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MODELLING THE ECONOMIC IMPACT OF COVID-19: IMPLICATIONS FOR AFRICAN COUNTRIES

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ABSTRACT: This study seeks to build an economic model for the impact of Covid-19 pandemic on economic indicators with far-reaching implications for African economies, given the huge economic challenges of the pandemic. Adopting a modified Solow-Swan (1956) model, the study built a model which incorporated capital stocks and income indicators, and established that the Covid-19 pandemic has implications for capital stocks through savings and investment, and in the long run impact economic output. Therefore, there is urgent need to build an inclusive and resilient policy framework to combat the ravaging effects of the pandemic towards economic recovery and stabilization.

Keywords: Framework, Neoclassical, Steady State, Investment.

INTRODUCTION

Covid-19 pandemic outbreak has spread at an alarming rate across the globe, prompting countries to adapt policies to halt the spread or curtail its effects. There is generally a consensus that the pandemic has severely affected socioeconomic trajectory of economies and has threatened food security, although the size and magnitude of economic damage is highly debatable (Ndulu, 2020; Ayanlade & Radeny, 2020).

Africa is not immune to the devastating effects of the pandemic on economic performance (Coulibaly & Madden, 2020). There have been spillover effects on Africa's economic, financial, health as well as social spheres, owing to Africa's high dependence on external factors (Ndulu, 2020; Martinez-Alvarez, *et. al*., 2020). With the continent being the domain of a large vulnerable population and weak economic structure, the pandemic is expected to exact more effects in Africa in relation to other parts of the globe. For instance, Sub-Sahara Africa is projected to shrink by 1.6%, (the worst in the region) with high disruption of production, drop in commodity prices, unfavourable financial conditions as well as sharp drop in aggregate demand of goods and services (African Development Bank, AfDB, 2020).

In the same vein, virtually all sectors of countries in Africa have been affected by the pandemic. For instance, travel bans and restrictions, in addition to imposed lockdowns have slowed down economic activities of governments, businesses and individuals. (Yaya, *et. al*., 2020; Lone & Aijaz, 2020). This has negatively impacted on tourism, aviation and

enterprises (SMEs), among others. African countries which depend on revenue from crude oil are further impoverished by the pandemic owing to steady decline in global oil prices. The pandemic has thoroughly weakened international trade and collapsed the flow of foreign direct investment, a state of de-globalization (Ndulu, 2020; Onyekwena & Ekeruche, 2020).

The fragility of African countries has been impeding development as well as lower growth rates (Hoeffler, 2019). The variability of growth in Africa is relatively high compared to other regions in the world. It also varies largely across economies within the continent, with some countries recording one or more years of negative growth (Chandy, 2015). Countries which have history of civil conflict in Africa such as Nigeria, Libya, Mali and others are characterized by economic challenges. In other words, macroeconomic performance of African economies is interwoven with governance and institutions (Williams, 2017).

In this paper, the focus was building a growth model for Africa in which the Covid-19 pandemic is embedded. This is largely different from other African studies which are basically mainly empirical in nature (see, Alhassan, et al, 2020; Ezimma, *et al*., 2020; Adesoji & Asongu, 2020; Gondwe, 2020; among others). To begin with, the paper recognizes that there are different dimensions and degrees of impact of the pandemic on Africa economies. Section 2 discuses stylized facts and economic projections due to the emergence of the pandemic, focusing on 5 economic indicators. Section 3 develops a modified Covid-19-inclusive growth model in order to capture the impact of the pandemic on economic performance of African economies. Section 4 then proffer economic strategies to break the spiral vicious circle being created by the pandemic among African countries.

Africa Macroeconomic Environment: Stylized Facts and Post-COVID-19 Projections

Africa has a complex macroeconomic environment, with various countries within the continent operating at different level of economic growth. In generality, the economy is lagging behind in terms of growth and development in relation to other regions in the globe. It is therefore imperative to examine some areas of Africa macroeconomic environment as a springboard to understanding the extent to which the COVID-19 pandemic might potentially impact economic growth among African economies.

Debt Burden

African economies have heavily relied on loans and grants from donors (bilateral and multilateral) to finance economic activities. This has dire consequences on countries owing to huge debt burdens (Miller, 2020). Some debts have become unsustainable especially when they are not monitored with a large proportion embezzled or when investments become unproductive. This has led to default and threats to national sovereignty (Onyekwena & Ekeruche, 2019).

Many African economies entered the era of the pandemic on the back of high debt-to-GDP ratios. Due to the risk structure of debts such as Eurobonds, the pandemic is expected to worsen the debt burden of African economies. It is projected that debt-to-GDP ratio will increased approximately by 10 percentage points beyond the pre-COVID-19 trajectory in both 2020 and 2021 (AfDB, 2020).

Poverty

Africa is a continent with a high rate of poverty. A large proportion of its population live on less than a dollar per day. The continent also hosts a country such as Nigeria which is currently the *poverty capital* of the world (Homi, *et al.*, 2018). The poverty level in Africa is expected to rise due to the COVID-19 pandemic. It is expected that the previous projection of number of people living in extreme poverty in 2020 will increase from 425.2 million to between 453.4 million and 462.7 million. This could further increase by 34 million to 49.2 million in 2021, with countries such as Nigeria and Democratic Republic of Congo expected to have the lion share (AfDB, 2020). In all, it is projected that between 25 million to 30 million jobs could be lost in Africa. This would further impoverish the poor, since a large proportion of jobs in Africa is the informal sector (AfDB, 2020).

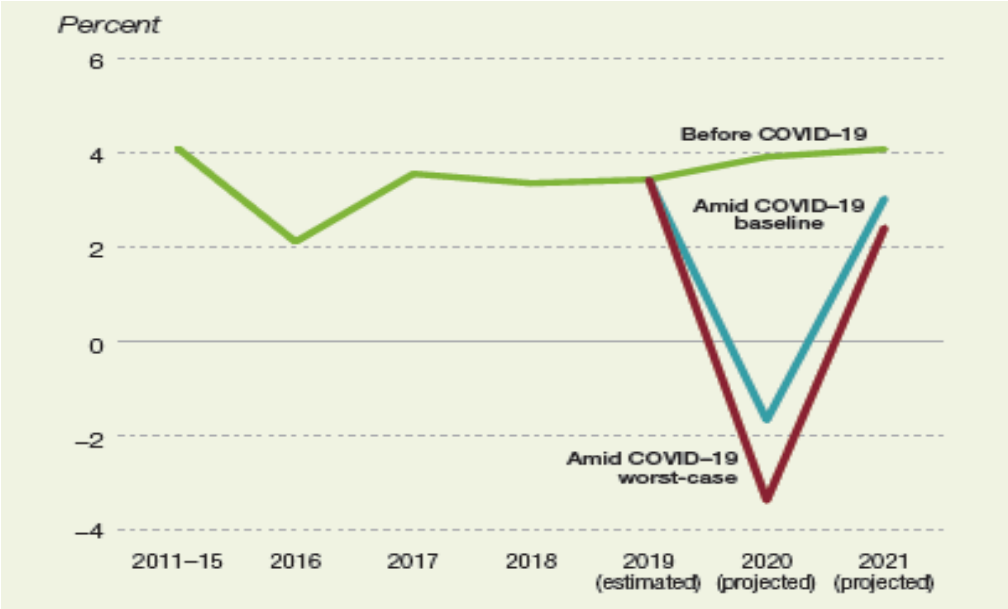
Inflation

Prior to outbreak of the pandemic, Africa has been grappling with inflation (Nguyen, *et. al*., 2017). Prices of commodities soars leading to decline in purchasing power in most economies. The high rate of inflation has crippled economic activities ultimately leading to dismal economic performance. The COVID-19 pandemic has triggered a further increase in inflation throughout the African continent. This was partly because most African economies highly depend on importation for local consumption (Verter, 2017). Drawing from such precedence, during the lockdowns effected by African countries orchestrated by the pandemic, the prices of essentially commodities especially food soared. This is especially disturbing with the exponential increase in population growth rates.

Real GDP (RGDP)

In spite of human and natural resources, the African continent still languishes in poverty, violence, unemployment, inequality and exclusivity of common wealth (African Economic Outlook, 2020). The emerging COVID-19 pandemic has worsened the scenario. Due to the COVID-19 pandemic, RGDP is projected to shrink by 3.4 percent if the pandemic exceeds the first half of 2020, with the continent expected to loss between $145.5 billion and $189.7 billion (AfDB, 2020). Owing to the incapacitation of the various sectors, Africa which highly depends on volatile external financial flows will be severely affected. As such it is predicted that the pandemic will shrink economic growth, but all things being equal, recovery will be sporadic (see Figure 1). The projections are at wide variance from the initial growth path. It is projected that recovery would have been almost achieved by 2021. However, the possibility of achieving such recovery in economic growth looks bleak given the worsening economic indicators and other potential exigencies.

Figure 1: COVID-19 and growth projections in Africa



Source: *AfDB (2020) Africa's economic performance and Outlook amid COVID–19*

Specifically, different regions in Africa are expected to be affected by the pandemic in varying degrees. For instance, Sub-Saharan Africa is projected to have the least growth in Africa, at -1.6% in 2020 with five economies (Algeria, Egypt, Morocco, Nigeria and South Africa) earmarked to drive the growth contraction (AfDB, 2020).

A Micro-Model of COVID-19 – Growth Nexus

In a bid to build an model which captures the economic impact of COVID-19, the study adopt a modified Solow (1956) and Swan (1956) neoclassical growth model commonly termed the Solow-Swan (1956) growth model. The justification for choosing this model as a building framework for a COVID-19 model lies in the fact that the basic Solow-Swan model covers wide range of extensions by capturing factors such as political systems, inequality, and trade dynamics among others. It also considers technological change as exogenously determined through research and development (R & D) investment or physical capital accumulation. In addition, the Solow-Swan model develops empirics that adequately account for differences in income levels across countries, unlike other growth models (Durlauf & Quah, 1999).

Taking a holistic appraisal of the continent of Africa since the various countries have different characteristics in terms of structure and economies, the model can be expressed as:

The theoretical framework of the study is based on the modifications of the Solow-Swan (1956) standard neoclassical growth model. It is expressed below;

$$Q_{it} = RD_{it}^{\delta} K_{it}^{\pi} H_{it}^{\gamma} E^{\tau} [A_{it} N_{it}]^{1-[\delta+\pi+\gamma+\tau]} \quad (1)$$

Where, *Q* is the effective labour per unit output; *RD* is the level of research and development (R & D) in the economy; *K* is the level of physical capital; *H* refers to health human capital; *E* refers to education human capital; *A* captures institutional quality and technological level; while *N* is the total population. The exponents δ, π, γ, ρ and τ represents the factor shares of RD, K, H, and E. these variables are essential given the role they place in determining the growth pattern of any economy.

Building blocks

Assumption I: Growth trends

A fundamental building block is the assumption that the population of the economy grows at the rate of n_i which is peculiar to the economy; all the capital stocks are assumed to depreciate constantly at the rate of σ; and institutional quality and technology level (A_{it}) grows at g_{it} rate. Given these, Equation (1) can be rewritten as;

$$q_{it} = rd_{it}^{\delta} k_{it}^{\pi} h_{it}^{\gamma} e_{it}^{\tau} \quad (2)$$

Where, *q* is effective output per capita; *k*, physical capital per capita; *rd*, research & development per capita; *h*, human health capital per capita; and *e*, health capital per capita.

Assumption II: Savings composition

The model assumes that total savings is distributed among the capital stocks (health human, physical and education human) and research and development (R & D). It is assumed that savings equal investment in the economy, which implies that investment in the economy, is distributed among the aforementioned capital stocks and research & development. This is shown in Equation (3);

$$s_{it} = s_{it}^{rd} + s_{it}^{k} + s_{it}^{h} + s_{it}^{e} = \frac{S_{it}}{Q_{it}} = \frac{I_{it}}{Q_{it}} = \frac{I_{it}^{rd} + I_{it}^{k} + I_{it}^{h} + I_{it}^{e}}{Q_{it}} \quad (3)$$

Where

s_{it} = savings and investment in the economy

s^{rd}_{it}= research and development saving rate

s^k_{it} = physical capital saving rate

s^h_{it}= health human capital saving rate

s^e_{it}= education human capital saving rate

Given the savings function, the rates of physical capital growth per unit of labour, human health capital growth per unit of labour, education health capital growth per unit of labour, as well as research and Development (R & D) growth per unit of labour are defined below:

$$\dot{rd}_{it} = s^r_{it}\dot{q_{it}} - rd_{it}(n_{it} + g_{it} + \sigma_{it}) \quad (4)$$

$$\dot{k_{it}} = s^k_{it}\dot{q_{it}} - k_{it}(n_{it} + g_{it} + \sigma_{it}) \quad (5)$$

$$\dot{h_{it}} = s^h_{it}\dot{q_{it}} - h_{it}(n_{it} + g_{it} + \sigma_{it}) \quad (6)$$

$$\dot{e_{it}} = s^e_{it}\dot{q_{it}} - e_{it}(n_{it} + g_{it} + \sigma_{it}) \quad (7)$$

Assumption III: Emergence of COVID-19 pandemic

The COVID-19 pandemic can be introduced into the neoclassical growth model to alter the growth process of the economy, since its presence in the model is considered a disturbance or distortion in the growth path of the economy. Due to the deaths experienced during the pandemic, the growth rate in the population is given as;

$$\dot{n} = \varphi^n\left[n_t - (n^* - a^{n^*})\right] - a^n_{it} \quad (8)$$

ṅ = population growth rate

φ^n = COVID-19 pandemic persistent effect on population growth ($\varphi<0$)

a_t^n = COVID-19 pandemic related-deaths

$a_t^{n^*}$ = COVID-19 pandemic permanent effect on population growth

(n^* - a^{n^*}) = long run steady state growth attainable at the climax of the pandemic.

When the pandemic is incorporated into the savings and investment functions (research and development, physical capital, health human capital, education human capital), the following functions are obtained;

$$\dot{s}^{k} = \varphi^{k}\left[s_t^{k} - (s^{k^*} - a^{k^*})\right] - a_t^{k} \quad (9)$$

$$\dot{s}^{rd} = \varphi^{rd}\left[s_t^{rd} - (s^{rd^*} - a^{rd^*})\right] - a_t^{rd} \quad (10)$$

$$\dot{s}^{h} = \varphi^{h}\left[s_t^{h} - (s^{h^*} - a^{h^*})\right] - a_t^{h} \quad (11)$$

$$\dot{s}^{e} = \varphi^{k}\left[s_t^{k} - (s^{k^*} - a^{k^*})\right] - a_t^{k} \quad (12)$$

The shocks of COVID-19 pandemic are captured by a_t^{k}, a_t^{rd}, a_t^{h} and a_t^{e}. The permanent effects on each of the variables are represented by a^{k*}, a^{rd*}, $a^{h*}$and a^{e*}, while φ^{k}, φ^{rd}, φ^{h} and φ^{e} represent COVID-19 pandemic persistent shocks on the economic variables and are assumed to be less than zero. (s^{k*}- a^{k*}), (s^{h*}-a^{h*}), (s^{e*}-a^{e*}) and (s^{rd*}-a^{rd*}) represent long run steady state values of allotted savings to the economic variables.

The expressions below represent the convergence for all capital stocks for economy *i* at time *t*;

$$rd_{it}^{*} = \left[\frac{\left(s_i^{rd}\right)^{1-[\pi+\gamma+\tau]}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{\tau}}{n_i^{*} - a^{n^*} + g_{it} + \sigma}\right]^{\frac{1}{1-[\pi+\gamma+\tau+\delta]}} \quad (13)$$

$$k_{it}^{*} = \left[\frac{\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{1-[\delta+\gamma+\tau]}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{\tau}}{n_i^{*} - a^{n^*} + g_{it} + \sigma}\right]^{\frac{1}{1-[\pi+\gamma+\tau+\delta]}} \quad (14)$$

$$h_{it}^{*} = \left[\frac{\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{1-[\delta+\pi+\tau]}\left(s_i^{e}\right)^{\tau}}{n_i^{*} - a^{n^*} + g_{it} + \sigma}\right]^{\frac{1}{1-[\pi+\gamma+\tau+\delta]}} \quad (15)$$

$$e_{it}^{*} = \left[\frac{\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{1-[\delta+\pi+\gamma]}}{n_i^{*} - a^{n^*} + g_{it} + \sigma}\right]^{\frac{1}{1-[\pi+\gamma+\tau+\delta]}} \quad (16)$$

A cursory examination of equations (13)-(16) shows a high level of interdependence and interrelationship among the variables. Although there is a high complexity in the growth behaviour of the economic variables in the above equation, it is imperative to state that a distortion to any variable is instantly transmitted through the economy with implications for growth. The steady state output per capita is thus represented in Equation 17. Such

relationship is highly essential in the evaluation of the macroeconomic impact of COVID-19 in the economy, because it is expected that the COVID-19 pandemic will impact on all capital stocks as well as research and development, which will have a ripple effect in all spheres of the economy.

$$q_{it}^{*} = \left[\frac{\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{\tau}}{n_i^{*} - a^{n^{*}} + g_{it} + \sigma}\right]^{\frac{1}{1-[\pi+\gamma+\tau+\delta]}} \quad (17)$$

Thus, Equation (17) is the fundamental modified Solow-Swan growth model framework to access the impact of the COVID-19 pandemic on the growth path. However, given that Africa is a cluster of economies with varying macroeconomic complexities, the Mankiw, et al (1992) process can be adopted to transform the Solow-Swan model.

Therefore taking logs of both sides of equations (13) through (16), the following expressions are obtained;

$$\ln rd_{it}^{*} = \frac{1}{1-[\delta+\pi+\gamma+\tau)}\left[\ln\left(\left(s_i^{rd}\right)^{1-[\pi+\gamma+\tau]}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{\tau}\right) - \ln\left(n_i^{*} - a^{n^{*}} + g_{it} + \sigma\right)\right] \quad (18)$$

$$\ln k_{it}^{*} = \frac{1}{1-[\delta+\pi+\gamma+\tau)}\left[\ln\left(\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{1-[\delta+\gamma+\tau]}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{\tau}\right) - \ln\left(n_i^{*} - a^{n^{*}} + g_{it} + \sigma\right)\right] \quad (19)$$

$$\ln h_{it}^{*} = \frac{1}{1-[\delta+\pi+\gamma+\tau)}\left[\ln\left(\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{1-[\delta+\pi+\tau]}\left(s_i^{e}\right)^{\tau}\right) - \ln\left(n_i^{*} - a^{n^{*}} + g_{it} + \sigma\right)\right] \quad (20)$$

$$\ln e_{it}^{*} = \frac{1}{1-[\delta+\pi+\gamma+\tau)}\left[\ln\left(\left(s_i^{rd}\right)^{\delta}\left(s_i^{k}\right)^{\pi}\left(s_i^{h}\right)^{\gamma}\left(s_i^{e}\right)^{1-[\delta+\pi+\gamma]}\right) - \ln\left(n_i^{*} - a^{n^{*}} + g_{it} + \sigma\right)\right] \quad (21)$$

In order to obtain that of steady state of output per capita, equations (18) – (21) is substituted into equation (17) resulting in;

$$
\begin{aligned}
&ln\, q_{it}^{*} \\
&= \frac{\delta}{1-[\delta+\pi+\gamma+\tau)} ln\left(s_i^{rd}\right) \\
&+ \frac{\pi}{1-[\delta+\pi+\gamma+\tau)} ln\left(s_i^{k}\right) + \frac{\gamma}{1-[\delta+\pi+\gamma+\tau)} ln\left(s_i^{h}\right) \\
&+ \frac{\tau}{1-[\delta+\pi+\gamma+\tau)} ln(s_i^{e}) - \frac{\delta+\pi+\gamma+\tau}{1-[\delta+\pi+\gamma+\tau)} ln(n_i^{*} - a^{n^{*}} + g_{it} \\
&+ \sigma) \qquad (22)
\end{aligned}
$$

Where, s_i^{rd}, s_i^{k}, s_i^{h} and s_i^{e} captures savings rates allotted to represent the proportion of savings rates of the economic indicators. Linearizing equation (22) the following expression is obtained;

$$
\begin{aligned}
\frac{d \ln q_{it}}{dt} &= \mu(\ln q_{it}^{*} \\
&\quad - \ln q_{it}) \qquad (23)
\end{aligned}
$$

Where

$\mu = (n_i^{*} - a^{n^{*}} + g_{it} + \sigma)\,[1-(\delta + \varphi + \gamma + \tau)]$

q_{it} = output per capita in economy i at time t.

Solving equation (23) differentially, the following expression is arrived at;

$$
\begin{aligned}
\ln q_{it} &= (1 - exp^{-\mu t}) \ln q_{it}^{*} \\
&\quad + exp^{-\mu t}\, ln\, q_{i0} \qquad (24)
\end{aligned}
$$

Where, q_{i0} is the economy's i initial income. Thus, equation (24) less q_{i0} captures the change in income or output due to the COVID-19 pandemic. The final expression obtained is:

$$
\begin{aligned}
ln\, q_{it} - ln\, q_{i0} &= (1 \\
&\quad - exp^{-\mu t}) \frac{\delta}{1-[\delta+\pi+\gamma+\tau]} lns_i^{k} + (1 \\
&\quad - exp^{-\mu t}) \frac{\tau}{1-[\delta+\pi+\gamma+\tau]} lns_i^{e} + (1 \\
&\quad - exp^{-\mu t}) \frac{\gamma}{1-[\delta+\pi+\gamma+\tau]} lns_i^{h} \\
&\quad + (1 - exp^{-\mu t}) \frac{\pi}{1-[\delta+\pi+\gamma+\tau]} lns_i^{rd} \\
&\quad - (1 - exp^{-\mu t}) \frac{\delta+\pi+\gamma+\tau}{1-[\delta+\pi+\gamma+\tau]} \ln\left(n_i^{*} - a^{n^{*}} + g_{it} + \sigma\right) \\
&\quad - (1 \\
&\quad - exp^{-\mu t}) ln q_{i0} \qquad (25)
\end{aligned}
$$

Individual countries in Africa can thus estimate the potential economic impact of the COVID-19 pandemic by estimating equation (25) given the availability of economic data. Whatever the case may be, the expression above showed that COVID-19 pandemic will potentially affect economic output via capital stocks or investment. Monitoring and controlling these variables will highly be essential in proffering policies geared at economic recovery and stabilization.

The model above has several implications towards tackling the COVID-19 pandemic and reducing its economic impact. The model shows that the extent to which the pandemic will affect an economy is a factor of the prosperity of the country captured by its income level. Low-income countries will highly be affected and the recovery process will be agonizingly slow when compared with developed and emerging economies. The level of the country's technology and capital stocks will also determine the magnitude of economic damage orchestrated by the pandemic. Countries that have invested hugely in research and development (R & D) through the years will attain equilibrium in the very short-run given that their economies are equipped with the requisite soft and hard infrastructure for a smooth recovery process. The model developed has clearly showed the importance of stimulating capital stock investment through savings and investment in research and development (R&D), physical capital, health human capital, as well as education human capital in tackling the COVID-19 pandemic in African countries.

Conclusion

The paper rigorously build an economic model to capture the economic impact of COVID-19 in Africa given that the emerging COVID-19 pandemic has severely crippled the economic activities of fragile African economies, affecting the economic process of these countries with high implications for health, businesses, debt, employment and other economic indicators. The economic incidence of the COVID-19 pandemic will highly be felt in Africa economies with high dependence on imports, unfavourable deficit balances, highly volatile currencies, unfavourable debts (external and domestic) burdens and other exogenous fragilities. Individual countries in the continent have been providing economic and social palliatives to cushion the effects of the pandemic on their socioeconomic environment. In spite of these policy actions, the socioeconomic effects of pandemic still continue to ravage economies in Africa with growth indicators taking a nosedive trajectory in the wake of the pandemic. With impending economic catastrophes on the horizon, it becomes imperative to build an economic model which captures the pandemic in the growth process in Africa. Much depend on the epidemiology of COVID-19 in the short run as well as Africa economies' response to the prevailing health and socioeconomic situation. There is need for individual economies in Africa to design viable public policy framework(s) in order to effectively cushion the ravaging effects of the COVID-19 pandemic. The extent to which the pandemic will affect demand and supply is a function of adaption of such economic policies. Fiscal policies such as health, expenditure, cash transfers, tax reduction as well as unemployment benefits, among other economic palliatives should be rigorously pursued. Such policies should be targeted at the vulnerable groups or the "poorest of the poor" in the African economies. In line with this, the volume

of public investments should rigorously be extended to stimulate welfare. At a continental level, financial institutions such as the Africa Development Bank (ADB) and the World Bank should create internalized economic policies to assist economies in battling the economic challenges created by the pandemic.

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