of the COVID-19 pandemic impact both globally and in Africa.

We use a methodology relatively new in the context of time series analysis, namely fractional integration. It is very insightful for researching the effect of shocks in time series like the one caused by the present pandemic. The countries under examination are displayed in the Appendix.

The main contribution of the present work is the gap it fills in the analysis of the impact of the COVID-19 pandemic on African exports through the use of innovative fractional integration time series techniques. Exports play a critical role in the development of these countries, so it is vital to understand how they were impacted by the COVID-19 pandemic.

The rest of the paper is structured as follows: Section 2 introduces a short literature review. Section 3 describes the dataset, while Section 4 is devoted to the methodology. Section 5 reports the empirical results while Section 6 concludes the paper.

2. Literature review

The United Nations Conference on Trade and Development (2019) analyses, in a special report, the salience of commodities in the Commonwealth members' merchandise trade and estimates what the likely effect would be of the COVID-19 pandemic's induced trade disruptions to five main markets: China, the United States of America, the European Union, the United Kingdom and Australia. The analysis of the data finds that commodities constitute almost half of the Commonwealth countries global merchandise exports but that the share for 35 commodity dependent commonwealth countries is above 80 percent. Countries whose export prices collapsed due to the COVID-19 pandemic were more adversely affected. Overall, projections and simulation results would suggest that dependency patterns have at best been maintained because of the COVID-19 pandemic shock. At worst, and especially among highly dependent commodity exporters, the pandemic has further accentuated a fragile macroeconomic situation already under pressure due to heightened price fluctuations in several commodity markets.

Yaya et al. (2020) argue from different aspects that the COVID-19 pandemic has ushered in a period of uncertainty which is increasing protectionism. Globalisation is under significant threat as governments scramble to reduce their vulnerability to the virus by limiting global trade and flows of people. With the imposition of border closures and strict migration measures, there have been major disruptions to Africa's global supply chains with adverse impacts on employment and poverty. The African economies that are less diversified, depending on single, export-orientated industries such as oil and gas, are expected to be very adversely affected. The authors argue that the situation is further exacerbated by initially falling oil prices and a lowered global demand for African non-oil products. The agricultural sector is also affected by the enforcement of lockdowns, which threaten people's livelihoods and food security. The authors argue that maintaining cross-border trade and cooperation to continue generating public revenues is vital. They contend that economic diversification in Africa is vital, as is enhancing trade with a more regional focus as promoted by the African Continental Free Trade Agreement.

Espitia et al. (2020) analyses the impact of COVID-19 and uncooperative trade policies on world food markets. In the first part of the paper, under the assumption that products that are more labour intensive in production are more affected through workers' morbidity and containment policies, the

authors propose a theoretical model that quantifies the initial shock due to the pandemic. They next show how escalating export restrictions to shield domestic food markets magnify the initial shock. The model is then applied to data corresponding to Chinese exports of food during January and February 2020 and to world trade flows in food markets. The analysis demonstrates that, in the quarter following the outbreak of the pandemic, the global export supply of food cold decrease from 6% to 2% and global prices increase from 2% to 6% on average. Escalating export restrictions would multiply the initial shock by a factor of 3, with world food prices rising by up to 18 percent on average. Import food dependent countries, which are mainly developing countries, would be most adversely affected (Espitia et al., 2020).

Lin and Zang (2020) argue that it is vital to understand how COVID-19 has affected global food supply and markets. Specifically, they investigate the impact of COVID-19 on agricultural export companies in China using a unique firm-level survey data with a total of 102 agricultural export companies up to April 2020. The authors apply three different methods to compare current data with the previous year: the nonparametric Kruskal-Wallis test, bootstrapped quantile regression and an ordered logit model. They find that although on average agricultural businesses experienced declines in exports, exports of some agricultural products, especially grain and oil, held strong and even increased, implying the essential demand for staple food during the pandemic. Exports of medicinal herbs increased significantly during the pandemic. However, exports of goods such as edible fungus and horticultural products sharply decreased. Their results also showed that in general, impact of COVID-19 on smaller firms was more severe than that on larger firms.

Veeramani (2021) examines the impact of COVID-19 on India's exports of services. Owing to the important contribution of services in India's foreign trade, this study examines the impact of the pandemic on aggregate, sectoral and mode-wise services exports from India. The study seeks to highlight key opportunities, challenges and suggestions to protect and promote India's services interest amid this global disruption. The study reviews the quarterly and monthly services exports patterns from January to July 2020 based on the data obtained from the World Trade Organization and the Reserve Bank of India. The perspective on mode-wise services exports is derived from the Trade-in Services by Modes of Supply (TISMOS) data set of the WTO for 2017. The analysis highlights a severe drop in overall services exports, by over 10% during the second quarter of 2020. Travel, transport and financial services have been hit hardest. However, the decline in India's services exports was found to be relatively much lower in comparison to other major, services-exporting economies. The comparative edge in digital or Mode 1 services offers greater opportunities for the country in the longer term if urgent policy initiatives and support are extended to potential online services sectors.

Arising from the literature, the conceptual framework utilised for the study is the terms of trade shock framework. Worsening terms of trade lead to a decline in exports compared to imports and thus to a spending effect and resource movement effect (Funke et al., 2008). Lower export prices could arise from a decline in world market prices for export goods, leading to declining national income and hence lower demand for both tradables and non-tradables. A terms of trade shock also potentially reduces the marginal product of factors of production in the export sector, shifting resources away from this sector. The price of tradables relative to non-tradables will also decline. This terms of trade effect was clearly in evidence during the first year of the COVID-19 pandemic when world prices for commodity exports, notably oil produced by many African countries, dropped considerably following income shocks arising from the pandemic in many parts of the world. This view is reinforced by Schmitt-Grohe and Uribe (2018) who argue that terms of trade shocks can represent a major source of business cycles in developing countries based on calibrated business-cycle models.

Some empirical literature that specifically focusses on the trade shocks related to COVID-19 also exists. Espitia et al. (2022) studies the trade effects of COVID-19 up until June 2020 using monthly disaggregated trade data. The result showed that the negative trade effects caused by the pandemic shocks varied amply across sectors. Kejžar et al. (2022) showed how the interconnections of supply chains transmitted COVID-19-induced shocks during the initial wave of the pandemic. For their study they used the framework of the gravity model determining the links of the global value chain (GVC), so that as the chain progresses, it acts as a channel for the transmission of (demand) shocks. In a very specific sector, Japan's Machinery Trade, we find Ando et al. (2021) investigating the impacts of COVID-19. They affirmed that COVID-19 had two clear aspects: high demand for specific products related to the pandemic and low demand for products with little relevance to the disease and its consequences, thus explaining heterogeneous

effects not only between sectors but also between products of the same sector due to their relationship with the restrictions and needs of the pandemic. Based on UK data, Du and Shepotylo (2022), compared trade data during COVID-19 with other European countries and the US, showing inferior results for the Brexit country due to both external and internal factors.

In this paper we use fractional integration, which is very suitable and flexible to determine if, for instance, shocks in a series have temporary or permanent effects. Fractional integration or long memory methods analysing variables in the African continent can be found in numerous articles. The stochastic behaviour of unemployment in eleven African countries during five decades (1960–2010) was analysed in Caporale and Gil-Alana (2018), suggesting that hysteresis models are the most appropriate ones for the African experience. Solarin et al. (2021) examined income poverty in 53 African countries, finding that the series are highly persistent and that long-term policies aimed at addressing income poverty will have long-lasting effects on poverty reduction (Solarin et al., 2021). Nominal exchange rate dynamics in three groups of African countries were studied in Balparda et al. (2015). Their results showed that, except for three countries, there was a unit root related to the nominal exchange rate series. The Gross Domestic Product and growth rate series of Nigeria and Kenya were compared in Awe et al. (2021), finding that, since independence, both countries have followed different but somewhat similar paths towards economic growth. Nevertheless, none of the above studies focus on the effect of COVID-19 on exports in Africa.[1]

3. Data

The data for this study includes monthly data of African exports from January 2011 to December 2020 for 26 selected Africa countries from all over the continent. The source of the data is the United Nations International Trade Statistics Database. We choose this period of time for the study based on the data availability. Going back to 2011 implies to have a long span of data to perform the analysis based on fractional integration.

Table 2 presents some descriptive statistics. Most observations begin from January 2011, except for Angola, the Democratic Republic of Congo, the

Table 2. Descriptive statistics (in logs).

Series	Max.	Min.	Mean	Std. Dev.
ALGERIA	9.89686471	9.3332619	9.63209995	0.16579486
ANGOLA	9.58993975	9.19025982	9.45813613	0.08210172
BENIN	8.33044271	7.11883545	7.6754274	0.2401881
BOTSWANA	9.01374322	7.08092256	8.68316013	0.22846
BURUNDI	7.47782127	6.59522421	7.08005528	0.19995643
CABO VERDE	7.02050941	6.44229912	6.72400724	0.13961631
CAMEROON	8.76737849	8.16447827	8.45368255	0.16549464
COMOROS	7.14623064	5.35777481	6.26681947	0.35729606
COTE D'IVORY	9.29166233	7.81663368	8.97945693	0.16515691
DEM. R. CONGO	9.3414776	8.66924462	8.99542162	0.16437787
EGYPT	9.47301315	9.15533965	9.35239916	0.0682887
ETHIOPIA	8.73549518	7.8720535	8.23134122	0.16738513
GAMBIA	7.13061362	4.3287872	6.42149202	0.57603228
GHANA	9.67525326	8.31828566	9.10079579	0.16423298
KENYA	8.79330571	8.60461077	8.69155635	0.03847317
MADAGASCAR	8.55881273	7.73968215	8.23391879	0.159837
MOZAMBIQUE	8.78226591	8.23795112	8.50553978	0.12061894
RWANDA	8.12942573	7.1815299	7.74293928	0.18592002
SAO TOME & PRINC.	6.46811387	4.0949949	5.77712407	0.41441126
SENEGAL	8.74287154	8.19692405	8.39542872	0.1031571
SEYCHELLES	8.26315403	7.28675121	7.68044895	0.19422965
SOUTH AFRICA	10.0008086	9.45300986	9.87407073	0.06937523
TOGO	8.33357686	7.6852969	7.89087458	0.12034042
UGANDA	8.74816864	8.19401797	8.39033071	0.12201015
ZAMBIA	9.04947891	8.65854859	8.83639863	0.08801196
ZIMBABWE	8.76181097	8.15840631	8.49381933	0.11635895

[1] Fractional integration has been widely used in other areas in economics and finance, including the analysis of inflation (Canarella & Miller, 2017); tourism (Nowman & van Dellen, 2012) or the term premium (Abbritti et al., 2016).

Seychelles and Uganda, which begin in January 2015. The observations for Sao Tome and Principe begin in January 2013. The smallest standard deviations for the data set are observed for Angola, Egypt, Kenya and Zambia. The largest standard deviations in the data set are observed for Burundi, Rwanda, Gambia and the Seychelles.

4. Methodology

The analysis uses fractional integration, which is quite convenient to determine the nature of shocks, being transitory if the differencing parameter is lower than 1, while permanent if that parameter is equal to or higher than 1. This approach focuses on the following model,

$$(1-L)^d x_t = u_t, t = 1, 2, \ldots, \quad (1)$$

where x_t is the observed time series (or the errors in a regression model formed by deterministic terms like an intercept and or a time trend) and u_t is I (0) or short memory; L is the lag operator, i.e., $L^k x_t = x_{t-k}$, and d can be any real value, including thus fractional numbers. Clearly this approach is more general than the one based exclusively on integer degrees of differentiation, i.e., 0 for stationarity (e.g., ARMA) and 1 for nonstationarity (ARIMA). This model was first proposed in Granger and Joyeux (1980), Granger (1980) and Hosking (1981) though its applications became common during the late 90s (Gil-Alana & Robinson, 1997) and have now become standard in the analysis of time series during the last 20 years. Fractional differentiation is also more flexible that the standard unit root methods and allows for a higher degree of flexibility in the dynamic specification of the models, permitting, for example, nonstationary processes though with mean reverting behaviour, if the order of integration is in the interval [0.5, 1), discriminating then between transitory effects of the shocks ($d < 1$) and permanent effects ($d \geq 1$). More in particular, depending on the value of d, we can have different processes such as anti-peristence ($d < 0$); short memory ($d = 0$); stationary long memory ($0 < d < 0.5$); nonstationary mean reversion ($0.5 \leq d < 1$); unit roots ($d = 1$), or even explosive processes ($d > 1$).

The estimated model in the following section is:

$$y_t = \beta_0 + \beta_1 t + x_t; \quad (1-L)^d x_t = u_t,; \quad u_t = \rho u_{t-4} + \varepsilon_t. \quad (2)$$

Table 3. Estimates of the differencing parameter d.

Series	No terms	An intercept	A linear time trend
ALGERIA	0.97 (0.83, 1.18)	0.65 (0.54, 0.83)	**0.52 (0.33, 0.81)**
ANGOLA	0.93 (0.78, 1.12)	**0.81 (0.63, 1.07)**	0.81 (0.62, 1.07)
BENIN	0.99 (0.85, 1.19)	**0.55 (0.41, 0.78)**	0.54 (0.38, 0.78)
BOTSWANA	0.94 (0.82, 1.09)	0.24 (0.15, 0.37)	**0.19 (0.08, 0.34)**
BURUNDI	0.95 (0.77, 1.23)	**0.54 (0.33, 0.87)**	0.57 (0.34, 0.88)
CABO VERDE	0.92 (0.77, 1.15)	**0.22 (0.04, 0.48)**	0.22 (0.03, 0.48)
CAMEROON	0.93 (0.74, 1.23)	0.56 (0.43, 0.78)	**0.35 (0.07, 0.75)**
COMOROS	0.91 (0.79, 1.07)	0.37 (0.23, 0.56)	**0.36 (0.20, 0.58)**
COTE D'IVORY	0.92 (0.80, 1.08)	**0.19 (0.00, 0.43)**	0.17 (−0.02, 0.42)
DEM. R. CONGO	0.96 (0.81, 1.17)	**0.68 (0.59, 0.81)**	0.68 (0.58, 0.80)
EGYPT	0.98 (0.86, 1.14)	**0.53 (0.42, 0.71)**	0.53 (0.41, 0.72)
ETHIOPIA	0.97 (0.83, 1.15)	**0.52 (0.37, 0.74)**	0.52 (0.36, 0.74)
GAMBIA	0.88 (0.76, 1.06)	0.35 (0.28, 0.45)	**0.23 (0.14, 0.36)**
GHANA	0.95 (0.84, 1.10)	**0.23 (0.12, 0.39)**	0.23 (0.10, 0.40)
KENYA	0.93 (0.77, 1.21)	**0.03 (-0.18, 0.36)**	0.00 (−0.24, 0.38)
MADAGASCAR	0.96 (0.85, 1.10)	0.42 (0.33, 0.54)	**0.36 (0.23, 0.53)**
MOZAMBIQUE	0.96 (0.82, 1.14)	0.31 (0.22, 0.43)	**0.27 (0.17, 0.40)**
RWANDA	0.98 (0.86, 1.11)	0.49 (0.42, 0.59)	**0.40 (0.27, 0.57)**
SAO TOME& PRINCIPE	0.77 (0.62, 0.97)	−0.03 (−0.16, 0.16)	**−0.08 (-0.24, 0.14)**
SENEGAL	0.96 (0.85, 1.11)	0.27 (0.20, 0.37)	**0.12 (0.02, 0.25)**
SEYCHELLES	0.95 (0.77, 1.20)	0.15 (0.04, 0.31)	**−0.07 (-0.27, 0.20)**
SOUTH AFRICA	0.97 (0.86, 1.12)	**0.48 (0.37, 0.65)**	0.46 (0.33, 0.65)
TOGO	0.97 (0.84, 1.13)	**0.19 (0.09, 0.34)**	0.17 (0.06, 0.33)
UGANDA	0.93 (0.77, 1.19)	0.55 (0.94, 0.75)	**0.32 (0.05, 0.71)**
ZAMBIA	0.97 (0.85, 1.13)	**0.54 (0.44, 0.67)**	0.53 (0.43, 0.67)
ZIMBAWE	0.97 (0.85, 1.12)	**0.45 (0.30, 0.66)**	0.44 (0.27, 0.67)

The values in parenthesis are the 95% confidence bands for the values of the differencing parameter. We have marked in bold the selected specification for each country.

Table 4. Estimated coefficients based on the specified models in Table 3.

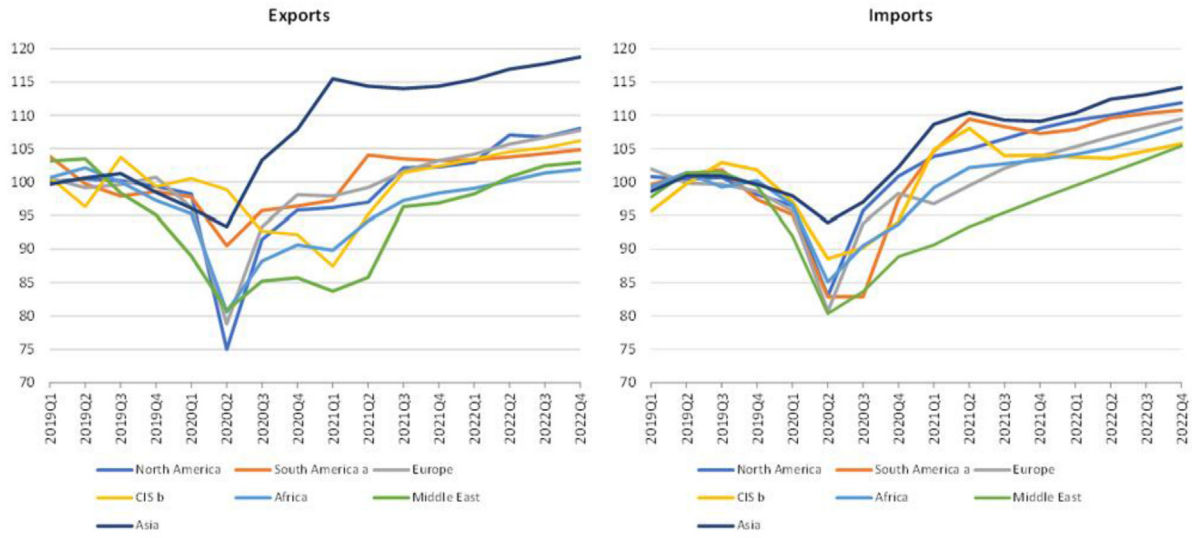
Series	No terms	An intercept	A time trend	Seasonality
ALGERIA	0.52 (0.33, 0.81)	22.417 (179.13)	−0.0096 (−2.88)	0.039
ANGOLA	0.81 (0.63, 1.07)	21.752 (217.42)	–	−0.0003
BENIN	0.55 (0.41, 0.78)	17.367 (63.08)	–	0.428
BOTSWANA	0.19 (0.08, 0.34)	20.210 (118.97)	−0.0044 (−1.70)	−0.046
BURUNDI	0.54 (0.33, 0.87)	16.117 (59.15)	–	−0.262
CABO VERDE	0.22 (0.04, 0.48)	15.464 (174.26)	–	0.128
CAMEROON	0.35 (0.07, 0.75)	18.894 (162.29)	0.0299 (5.57)	−0.113
COMOROS	0.36 (0.20, 0.58)	13.783 (36.53)	0.0119 (1.99)	0.272
COTE D'IVORY	0.19 (0.00, 0.43)	20.659 (287.16)	–	0.338
DEM. R. CONGO	0.68 (0.59, 0.81)	20.540 (139.38)	–	0.273
EGYPT	0.53 (0.42, 0.71)	21.559 (281.85)	–	0.496
ETHIOPIA	0.52 (0.37, 0.74)	18.884 (90.28)	–	0.351
GAMBIA	0.23 (0.14, 0.36)	16.234 (44.44)	−0.026 (−4.74)	0.005
GHANA	0.23 (0.12, 0.39)	20.957 (232.55)	–	−0.034
KENYA	0.03 (−0.18, 0.36)	20.013 (1514.66)	–	0.124
MADAGASCAR	0.36 (0.23, 0.53)	18.431 (153.71)	0.0084 (4.57)	0.251
MOZAMBIQUE	0.27 (0.17, 0.40)	19.405 (180.44)	0.0044 (2.22)	0.045
RWANDA	0.40 (0.27, 0.57)	17.097 (148.36)	0.0120 (16.69)	0.215
SAO TOME & PRINCIPE	−0.08 (−0.24, 0.14)	12.927 (67.62)	0.0123 (2.23)	0.204
SENEGAL	0.12 (0.02, 0.25)	19.072 (401.17)	0.0043 (6.60)	0.230
SEYCHELLES	−0.07 (−0.27, 0.20)	17.386 (194.64)	0.0098 (3.77)	0.293
SOUTH AFRICA	0.48 (0.37, 0.65)	22.782 (324.26)	–	0.340
TOGO	0.19 (0.09, 0.34)	18.175 (348.86)	–	−0.037
UGANDA	0.32 (0.05, 0.71)	19.285 (315.92)	0.0152 (5.38)	0.109
ZAMBIA	0.54 (0.44, 0.67)	20.387 (225.85)	–	0.082
ZIMBAWE	0.45 (0.30, 0.66)	19.504 (168.81)	–	0.398

The values in parenthesis in the third and fourth columns are the corresponding t-values.

where ρ refers to the seasonal component and ε_t is a white noise process. We consider the three standard approaches of i) no deterministic terms, ii) with an intercept, and iii) with an intercept and a linear time trend, and we mark in bold in Table 3 (in the following section) the significant selected model for each series. This selection is based on the t-values of the coefficients on the differenced regression. The estimation is conducted vía Whittle function in the frequency domain.

5. Findings and discussion

Table 3 displays the estimated values of d and the 95% confidence bands in the model given by 2, under the three scenarios described in the previous section. The first thing we observe is that the time trend is required in a number of cases, in twelve out of the 26 cases presented, and looking in Table 4 at the estimated coefficients, we observe that the time trend parameter is significantly positive in the twelve cases, implying that for these countries, exports are increasing across time. Next we look at the estimated coefficients of the differencing parameter d and we see that d is significantly smaller than 1 in all cases except a single case (Angola). We observe some countries with the estimates of d in the I (0) range: Sao Tome and Principe (−0.08), Seychelles (−0.07) and Kenya (0.03), i.e, displaying short memory; for another group of countries, the estimates of d are in the stationary range (0, 0.5). These are the cases of Senegal (0.12), Botswana (0.18), Cote d'Ivoire and Togo (0.19), Cabo Verde (0.22), Gambia and Gahan (0.23) and Mozambique (0.27); for another group of countries, the values are around 0.5, i.e., including stationary ($d < 0.5$) and nonstationary ($d \geq 0.5$), the values ranging from 0.32 in Uganda to 0.55 in Benin; finally, the estimated value of d is found to be significantly above 0.5 (and thus displaying nonstationary behaviour) for Democratic Republic of Congo (0.68) and Angola (0.81). It is observed that countries with more diversified exports such as Kenya, Senegal, Botswana and Cote D'Ivoire tend to have more transitory shocks. This is because an adverse shock impact in one export sub-sector is more likely to be offset by a positive shock impact in another sub-sector when the economy is diversified. On the other hand, countries that have a less diversified export base, for example, Angola which



a. Refers to South and Central America and the Caribbean.
b. Refers to Commonwealth of Independent States, including certain associate and former member States.

Fig. 2. Merchandise exports and imports by region, 2019Q1-2022Q4. a. Refers to South and Central America and the Caribbean. b. Refers to Commonwealth of Independent States, including certain associate and former member States. Source: WTO and UNCTAD.

is heavily dependent on oil exports, and the Democratic Republic of Congo which is very dependent on mineral exports, tend to have greater permanence of shocks as there are few offsetting export sub-sectors in the case of an adverse shock such as the COVID-19 pandemic. Export diversification therefore varies considerably across different African states. This in turn implies that we observe a large degree of heterogeneity in the degree of persistence across countries moving from values close to 0 and showing short memory to values close to 1 and displaying nonstationarity. The issue of whether institutions in countries are more or less inclusive also seems to have an important impact on whether shocks are transitory or not. In African countries with more inclusive political and economic institutions like Kenya, shocks then to be more transitory whereas in countries with less inclusive institutions like Angola, shocks tend to be more permanent. Whether shocks are permanent or transitory also has an impact on the types of policy actions that need to be taken in particular countries to address the shocks. Thus, in the event of a negative shock, like the one caused by the COVID-19 pandemic stronger policy actions should be adopted in countries such as Benin, Democratic Republic of Congo and Angola than in others like Sao Tome and Principe, Seychelles (−0.07) or Kenya since in the former countries the shock will have long lasting effects than in the latter countries.

In general, the export direction and components indeed influenced the impact and nature of any export shocks during the COVID-19 pandemic. Most African countries export to European and North American countries primarily because of former colonial ties. These exports are carried out primarily by air or by container shipping. During the COVID-19 pandemic, there were significant logistical constraints on exports as air travel, and container shipping restrictions were in force for several months of the pandemic as measures were put in place to slow down the spread of the pandemic globally. Even once travel restrictions were reduced excess demand for logistical facilities continued to prevail for several months because of the backlog making it difficult to export. There were also profound supply chain restrictions on inputs which also slowed down exports, as several critical imported inputs such as agricultural machinery and fertilisers are required for export production. Many African export production sectors still rely on imported imports, for example, the agricultural sector, which is still critical in many African exports. African countries rely heavily on imported inputs, especially from Asian markets such as China and India where supply chain restrictions were severe. In addition, as discussed earlier, for African countries with less diversified export components the nature of the shock on exports has been shown to be more permanent whereas those with more diversified export components having more

transitory shocks. Export components therefore influenced the nature of export shocks.

As a final remark, seasonality is not a very relevant issue, since the estimated parameter, reported in the last column of Table 4, shows low values in the majority of cases, the highest numbers corresponding to Cote d'Ivoire (0.338), South Africa (0.340), Zimbabwe (0.398), Benin (0.428) and Egypt (0.496).

6. Conclusion

In this paper we have investigated the degree of integration in the series corresponding to monthly African exports from 26 African countries to establish the effect of the impact of the COVID-19 pandemic on African exports. We established that the estimated values of d are smaller than 1 in all except a single case (Angola). The results for Angola can be explained by the fact that the economy is highly dependent on oil exports and hence shocks to oil prices tend to be more permanent. In general, the more diversified the export base of a country is, the more transitory the shocks. In the other African countries considered, shocks are transitory, showing mean reversion though with a different degree of it from low values to high values. The results are therefore heterogeneous. This implies that African countries should continue to diversify their exports in order to reduce the adverse impact of shocks such as COVID-19. For example, countries that rely heavily on extractive exports such as oil should diversity by strengthening their service and manufacturing sectors. Countries that already have some degree of diversification should aim to continue to strengthen their level of diversification to further reduce the adverse impact of negative shocks. Diversification will also have implications for the degree of policy action that needs to be taken in the event of shocks such as COVID-19. For African countries where shocks are transitory, the policy authorities do not need to take strong policy action to achieve mean reversion. On the other hand, for countries like Angola, strong policy measures need to be taken to achieve mean reversion. These strong policy actions need to be accompanied by urgent measures to diversify the Angolan economy to reduce its dependence on oil.

Fig. 2 (WTO, 2021) shows these conclusions are broadly confirmed by the growth trend in actual merchandise exports by region of the world up to the end of 2021Q2 and the latest forecasts from 2021Q3 to 2022Q4. The impact of the COVID-19 pandemic can be seen to have been transitory on Africa as well as all other regions of the world.

The impact of COVID-19 on export shocks could also potentially vary with the direction of individual African countries based on whether they export to the European Union, NAFTA, ASEAN, the Middle East or other regions of the world. This could introduce a certain asymmetry of terms of trade shocks. Such regional direction of trade analysis of African countries is also an interesting issue that could be examined in future studies.

Availability of data and materials

Data are available from the authors upon request.

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Authors' contributions

Prof. Robert Mudida proposed the original idea. He also wrote the introduction and the interpretation of the results along with the conclusions.

Prof. Luis A. Gil-Alana was in charge of the computation and the empirical results, the interpretation of the results and the conclusions.

Dr. Gema Lopez collaborated with the data search, introduction, literature review and conclusions.

Conflicts of interest:

There are no competing interests with the publication of the present manuscript.

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APPENDIX

Table A. Series under examination.

Country	Starting period	Ending period	N. observations
ALGERIA	January 2011	March 2017	75
ANGOLA	January 2015	September 2019	57
BENIN	January 2011	December 2019	108
BOTSWANA	January 2011	December 2020	107
BURUNDI	January 2011	December 2017	45
CABO VERDE	January 2011	February 2019	59
CAMEROON	January 2011	December 2013	36
COMOROS	January 2011	December 2019	108
COTE D'IVORY	January 2011	December 2019	108
DEM. R. CONGO	January 2015	December 2020	72
EGYPT	January 2011	December 2020	120
ETHIOPIA	January 2011	December 2018	95
GAMBIA	January 2011	December 2020	108
GHANA	January 2011	December 2019	107
KENYA	January 2011	December 2020	43
MADAGASCAR	January 2011	March 2020	111
MOZAMBIQUE	January 2011	December 2018	90
RWANDA	January 2011	May 2020	113
SAO TOME & PRINC.	January 2013	December 2019	61
SENEGAL	January 2011	December 2020	120
SEYCHELLES	January 2015	December 2019	60
SOUTH AFRICA	January 2011	December 2020	119
TOGO	January 2011	December 2019	108
UGANDA	January 2015	December 2020	51
ZAMBIA	January 2011	December 2020	119
ZIMBAWE	January 2011	December 2020	118

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