The Impact of COVID-19 Pandemic on Social Welfare and the Health System Capacity of East African Economies: A Comparative Analysis

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Abstract

This study analyzed the degree of impact of COVID-19 on social welfare and health system capacity across some selected EAC countries using monthly series data for the period March 2020-May 2021. The potential Intensive Care Unit (ICU) bed and ventilator surge capacity were estimated based on the confirmed COVID-19 cases & the actual number of ICU beds and oxygen ventilators while the degree of variation of the pandemic's impact on social welfare was analyzed using the Pooled Mean Group (PMG) estimator. The findings revealed the existence of significant gaps across hospitals in the EAC region in accommodating any potential surge in the caseload emanating from COVID-19. This was evidenced by a continuously rising number of confirmed COVID-19 cases against a backdrop of a limited number of ICU beds and ventilators needed to provide critical care. The PMG results revealed that COVID-19 significantly decreased the Consumer Price Index (CPI) in the long run. In the short run, the impact was negative and significant for Kenya but insignificant for Rwanda, South Sudan, and Uganda. Conversely, COVID-19 significantly increased oil prices in the long run. In the short run, the impact was positive and significant for South Sudan but negative and insignificant for Uganda. This study, thus, recommended adequate investment in the health sector targeted at a substantial increase in the number of ICU beds and ventilators. Further, governments within the region need to employ a coordinated approach in addressing welfare effects stemming from increased oil prices. There is a need to promote regional market integration & cooperation within the EAC region regarding oil. A robust & vibrant EAC oil market will enable countries within the region to harness optimal benefits from their oil reserves as well as withstand any global price shock dynamics that emanate from a pandemic of this nature.

JEL Classification: I14, I31, H12

Keywords: COVID-19, Health system capacity, Social welfare, PMG estimator, EAC region.

1. Introduction

1.1 Background

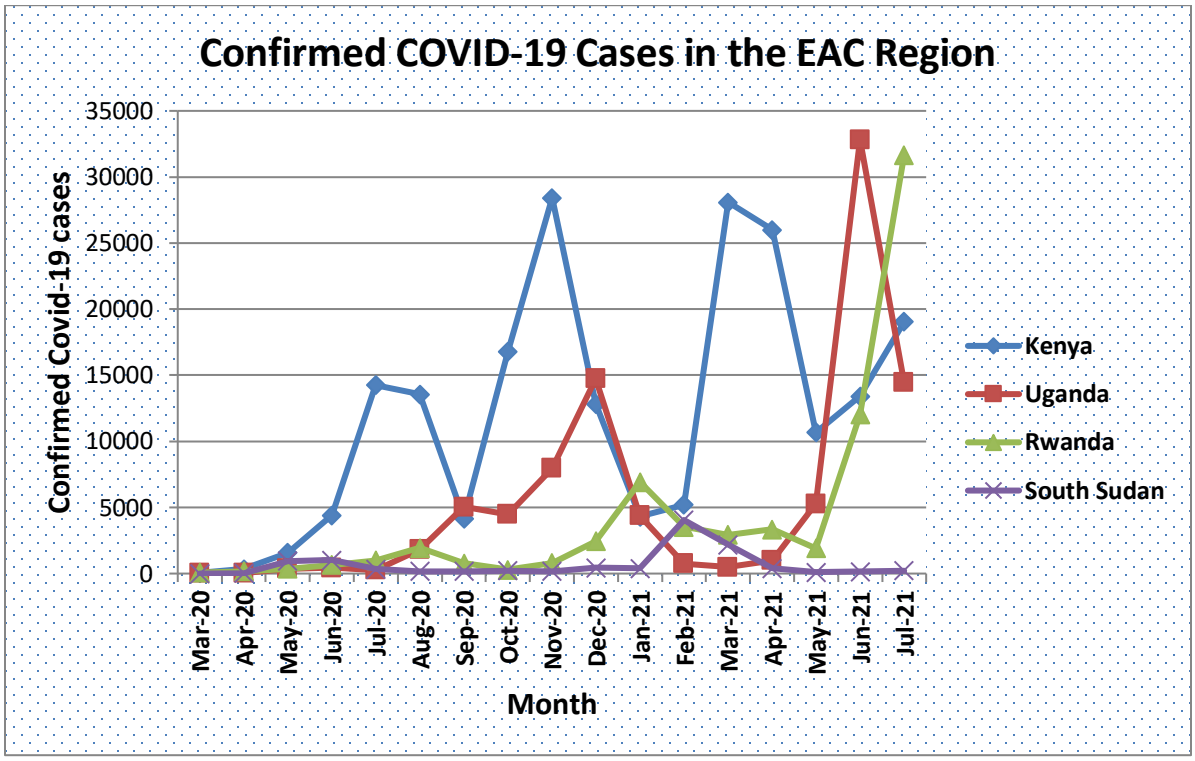
The COVID-19 pandemic has yielded an unprecedented impact on socio-economic welfare and the health system capacity of economies globally. The pandemic has spread rapidly around the world since December 2019 when it was first reported in Wuhan, China. It has directly affected food prices as well as disrupted the normal flow of household incomes, thus, leading to increased food and nutritional insecurity around the world (AGRILINKS, 2020).

Disrupted global food chains (stemming from both domestic and international trade restrictions) coupled with massive job layoffs attempted at addressing many firms' revenue losses implies that the socio-economic welfare of people across the world has been negatively impacted. The most recent poverty and shared prosperity report by World Bank (2020) approximate that the pandemic could plunge 100 million people into extreme poverty in 2020 year alone, leading to increased global poverty for the first time since 1998. Baldwin and Tomiura (2020) further predict that the pandemic could pose severe health and economic crisis comparable to the catastrophic effects brought about by the Second World War.

Health shocks are found to significantly increase public health expenditure (Amutabi, 2021). Given that the health financing system of the majority of the African countries is generally too weak to cushion its households from the effects of health shocks (Leive and Xu, 2008), there is no doubt that significant gaps exist in the capacity of hospitals within the East Africa Community (EAC) region to accommodate any potential surge in the caseload arising from the COVID-19 pandemic (Barasa *et al.,* 2020). The situation is further exacerbated by the mutating nature of the disease (through the generation of new variants) which makes its eventual impact on the EAC economies unknown (McKibbin and Fernando, 2020).

The first confirmed case of the COVID-19 disease was reported in the EAC region in March 2020. Since then, the numbers have been skyrocketing with Kenya reporting the highest number in the region over the March 2020-June 2021 period (see figure 1). The figure also reveals a trend of uncertainty in the spread of the pandemic stemming from the development of several waves and the emergence of new strains of the virus over the pandemic period.

Figure 1. Confirmed COVID-19 cases in the EAC region (March 2020 - June 2021)



Source: JHU CSSE COVID-19 Data (2020-2021)

In response to the pandemic, governments globally instituted and implemented various fiscal and monetary measures to help mitigate the effects of the pandemic. While some policies were welfare-oriented, some aimed at easing the health system capacity burden across the EAC countries.

In this light, this study, therefore, sought to establish the impact of the pandemic on social welfare and health system capacity of East African Economies for the period March 2020-May 2021. We specify this period since the first case of the COVID-19 disease was reported in March 2020 in the EAC region. The contribution to literature is three-fold. First, we analyze the effect of the pandemic on social welfare across EAC economies by estimating a panel ARDL model using the PMG estimator. This approach will enable us to draw comparisons on the degree of impact of the pandemic on social welfare across the selected EAC countries. The majority of the conducted studies have rather focused on descriptive study analysis. The few that attempted at the estimating model(s) have rather focused on country-specific needs. Secondly, we provide an estimated comparative overview of the hospitals' surge capacity across the EAC economies.

And, thirdly, we evaluate two different indicators of social welfare namely inflation (proxied by CPI) and oil prices across the selected countries. This is unlike previous studies that tend to focus on only one given aspect of social welfare.

While different measures have been instituted by respective governments globally to help combat the pandemic, the study findings will draw insights on how governments across EAC region should re-orient their policy responses towards dealing with the pandemic in the long run.

1.2 Social welfare indicators

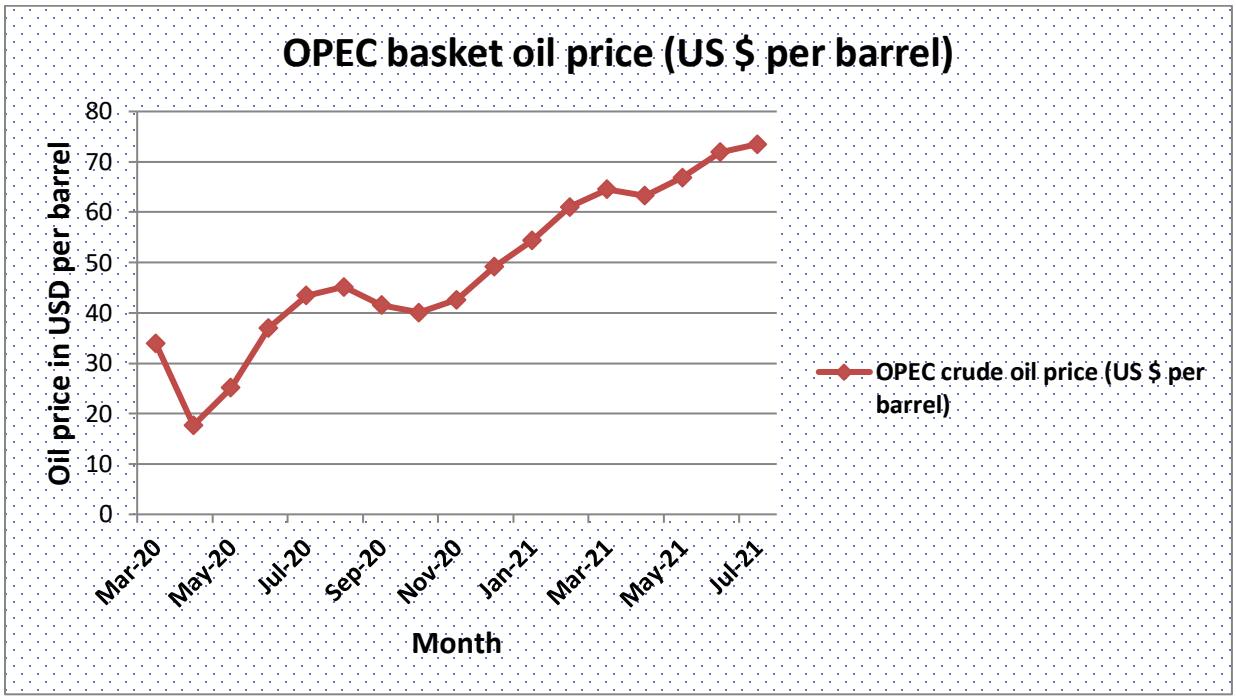
Hurnik *et al.* (2020) observed that measuring the impacts of the COVID-19 pandemic on food security and prices, in general, could be quite challenging since its full effects are still yet to be completely visualized. However, as pointed out by Rahman *et al.* (2020), the pandemic has already affected food systems directly by impacting food supply and demand & indirectly through decreasing the purchasing power as well as the production & distribution capacity of food. This could ultimately have far-reaching consequences on food prices and by extension on food security & nutrition, especially for the already vulnerable segment of the African population (World Bank, 2020).

Ebrahimy *et al.* (2020) globally analyzed the drivers and dynamics of inflation during the coronavirus pandemic by differentiating between the lockdown period which was noted for mobility restrictions, and the reopening phase period when mobility restrictions were lifted. The immediate proofs from emerging markets and developed economies pointed to the increased price of food. For the developing economies, the demand for pandemic-related goods such as Personal Protection Equipment (PPEs), face masks, testing reagents, and oxygen ventilators was noticeable. However, no proof of inflation could be visualized when with broader indexes. Albeit the time is short to assess the inflation trends following the economy reopening, inflation expectation measures do not reveal a palpable trend of upward inflationary moves.

Notwithstanding that the effects of the pandemic on inflation cannot be visualized as noted by Ebrahimy *et al.* (2020), food and non-food prices have indeed recorded inflationary patterns at various points in time across the EAC countries over the study period. A clear demonstration of this is the general upward trend in global oil prices. With oil being considered a necessity and a major driver of economies worldwide, sight cannot be taken off this precious commodity.

Increased oil prices suggest increased domestic prices of most commodities across the EAC countries; something that negatively impacts the social welfare of the citizens (see figure 2).

Figure 2. OPEC crude oil prices in US $ per barrel



Source: Organization of the Petroleum Exporting Countries (OPEC, 2021)

Moreover, since the outbreak of the pandemic in December 2019, trade flows have been disrupted due to the panic created in the business environment globally. To contain the spread of the disease, governments globally introduced lockdown measures that restricted the mobility of people and commodities. These measures impeded trade flows domestically & internationally by disrupting the demand & supply chains of commodities. Baldwin and Tomiura (2020) observed that these disruptions yielded negative shocks that culminated with uncertainty. Further, Banga *et al.* (2020) noted that the closure of countries' borders and international travel restrictions mired trade flows globally through delayed cross-border clearance which subsequently lead to increased trade costs.

According to Molde and Mveyange (2020), the lockdown measures yielded demand-side shocks on medical items with the majority of the countries worldwide scrambling for those valuable commodities in a frantic attempt to contain the spread of the disease. This demand

shock increased the price of those commodities with the welfare effect squarely falling on the importing countries. Excessive importation does not only increase a country's trade deficit but also hinders the growth of domestic infant industries. The result is the closure of important manufacturing and service-providing industries coupled with substantial job losses due to dwindled economic activity (Kassa, 2020). The uncertainty of the business environment instigated by the effects of the pandemic resulted in massive job losses culminated with increased poverty at household levels across all the EAC countries. Further, these economies reported contracted economic growth rates since the inception of the pandemic. The tourism and hotel industry was largely affected due to restricted domestic and international travel coupled with other country-specific internal lockdown measures & social-distancing operational requirements.

1.3 Health system capacity

The capacity of health systems globally has been tested and continues to be tested by the surge in the number of COVID-19 patients demanding critical care. The situation is even much direr for the developing economies and more particularly those in the EAC region. This study seeks to show a comparative analysis of the ability of the EAC countries to handle the hospital surge capacity created by the ever-rising number of COVID-19 patients. We define hospital bed surge capacity as the percentage of available hospital beds with oxygen supply across both the public and private hospitals in a given country at a given point in time. On the other hand, we define ICU bed surge capacity as the proportion of available ICU beds (equipped with ventilators) in both the public and private hospitals in a given country that are needed to care for the COVID-19 patients (Barasa *et al.,* 2020). Table 1 presents the true reality check of this capacity across the countries under investigation.

Table 1. Number of ICU beds and ventilators across EAC region

	Number of ICU beds	Year of Data Point/Estimate	Number of Ventilators	Year of Data Point
Kenya	518	2020	259	2020
Rwanda	50	2020	46	2020
South Sudan	24	2020	4	2019
Uganda	55	2020	100	2020

Source: Compiled statistics by Craig *et al.* (2020).

Table 1 reveals the daunting impact of the pandemic on the health systems of the EAC countries and demonstrates their inability to absorb any surge in the number of patients requiring critical care. Since March 2021, countries within the region have rolled out vaccination drive initiatives to help combat the disease. The vaccination drive is a continuous one and aims at targeting the entire population across all the EAC countries. However, the continuously mutating nature of the disease through the development of new variants implies that the road to recovery from the socio-economic disruption caused by the pandemic will be a long and arduous one. Understanding the impact of COVID-19 on social welfare and health system capacity is paramount in designing the most astute measures that are welfare-oriented and can cushion households from the devastating effects of the pandemic both in the short run & in the long run.

Following the introduction, chapter two will review the literature. Chapter three will discuss the methodology. Chapter 4 will present the empirical findings while the final chapter will provide conclusions & policy recommendations.

2. Literature Review

2.1 COVID-19 impacts on social welfare

According to Rahman *et al.* (2020), the COVID-19 pandemic has affected food systems directly by impacting food supply and demand. Similarly, the pandemic has indirectly decreased the purchasing power as well as the production and distribution capacity of food. Vickers *et al.* (2020) revealed that lockdown measures culminated with temporary trade restrictions were found to have impacted food demand and pricing by causing an acute disruption on the global

food supply chains. In their survey, the authors posit that a protracted pandemic could pose both short-run and medium-term impacts on food availability and eventually undermine the long-term food security of many countries.

Ebrahimy *et al.* (2020) also reiterated the presence of differentiated effects of the pandemic on inflation during the lockdown period (when mobility restrictions were present), and the reopening phase period (when mobility restrictions were lifted). The immediate proofs from emerging markets and developed economies pointed to the increased price of food. For the developing economies, the demand for pandemic-related goods such as Personal Protection Equipment (PPEs), face masks, testing reagents, and oxygen ventilators was noticeable. However, no proof of inflation could be visualized when with broader indexes. Albeit the time is short to assess the inflation trends following the economy reopening, inflation expectation measures do not reveal a palpable trend of upward inflationary moves.

Coulibaly (2021) found the number of COVID-19 cases to significantly increase the CPI among the West African Economic and Monetary Union (WAEMU) countries. The government policy response measures were, however, found to negatively influence CPI. Buheji *et al.* (2020) revealed that it is hard for the poor to cope with strict Covid protocols of lockdown and social distancing as most are casual and informal sector workers depending on daily and hourly remunerations. Similarly in a simulation study in Ghana, Dzigbede & Pathak (2020) identified a significant direct association between the coronavirus pandemic and poverty measures over time using daily and monthly economic indicators and the latest Ghana Living Standards Survey (GLSS). The study also suggested that an extension in government expenditure under a prevailing cash transfer program would help to reduce the economic shocks associated with the coronavirus pandemic and improve the livelihood of the poor and the vulnerable.

The distribution of the economic cost of COVID-19 has also been varied concerning income status, with higher income countries bearing more. Using the ARDL model, Erokhim and Gao (2020) discovered that the pandemic's impact on food insecurity was more noticeable in high-income economies than in low-income economies. The commodity market and stock market have had it blow off the Covid-19 pandemic, with stock market returns declining (Jelilov *et al.,* 2020).

Equally, on the demand side, the lockdown measures instituted by various governments worldwide to mitigate the effects of the pandemic slowed down production & mobility, generating a significant drop in the global oil demand. According to the April 2020 estimates by the International Energy Agency (IEA, 2020), oil demand dropped by a whopping 30% compared to the previous year, reaching a low level that has not been witnessed since 1995. However, oil prices are projected to rebound and steadily increase in the long run as economies globally continue to stabilize (IEA, 2020).

2.2 COVID-19 impacts on health system capacity

In containing the outbreak and its impact on the economy, some studies have suggested an increase in investment in the health system and traveling restriction measures. Ataguba (2020) & McKibbin and Fernando (2020) used a global hybrid DSGE/CGE model to show that even a controlled outbreak can substantially influence economies worldwide in the short run but with increased investment in public health systems, economic costs related to coronavirus pandemic could be reduced.

Health systems become challenged globally in the wake of epidemics as they trigger a critical increase in the demand for health services (Tsai *et al.,* 2020; Verhagen *et al.,* 2020). This strident surge in the demand for health services has to be absorbed by the existing healthcare systems. However, this becomes a tall order since medical facilities are typically intended to cater to just average healthcare demand and not epidemics of this nature (Cavallo *et al.,* 2020).

The pandemic imposes enormous demands on the health system which encompasses; screening & testing of the suspected cases, contact tracing, isolation of confirmed cases as well as those critical cases that demand intensive care (WHO, 2020). In the early phase of the pandemic, several countries worldwide namely, China, Italy, Spain & the United States reported sudden surges in COVID-19 cases despite their more sophisticated and well-resourced health systems. Further, the Institute for Health Metrics (IHME, 2020) and the European Society of Anesthesiology (ESA, 2020) revealed evidence of overwhelmed health systems with hospitals showing inability to handle the surge in the COVID-19 patients requiring hospitalization & critical care.

In analyzing the hospital surge capacity of the Kenyan hospitals in the wake of the COVID-19 pandemic, Barasa *et al.* (2020) estimated the hospital & ICU bed capacity and their respective tipping points. The findings revealed that Kenyan hospitals' ability to absorb the increases in caseload resulting from the pandemic was constrained by oxygen availability. The study found that only 58% of the Kenyan hospital beds were equipped with oxygen supply. Furthermore, the study found considerable disparities in the surge capacity across the 47 counties. According to Tsai *et al.* (2020), understanding the health system surge capacity in the wake of health pandemics provides expedient information for prior planning, mobilizing & the allocation of resources for effective policy response measures.

This study contributes to the existing literature by exploring the impact of the pandemic on social welfare and health system capacity across four economies in the Eastern Africa region using a dynamic panel ARDL model. Furthermore, this study will also assess the differences in the degree of impact of COVID-19 on social welfare & health system capacity across the selected countries.

3. Methodology

This section highlights the estimation techniques for both the surge capacity and the social welfare effects of the pandemic across the selected EAC countries.

3.1 Surge capacity estimation

We computed the ICU surge capacity based on the number of ICU beds and ventilators available (see Table 1 in the introduction section) against the actual number needed to cater for the COVID-19 critically ill patients. The statistics in Table 1 of the introduction section present the health system capacity of hospitals within the EAC region before the first case was reported in March 2020. Therefore, subsequent estimates for the period commencing March 2020 are modeled based on these statistics. Unlike the study by Barasa *et al.* (2020) that simply makes assumptions on the possible surge capacity using an unknown number of infected COVID-19 patients, this study makes reasonable assumptions by predicting the surge capacity based on the actual monthly number of confirmed COVID-19 cases.

We denote the COVID-19 cases reported for country $\boldsymbol{i}$ at time $\boldsymbol{t}$ be $\boldsymbol{CC}$. We assume that 15% of the confirmed COVID-19 patients across each country over 3 months require critical ICU care and or ventilator for oxygen supply. We justify the small proportion of 5% cases monthly on the basis that most of the infected persons might recover from the disease without necessarily requiring critical care. We, therefore, specify equation (1) as follows:

$$\boldsymbol{CP_{it} = \delta CC_{it}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . \boldsymbol{(1)}$$

Where $\boldsymbol{CP_{it}}$ is the estimated number of COVID-19 patients needing critical care and $\boldsymbol{\delta}$ is the assumed critical care proportion.

Differently from Barasa et al. (2020), this study acknowledges that since the first case of the virus was reported in March 2020 in the EAC region, economies within the region strengthened their health systems to accommodate the increasing number of infected COVID-19 patients. As a result, governments stepped up the hospitals' ability to accommodate the critically ill COVID-19 patients by providing financial support to various hospitals. This aimed at enabling them to acquire more ICU beds as well as equipping them with requisite equipment such as ventilators. In this light, therefore, we assume that the number of ICU beds and ventilators increased proportionately by 5% (monthly) across all the hospitals in the selected EAC countries. This translates to about an additional 26 and 13 ICU beds and ventilators respectively per month. Based on this assumption, we proceed and compute this additional increase on a 3-month basis for the period March 2020-May2021as shown in equations (2a) and (2b).

$$\boldsymbol{ICUest_{it} = \gamma ICUact_{it}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \boldsymbol{(2a)}$$

$$\boldsymbol{VENTest_{it} = \gamma VENTact_{it}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . \boldsymbol{(2b)}$$

Where $\boldsymbol{ICUest_{it}}$ and $\boldsymbol{VENTest_{it}}$ denote the estimated ICU beds & ventilators based on the actual number reported at country levels before the inception of the pandemic. $\boldsymbol{ICUact_{it}}$ and $\boldsymbol{VENTact_{it}}$ are the actual numbers whereas $\boldsymbol{\gamma}$ is the assumed proportionate increase on a 3-month basis. The surge capacity is subsequently computed as follows:

$$\boldsymbol{ICUsur_{it} = CP_{it} - ICUest_{it}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . \boldsymbol{(3a)}$$

$$\boldsymbol{VENTsur_{it} = CP_{it} - VENTest_{it}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . \boldsymbol{(3b)}$$

Whereas, $\boldsymbol{ICUsur_{it}}$ and $\boldsymbol{VENTsur_{it}}$ represent estimated ICU bed and ventilator surge capacity respectively. In computing these estimates, we also assume that any COVID-19 patient requiring intensive medical care services will not be admitted for more than 30 days. This paves room for any incoming COVID-19 patients in need of the same ICU services.

We presented these estimates in Table 2.

Table 2. Hospital surge capacity estimates for the selected EAC countries

Country	Indicators	Mar-May 2020	Jun-Aug 2020	Sep-Nov 2020	Dec-Feb 2021	Mar-May 2021
Kenya	Confirmed Covid cases	1962	32239	49417	22355	64762
	Estimated critical patients	294	4836	7413	3353	9714
	Number of ICU beds	596	674	752	830	908
	Number of ventilators	298	337	435	474	513
	ICU bed surge capacity	**(302)**	**4162**	**6661**	**2523**	**8806**
	Ventilator surge	**(4)**	**4499**	**6978**	**2879**	**9201**
Rwanda	Confirmed Covid cases	613	3593	1871	12916	8173
	Estimated critical patients	92	539	281	1937	1226
	Number of ICU beds	58	66	74	82	90
	Number of ventilators	53	60	67	74	81
	ICU bed surge capacity	**34**	**473**	**207**	**1855**	**1136**
	Ventilator surge	**39**	**479**	**214**	**1863**	**1145**
South Sudan	Confirmed Covid cases	994	1525	590	4901	2678
	Estimated critical patients	149	229	89	735	402
	Number of ICU beds	28	32	36	40	44
	Number of ventilators	5	6	7	8	9
	ICU bed surge capacity	**121**	**197**	**53**	**695**	**358**
	Ventilator surge	**144**	**223**	**82**	**727**	**393**
Uganda	Confirmed Covid cases	458	2514	17487	19908	6780
	Estimated critical patients	69	377	2623	2986	1017
	Number of ICU beds	63	71	79	87	95
	Number of ventilators	115	130	145	160	175

	ICU bed surge capacity	**6**	**306**	**2544**	**2899**	**922**
	Ventilator surge	**(46)**	**247**	**2478**	**2826**	**842**

Source: Author's computed estimates

Notes: *Table 2 shows the ICU bed surge and ventilator surge capacity estimates. Note that these are modeled based on the actual monthly number of confirmed COVID-19 cases, the actual number of ICU beds & the actual number of ventilators across the selected EAC countries.*

The results in Table 2 revealed that the capacity of hospitals across the EAC region to absorb the increases in the caseload stemming from COVID-19 was constrained by oxygen availability with most of the ICU beds lacking the requisite number of ventilators to cater for the critically ill patients. More so surprising, is the limited number of ICU beds needed to absorb the estimated COVID-19 patients expected to require intensive care. In the case of Kenya and Uganda, hospitals were able to absorb the surge at the early phase of the pandemic probably because of the lower number of people who had contracted the virus by that time. Nonetheless, the general trend across all the countries reveals the presence of significant gaps in their hospitals' ability towards accommodating a potential surge in the caseload resulting from COVID-19.

3.2 Social welfare estimation

This study proposes to employ panel ARDL developed by Pesaran *et al.* (1999). The choice of this dynamic panel ARDL model is informed by the recency of the coronavirus pandemic resulting in a shorter time dimension (T=15) but a multiple country-case dimension (N=4). Hausman's (1978) test would be used to establish the technique to be used, whether the Mean Group (MG) or the Pooled Mean Group (PMG).

To examine the impact of relevant variables on the Consumer Price Index (CPI), we begin by specifying the following model:

$$\boldsymbol{\pi_{i,t} = \sum_{j=1}^{p} \lambda_{ij}\pi_{i,t-j} + \sum_{j=0}^{q} \rho_{ij}X_{i,t-j} + u_i + \varepsilon_{it}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(4)}$$

Where λ_{ij} are the coefficients of lagged dependent variables, ρ_{ij} are the *(k x1)* coefficients vectors π_{it} is the Consumer Price Index, X_{it} is a $(k \times 1)$ vector of variables (regressors) indicated in equation (3) and the subscript $i = 1,2,\ldots N$ refers to the cross-sectional unit, i.e., country, $t = 1,2,\ldots N$ refers to the time. The term $\boldsymbol{u_i}$ allows for cross-sectional fixed effects &

ε_{it} is the error term. The terms p and q are the optimal lag orders. The **re-parameterized** ARDL model is shown in equation (5) and gives the short and long-run coefficients.

$$\Delta\pi_{it} = \phi_i \pi_{i,t-1} + \beta_i X_{it} + \sum_{j=1}^{p-1} \lambda_{ij}\,\Delta\pi_{i,t-j} + \sum_{j=0}^{q-1} \rho_{ij}\,\Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots (5)$$

Equation (5) shows both the short-run coefficients (with difference operators) and the long-run coefficients (without difference operators).

In assessing the impact of the pandemic on social welfare, two separate models will be estimated. First, we specify a model where CPI is treated as the regressand, and in the second model; we treat oil prices as the dependent variable. The 2 models are specified as follows:

$$ln(CPI)_{it} = \beta_0 + \beta_1 ln(COV)_{it} + \beta_2 ln(TB)_{it} + \beta_3 ln(M2)_{it} + \beta_4 lnE_{it} + \beta_5 R_{it} + \mu_i + \varepsilon_{it} \dots\dots\dots\dots (6)$$

$$ln(OIL)_{it} = \beta_0 + \beta_1 ln(COV)_{it} + \beta_2 ln(TB)_{it} + \beta_3 ln(M2)_{it} + \beta_4 lnE_{it} + \beta_5 R_{it} + \mu_i + \varepsilon_{it} \dots\dots\dots\dots (7)$$

Where **CPI** is the Consumer Price Index and is used as a proxy to inflation while **OIL** denotes the OPEC oil prices per barrel in USD. **COV** is the confirmed and reported COVID-19 cases & **TB** denotes trade balance. **M2** refers to the broad money supply, **E** is the exchange rate against USD, and **R** denotes the average commercial banks' lending rate.

3.3 Descriptive statistics

Consumer Price Index (CPI): An index that measures the price-level changes of a weighted average market bundle of consumer commodities**.** It's expressed in a natural log. It's the dependent variable in our first model and is used as a proxy for inflation.

Crude oil price (*OIL*): The monthly average price of crude oil per barrel measured in US $. It's expressed in logarithm form. It's the dependent variable in our second model.

COVID-19 confirmed cases (COV): The number of confirmed cases in a country since the first case was reported (March 2020-May 2021). It's expressed in a natural logarithm and is our main explanatory variable in this study. As an economic shock, the pandemic triggers restricted aggregate demand and supply globally yielding inflationary pressures and is, thus, expected to positively impact the CPI (Coulibaly, 2021).

Trade balance (*TB*): Measured as the difference between the total value of exports and imports of commodities in USD million. This is recorded monthly and is expressed in a natural logarithm.

Broad Money Supply (*M2*): Includes all cash and coins in circulation, short-term bank deposits & money market short-term securities. M2 is expressed in a natural logarithm.

Exchange rate (*E*): The rate at which one country's currency exchanges for another. This is recorded monthly and will be expressed in terms of the US dollar. The exchange rate is expressed in a natural log.

Banks' lending rate (*R*): The rate at which the majority of the deposit money banks lend to their credit-worthy customers. It is measured in percentage form and recorded monthly.

3.4 Summary statistics

We show summary statistics for the entire panel as well as different statistics per panel. Country-specific statistics enable us to draw comparisons for the variables across all the countries under investigation.

3.4.1 General panel statistics

This is shown in Table 3.

Table 3. General statistics

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
Consumer Price Index (CPI)	60	4145.429	7089.687	107	18863.10
Oil Prices	60	45.73	14.073	17.66	66.91
Covid Cases	60	4262.267	6785.745	0	28426
Trade Balance	60	437.079	274.954	128.6	1083.11
Broad Money (M2)	60	9642.654	11789.570	591.14	30663.40
Exchange Rate	60	1236.022	1472.391	103.74	3791.46
Lending Rate	60	15.599	2.636	11.75	20.93

Source: Author's computation from stata

Notes: *For uniformity in analysis, we expressed broad money (M2) and trade balance in USD by dividing them against each country's monthly average exchange against the US Dollar. The trade balance for each of the countries under investigation was negative implying a trade deficit. The figures represented*

here denote a trade deficit of USD million. Generally, the total value of imports exceeded that of exports for all the countries under the study period.

Table 3 revealed that the average Consumer Price Index (CPI) across the panel was 4145.43 points. The CPI variable exhibited a standard deviation of 7089.69 and varied in the intervals of between 107 and 18863.10. The price of a basket of oil (in US $ per barrel) averaged 45.73 USD. The variable had a dispersion of 14.07 with a minimum price of 17.66 USD and a maximum price of 66.91 USD over the study period. The total number of confirmed COVID-19 cases across the four countries averaged about 4262 monthly. The variable had a standard deviation of 6785.75 around the mean value with a minimum of 0 confirmed cases and a maximum of 28426 confirmed cases over the March 2020-May 2021 period.

On average, the trade balance (trade deficit) across the selected countries in the COVID-19 study period was about 437.08 million USD monthly. This signifies the rising trend in trade deficit across the EAC countries; a situation that might have escalated in the COVID-19 pandemic period. Trade deficit implies overreliance on imports which in turn weakens a country's domestic currency. The variable had a standard deviation of 274.95 and varied within the intervals of between 128.60 million USD and 1.08 billion USD. The mean broad money supply (M2) was 9642.65 million USD monthly across the four countries and exhibited the highest spread of 11789.57. The lowest monthly recorded M2 money was 591.14 million USD with the highest value recorded at 30663.40 million USD. The average exchange rate recorded over the period under study was 1236.02 and varied in the intervals of 103.74 and 3791.46 against the USD. The variable had a standard deviation of 1472.39. The mean rate at which commercial banks' lent out money was 15.60% with the lowest standard deviation of 2.64. The lowest rate charged was 11.75% with the highest rate being 20.93%.

3.4.2 Country-specific panel statistics

To draw comparisons across the selected countries, we also conducted a comprehensive summary that highlighted the different statistics per panel (see Appendix Table A1).

3.5 Data sources

This study utilized monthly panel data for the period March 2020-May 2021 which covered four countries: Kenya, Rwanda, South Sudan, and Uganda. The first case of COVID-19 in the EAC region was reported in March 2020 hence the choice for this study period. The data on CPI, exchange rate, trade balance, M2 money & Commercial Bank's lending rate was obtained from country-specific Central Banks' and the National Bureau of Statistics databases. The data on COVID-19 confirmed cases were sourced from WHO reports and country-specific ministries of health databases while data on oil prices were obtained from the OPEC database.

4. Empirical Findings

4. 1 Pre-estimation tests

To obtain efficient and unbiased estimates, several pre-estimation tests were first carried out.

4.1.1 Correlation analysis

The correlation analysis was conducted to test for the presence of multicollinearity. The pairwise correlation matrix revealed a weak degree of correlation among the independent variables (see Appendix Table A2).

4.1.2 Panel unit root test

This study conducted a panel unit root test using the IPS test (Im *et al.,* 1997) to check for the stationarity level of the variables. The panel ARDL model requires that the variables be integrated of order 0 or 1 or a combination of both. The IPS unit root test assumes that slopes are heterogeneous across the panels. The null hypothesis postulates that all panels contain unit roots against the alternative hypothesis that some panels are stationary. If the probability value is less than the 0.05 level of significance, we reject the null hypothesis of non-stationarity. Table 4 shows the unit root test results.

Table 4. Stationarity test results

Variable	Testing level	W-t-bar Statistic	W-t-bar P-value	Order of Integration
$lnConsumer\ Price\ Index$	Level 1st D	-1.0382 -3.2160	0.1496 0.0006	I (1)
$lnOil\ Price$	Level	-3.5196	0.0002	I (0)
$lnCovid\ Cases$	Level	-3.4229	0.0003	I (0)
$lnTrade\ Balance$	Level 1st D	0.2187 -4.7161	0.5866 0.0000	I (1)
$lnM2\ Money$	Level	-1.6489	0.0496	I (0)
$lnExchange\ Rate$	Level	-2.0753	0.0190	I (0)
$Lending\ Rate$	Level 1st D	-0.7678 -3.5540	0.2213 0.0002	I (1)

Source: Author's computation from stata

Notes: *D denotes difference.*

From the stationarity test results presented in Table 4, the variables were found to be integrated of order 0 or 1 or a combination of both. Thus, we estimate a panel ARDL model. The optimal lag length of the variables was determined using Schwarz's Bayesian Information Criterion (SBIC). The criterion specified a lag selection of 1 for the CPI & oil price variables and 0 for the rest of the variables which was common for each variable across all the countries forming the panel.

4.1.3 Hausman model specification test

Hausman's (1978) test was carried out to determine the most suitable model to be estimated between the MG & the PMG estimators. In choosing between the MG and PMG, the null hypothesis states that MG and PMG estimates are not significantly different; hence, PMG is more efficient. Failing to reject the null hypothesis implies that we employ the PMG model. For both the two social welfare models, the probability value of chi2 was found to be greater than the 0.05 level of significance. That is 0.131 & 0.642 for the two models respectively. We, thus,

failed to reject the null hypothesis and concluded that the PMG was the most suitable estimator to be used in this study.

The PMG estimator proposed by Pesaran *et al.* (1999) assumes the homogeneity of long-run coefficients. It does allow the intercepts, short-run coefficients & error variances to differ freely across groups. It is, therefore, consistent and efficient under the assumption of long-run slope homogeneity. On the other hand, the MG estimator earlier proposed by Pesaran and Smith (1995) produces consistent estimates of the mean of the long-run coefficients but these will be inefficient if the slope homogeneity holds. In other words, MG fails to recognize the fact that certain parameters may be the same across groups hence less informative compared to the PMG.

4.2 Estimation results

In analyzing the impact of COVID-19 on social welfare among selected EAC countries, we estimated two separate models. Model 1 showed the impact of COVID-19 on CPI (see Table 5 for results) while Model 2 showed the impact of COVID-19 on oil prices (see Table 6 for results) The CPI and oil prices were used as indicators for social welfare. In this study, we estimated the full PMG models to visualize the degree of impact of the pandemic on social welfare across the selected EAC countries.

Table 5. Model 1: Pooled Mean Group (PMG) regression results

VARIABLES **D. lnCPI**	**(1)** **EC**	**(2)** **Kenya**	**(3)** **Rwanda**	**(4)** **South Sudan**	**(5)** **Uganda**
EC		-0.208***	-0.00724	-0.405***	0.00351
		(0.0698)	(0.0373)	(0.0692)	(0.00597)
D.lnCovid Cases		-0.00945***	-0.000512	0.00395	-0.000481
		(0.00312)	(0.00248)	(0.00264)	(0.000986)
D.lnTrade Balance		-0.00365	-0.0139*	-0.110***	-0.00783*
		(0.0196)	(0.00773)	(0.0108)	(0.00429)
D.lnM2 Money		1.015***	0.250**	0.0796**	0.110***
		(0.193)	(0.123)	(0.0377)	(0.0228)
D.lnExchange Rate		2.016***	-0.175	0.467***	-0.141*
		(0.378)	(0.201)	(0.0469)	(0.0834)
D.lnLending Rate		0.864***	-0.00992	-0.754***	0.0136
		(0.308)	(0.0791)	(0.0905)	(0.0180)
lnCovid Cases	-0.0203***				
	(0.00774)				
lnTrade Balance	-0.0293				
	(0.0197)				
lnM2 Money	-1.046***				
	(0.0980)				
lnExchange Rate	-0.720***				
	(0.234)				
lnLending Rate	3.246***				
	(0.491)				
Constant		2.316***	0.0667	4.829***	-0.0363
		(0.807)	(0.339)	(0.686)	(0.0623)
Observations	56	56	56	56	56

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: *In model 1, CPI is the dependent variable. The long-run estimates are represented in the second column and lack the difference operator* ***'D'*** *while columns 3, 4, 5, and 6 present the short-run PMG estimates with the difference operator.* ***ECT*** *is the Error Correction Term and denotes model convergence in the long run.*

The estimation results in Table 5 revealed that COVID-19 significantly decreased CPI in the long run. The impact was negative and significant for Kenya but insignificant for Rwanda, South Sudan, and Uganda in the short run. These results support the findings by Ebrahimy *et al.* (2020) who find no proof of inflation when broader indexes are factored in. Their findings reiterate that

the time is too short to assess the inflation trends following the economy reopening and as such, inflation expectation measures do not reveal a palpable trend of upward inflationary moves. However, this is contrary to findings by Coulibaly (2021) who finds a significant increase in CPI for the WAEMU countries in the wake of the COVID-19 pandemic.

Trade deficit significantly decreased CPI for Rwanda, South Sudan, and Uganda in the short run. The impact was, however, insignificant in the long run. The exchange rate increase (depreciation) and M2 money increase were surprisingly found to significantly decrease the CPI in the long run. In the short run, M2 money positively and significantly influenced the CPI. This is primarily because, at the onset of the pandemic, governments across the EAC region instituted fiscal measures to help cushion their citizens from the effects of the pandemic. While these measures were instrumental in improving welfare, they at the same time increased government spending hence increasing the amount of money circulating in the economy. This yielded inflationary tendencies in the short run. However, in the long run, economic stabilization implied retracted movements from the fiscal & monetary policy expansion tools. Equally, in the short run, exchange rate increase (depreciation) was found to positively and significantly increase CPI in Kenya and South Sudan but significantly lowered CPI for Uganda.

The commercial banks' lending rate was found to significantly increase the CPI in the long run. In the short run, the impact was positive and significant for Kenya but negative and insignificant for South Sudan. The Error Correction Term (ECT) was found to be negative and statistically significant for Kenya and South Sudan hence denoting model convergence in the long run for these two countries. This implied that any deviations from the long-run equilibrium are corrected at an adjustment speed of 20.8% and 40.5% for Kenya and South Sudan respectively. Table 6 presents the PMG estimates for Model 2.

Table 6. Model 2: PMG regression results

VARIABLES **D. lnOil price**	**(1)** **EC**	**(2)** **Kenya**	**(3)** **Rwanda**	**(4)** **South Sudan**	**(5)** **Uganda**
EC		-0.542**	-0.751***	-1.349***	-0.907***
		(0.264)	(0.225)	(0.386)	(0.212)
D.lnCovid Cases		0.00568	-0.0240	0.0945***	-0.131***
		(0.0638)	(0.0482)	(0.0270)	(0.0440)
D.lnTrade Balance		0.539	0.482***	0.306	0.614***
		(0.374)	(0.154)	(0.246)	(0.167)
D.lnM2 Money		7.196*	4.422**	1.390***	4.509***
		(3.877)	(1.874)	(0.453)	(0.883)
D.lnExchange Rate		3.700	1.462	1.373***	5.727*
		(6.727)	(4.053)	(0.472)	(3.303)
D.lnLending Rate		3.830	1.196	-1.857**	0.691
		(6.835)	(1.142)	(0.907)	(0.730)
lnCovid Cases	0.0423**				
	(0.0193)				
lnTrade Balance	-0.0596				
	(0.0944)				
lnM2 Money	-0.147				
	(0.266)				
lnExchange Rate	-1.563**				
	(0.612)				
lnLending Rate	-0.0232				
	(0.820)				
Constant		6.872*	11.76**	17.53**	16.31**
		(3.974)	(4.953)	(7.293)	(6.634)
Observations	56	56	56	56	56

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: *In model 2, the oil price is the dependent variable***.**

From Table 6**,** COVID-19 was found to significantly increase oil prices in the long run. In the short run, the impact was positive and significant for South Sudan but negative and insignificant for Uganda. Consistent with the estimations by the International Energy Agency (IEA, 2020), oil prices were projected to decline globally at the early phase of the pandemic. However, as economies continue to stabilize, oil prices are expected to rebound and steadily increase in the long run. Since oil is a basic good, an increase in its price will ultimately increase the costs of

living hence impacting negatively on people's welfare. This impact may be visualized both in the short run & long run for some countries owing to their position in the global oil market.

The trade deficit was found to impact positively and significantly on oil prices across all the selected EAC countries in the short run. Globally, countries instituted lockdown measures that restricted the mobility of people and commodities. These measures impeded trade flows domestically and internationally by disrupting the demand and supply chains of commodities (Baldwin and Tomiura, 2020). As a result, Banga *et al.* (2020) noted that mired trade flows caused delayed cross-border clearances which subsequently lead to increased trade and shipping costs. The mobility restrictions eventually yield oil price increases for the oil-importing countries since oil importers will always try to compensate for the supply-side bottlenecks that are associated with importation. M2 money was also found to be associated with a significant increase in oil prices across all 4 countries in the short run. Trade deficit and M2 money were, however, found to insignificantly determine oil price in the long run.

The impact of an exchange rate increase (depreciation) on oil price was found to be negative and significant in the long run. In the short run, exchange rate depreciation significantly increased oil prices in South Sudan and Uganda. Conversely, the lending rate was found to significantly decrease oil prices in the short run in South Sudan only. The variable was insignificant in the long run. Finally, the Error Correction Term results reveal model convergence in the long run across all the 4 counties employed in this study.

6. Conclusions and Policy Recommendations

This study primarily sought to investigate the degree of impact of COVID-19 on social welfare and health system capacity across some selected EAC countries. The study estimated the potential ICU bed and ventilator surge capacity based on reasonable modeled assumptions. The degree of variation of the pandemic's impact on social welfare was visualized using the PMG estimator. From the estimated surge capacity results, we conclude that significant gaps exist across hospitals in the EAC region to accommodate any potential surge in the caseload emanating from COVID-19. This is evidenced by a continuously rising number of confirmed COVID-19 patients against a backdrop of a limited number of ICU beds & ventilators needed to provide critical care. In this regard, we recommend adequate investment in the health sector.

This should specifically target at strengthening the essential services which include a significant addition of the number of ICU beds and the associated support equipment i.e. ventilators. This will beef up hospital efficiency in handling critical care services in the wake of health pandemics of this nature.

From the estimated social welfare indicator models, it was apparent that the impact of the COVID-19 pandemic on CPI and oil prices yielded mixed results. First, COVID-19 significantly decreased CPI in the long run. The impact was negative and significant for Kenya but insignificant for Rwanda, South Sudan & Uganda in the short run. Secondly, COVID-19 was found to significantly increase oil prices in the long run. In the short run, the impact was positive and significant for South Sudan but negative and insignificant for Uganda. From a regional perspective, we recommend that governments within the region employ a coordinated approach in addressing welfare effects that largely stem from increased oil prices due to disrupted trade activities. There is a need to promote regional market integration & cooperation within the EAC region regarding oil. A robust & vibrant EAC oil market will enable countries within the region to harness optimal benefits from their oil reserves as well as withstand any global price shock dynamics that emanate from a pandemic of this nature.

Future studies should attempt at analyzing the effect of the COVID-19 pandemic on the health system capacity in the post-vaccination period. Furthermore, there is a need to visualize separate inflationary effects of the pandemic on both food and non-food items; a feat that was not realized in this study.

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Appendix Table A1. Country-specific statistics

Variable		Mean	Std. Dev.	Min	Max	Obs.
CPI	Overall	4145.429	7089.687	107	18863.10	N=60
	Between		8057.323	110.601	16231.41	n=4
	Within		864.907	736.022	6777.122	T=15
Oil Prices	Overall	45.730	14.073	17.66	66.91	N=60
	Between		0	45.73	45.73	n=4
	Within		14.073	17.66	66.91	T=15
Covid Cases	Overall	4262.267	6785.745	1	28426	N=60
	Between		4849.632	712.533	11382.330	n=4
	Within		5301.713	-7061.067	21305.930	T=15
Trade Balance	Overall	437.079	274.954	128.6	1083.11	N=60
	Between		275.977	184.471	829.168	n=4
	Within		132.322	184.521	1013.084	T=15
M2 Money	Overall	9642.654	11789.57	591.14	30663.400	N=60
	Between		13493.46	848.779	29626.790	n=4

	Within		352.754	8571.96	10679.26	T=15
Exchange Rate	Overall	1236.022	1472.391	103.74	3791.460	N=60
	Between		1685.482	108.006	3697.280	n=4
	Within		34.401	1091.53	1330.202	T=15
Lending Rate	Overall	15.599	2.636	11.750	20.93	N=60
	Between		2.869	11.979	18.951	n=4
	Within		0.819	12.419	17.578	T=15

Source: Author's compilation from stata

Appendix Table A2: Pairwise correlation matrix

	Covid Cases	***Trade Balance***	***M2 Money***	***Exchange Rate***	***Lending Rate***
Covid Cases	1.0000				
Trade Balance	0.6228	1.0000			
M2 Money	0.6322	0.5247	1.0000		
Exchange Rate	-0.1630	-0.3524	-0.2988	1.0000	
Lending Rate	-0.4435	-0.6359	-0.7063	0.6148	1.0000

Source: Stata computation