‘Not a good time’: Assessing the economic impact of COVID-19 in Africa using a macro-micro simulation approach

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Abstract
The paper studies the effects of the coronavirus disease 2019 (COVID-19) pandemic on African economies and household welfare using a top-down sequential macro-micro simulation approach. The pandemic is modeled as a supply shock that disrupts economic activities of African countries and then affects households’ consumption behavior, the level of their welfare, and businesses’ investment decisions. The macroeconomic dynamic general equilibrium model is calibrated to account for informality, a key feature of African economies. We find that COVID-19 could diminish employment in the formal and informal sectors and contract consumption of non-savers and, especially, savers. These contractions would lead to an economic recession in Africa and widen both fiscal and current account deficits. Extreme poverty is expected to increase further in Africa, in particular if the welfare of the poorest households grows at lower rates. We also use the macroeconomic model to analyze the effects of different fiscal policy responses to the COVID-19 pandemic.

1 INTRODUCTION

What began as a simple health crisis in the city of Wuhan, China, has quickly turned into an unprecedented economic crisis, with disruptions taking a toll on both developed and developing countries. Although the coronavirus disease 2019 (COVID-19) appeared later in Africa than elsewhere, it has spread rapidly across the continent and triggered a series of stabilization policies and containment measures that have important economic implications.

The COVID-19 pandemic has revived interest in studies on the macroeconomic and distributional impacts of economic crises and triggered empirical research on the ongoing crisis. Baker et al. (2020), Eichenbaum et al. (2020), Faria-e-Castro (2020), and Yilmazkuday (2020) applied macroeconomic techniques to simulate the effects of the coronavirus in developed countries. In Africa, Nonvide (2020) studied the short-term effect of COVID-19 on poverty assuming a 10%, 20%, and 30% contraction of household consumption. Sumner et al. (2020) applied a similar approach but uses 5%, 10%, and 20% contractions of household consumption.

There are three main knowledge gaps in the above studies on the macro and micro impact of COVID-19, which this paper aims to fill. First, almost all empirical research on the pandemic's macroeconomic impact has focused on developed economies, in particular the United States and Europe. But the magnitude of COVID-19’s effect on African economies and its transmission channels might vary from those observed in developed economies, given for instance the predominance of the informal sector, the absence of unemployment insurance schemes for most workers, and available policy instruments in African countries. Second, the assumptions applied in most studies investigating the micro impact of COVID-19 in Africa are...
not grounded in economic literature or backed up by existing macroeconomic analyses. In addition, by imposing to all African countries a similar set of assumptions on how household welfare could be impacted by COVID-19, these studies ignore heterogeneity across countries in the structure of welfare distribution and in the degree of vulnerability and resilience to shocks, as well as the importance of initial conditions. Finally, to the best of our knowledge, all existing studies analyze either the macroeconomic or the micro (household) effect of COVID-19 and never both together. As such, they present an incomplete picture of the effects of the COVID-19 crisis on aggregate economy-wide variables—such as employment, inflation, or real gross domestic product (GDP) growth—and on income distribution and poverty.

The objective of this paper is to assess the macroeconomic and welfare effects of the COVID-19 pandemic in Africa, drawing from previous analyses of similar shocks. The paper also fills the above gaps by adopting a macro-micro sequential simulation approach (Bourguignon & Savard, 2008; Cockburn, 2006; Cugneau & Robilliard, 2008) applied to African countries. To the best of our knowledge, this is the first empirical study to apply a top-down modeling approach to estimate the impact of the coronavirus pandemic in Africa. In this modeling approach, a deterministic dynamic general equilibrium (DDGE) model is first used to simulate the effects of the pandemic on macroeconomic aggregates and estimate the effects of stimulus policy responses. The model is calibrated to account for a key feature of African economies: the existence of a large informal sector that employs non-saving households and low-skilled workers who live hand-to-mouth and consume all their disposal income each period (Colombo et al., 2019). Macro projections from the DDGE model are then fed into household survey datasets to simulate changes in household welfare indicators such as poverty.

The rest of the paper is organized as follows. The next section discusses some contextual issues related to COVID-19 in Africa. Section 3 discusses the sequential macro-micro simulation approach used to estimate the effects of COVID-19. Section 4 describes the data used, while Section 5 presents and discusses the main simulation results. Section 6 extends the benchmark results to analyze the impact of policy responses to the pandemic and changes in within-country welfare distribution. The last section concludes. The technical calibration details of the DDGE model are in the Online Supplementary Appendix.

2 | CONTEXTUAL ISSUES ON THE COVID-19 PANDEMIC IN AFRICA

Since the first case of COVID-19 infection was confirmed in Egypt on February 14, 2020, the pandemic has spread across all 54 African countries, threatening the lives and livelihoods of millions of people. At the time this paper was finalized (March 21, 2021), more than 4 million COVID-19 cases were reported in Africa, more than 100,000 people have died from the coronavirus and the total number of active cases in Africa exceeded 300,000 (Figure 1). Spatially, finalized (March 21, 2021), more than 4 million COVID-19 cases were reported in South Africa (37.4%), Morocco (12%), Tunisia (6%), Egypt (4.8%), Ethiopia (4.6%), Libya (3.7%), and Kenya (2.9%), which together account for more than 70% of the total cases in Africa.

However, compared to the rest of the world, the COVID-19 pandemic has had less-than-anticipated health effects in Africa, despite the fear that the continent was inadequately prepared to contain the spread of the virus (AfDB, 2021). Hence, though accounting for around 17% of the world population (UN, 2019), Africa represented only 3.3% of the total global cases, 4% of deaths, and 0.7% of active cases as of March 21, 2021. One possible reason of low COVID-19 infections and death rates in Africa is related to the demographic structure of Africa's population. Indeed, the continent has both the world's highest concentration of young people (58% of the population are aged 24 years or below) and the world's lowest share of elderly people (only 3.7% of the population are 65 years or above) (UN, 2019). Recent empirical studies have shown that COVID-19 infection and death rates were positively correlated with the proportion of elderly people in a country and negatively associated with the share of the youth (Dowd et al., 2020; Goldstein & Lee, 2020; Medford & Trias-Llimós, 2020).

It is also possible that the reported COVID-19 figures could be understated due to limited testing capacities of healthcare systems in most African countries. Therefore, a large proportion of Africa's population could be affected by the coronavirus but remain unrecorded in official health statistics. Despite significant efforts to increase the number of tests and testing capabilities, Africa still lags behind other regions, with around 29,000 tests per million people against a world average of more than 230,000 as of March 21, 2021.

3 | METHODOLOGICAL APPROACH

We adopt a top-down simulation approach to estimate the macro- and microeconomic impacts of COVID-19 in Africa using different scenarios. First, we simulate the pandemic shock at the macroeconomic level through the transmission channels—both the supply-side shock resulting from domestic containment measures and the external shock caused
by global trends. We assess the impact on key macroeconomic variables, which then serve as inputs for the micro-model to study the impact on poverty in Africa.

### 3.1 | A dynamic general equilibrium model of the macroeconomic effect of COVID-19

#### 3.1.1 | Model description

The model is an open-economy dynamic general equilibrium model that features the informal economy (Boukar et al., 2021 and Colombo et al., 2019). The supply side features three private sectors: tradable formal $x$, non-tradable formal sector $n$, and informal sector $j$. Each sector utilizes private capital; low- and high-skill labor; government-supplied infrastructure, which increases the productivity of all sectors; and land, which is specific to agriculture.

Furthermore, the model assumes that the productivity of low-skill labor depends on work effort versus leisure. This allows us to assume that with COVID-19 and the resulting confinement measures, workers’ leisure is increasing relative to their work effort. The death toll on human capital is captured indirectly through a loss of productivity in the spirit of Adedeji and Akinlo (2016), while lockdowns and the confinement of workers at home are captured through increased leisure or decline in work effort. This assumption reflects the modeling of total factor productivity. In fact, TFP in our model improves with investment in human capital (see Brixiova, 2010; Diandy and Seck, 2021). Thus, it is clear that the death toll on the workforce including on qualified workers will reduce the overall productivity of the economy. Therefore, we capture this human loss through a corresponding decline in TFP.
Production functions

The production technologies $q$ of the different sectors $x, n$, and $j$ in period $t$ are given as:

$$q_{x,t} = a_x z_{t-1} k_{x,t-1}^{\gamma_x} s_{x,t-1}^{\delta_x} H_x (e_{h,t} L_{x,t})^{(1-\alpha_x-\delta_x)}.$$  (1)

$$q_{n,t} = a_n z_{t-1} k_{n,t-1}^{\gamma_n} s_{n,t-1}^{\delta_n} (e_{b,t} L_{n,t})^{(1-\alpha_n-\delta_n)}.$$  (2)

$$q_{j,t} = a_j z_{t-1} k_{j,t-1}^{\gamma_j} s_{j,t-1}^{\delta_j} (e_{b,t} L_{j,t})^{(1-\gamma_j-\delta_j)}.$$  (3)

All sectors utilize private capital $k$, low-skill labor $L$, high-skill labor $S$, and government-supplied infrastructure $z$. Infrastructure is a public good that enhances productivity in all sectors, and land or some natural resource $H$ is a sector-specific input in sector $x$. The variable $e$ links the quantity and quality of primary education to human capital of low-skill labor. In the formal sector, where efficiency wage considerations apply, the productivity of low-skill labor also depends on work effort $e_n$.

Households

The demand side of the model has two representative households—non-savers and savers—both of which derive their utility from consumer goods produced domestically in the formal sector and informal sector, and from imported traded goods.

The non-saving group comprises unemployed individuals and low-skill workers in the informal sector. They live hand-to-mouth and consume all their income each period and receive transfers from the government; their earnings in agriculture may include a share of land rents. The savings class comprises skilled workers and low-skill workers in the formal sector. They maximize a deterministic intertemporal utility function subject to a budget constraint. Unlike the non-savers, these households have access to capital and financial assets and/or liabilities and therefore the possibility to smooth their consumption subject to a discount factor that measures their preference for the future or the present.

On the spending side of their budget constraint, savers pay tax on capital income, land rent, and wage income in the formal sector. In addition, they pay user fees on infrastructure services. Furthermore, they face adjustment costs in accumulating capital, and portfolio adjustment costs in accumulating debt. The spending side of non-savers’ budget constraint is similar, except that they are exempt from user fees on infrastructure services and do not accumulate capital or debt.

The budget constraint of the representative non-saver is given by:

$$p_{c,t}= (1- f_{wx}) w_{x,t} L_{x,t} + \sigma n_t H + (1- f_{wy}) w_{y,t} L_{y,t} + a_t T_t,$$  (4)

where $L_{x,t}$ and $L_{y,t}$ are the supply of low-skill labor in the formal tradable and informal sectors, respectively; $w_{x,t}$ and $w_{y,t}$ are the corresponding real wages; $f_{wx}$ and $f_{wy}$ are ad valorem taxes on low-skill wage income; $c_t$ is consumption by non-savers; $T_t$ represents public transfers; the coefficient $a_t$ measures the share of transfers going to non-savers, and $(1- a_t)$ measures the share going to the counterpart savers.

The savers maximize the following intertemporal utility function:

$$V = \sum_{t=0}^{\infty} \beta^t c_{2,t} \left( \frac{1}{1 - \tau} \right),$$  (5)

subject to the following budget constraints:

$$R b_t - b_{f,t} = \left(1 - f_w\right) \left( w_{h,t} L_{n,t} + w_{s,t} S_{t-1} \right) + \sum_{q=j,n,x} \frac{r_{q,t}}{1+g} \left( k_{q,t-1} - \delta P_{q,t-1} \right) + \sum_{q=j,n,x} \frac{r_{q,t}}{1+g} \left( k_{q,t-1} - \delta P_{q,t-1} \right) + \left(1 - f_b\right) H + \left(1 - a_t\right) T_t - \frac{1 + r_f}{1+g} b_{f,t-1} + \frac{1 + r_f}{1+g} b_{f,t-1} - P_{k,t} \sum_{q=j,n,x} \left( q_{k,t} + A C_{q,t} \right) - \frac{\eta}{2} \left(b_{f,t} - \bar{b}_{f}\right)^2 - p_{c,t} c_{2,t}$$  (6)

The model assumes that high-skilled labor is mobile across sectors. Basically, investment in human capital, by upskilling the labor force, also leads to a shift of the high-skilled working group to the formal sectors. Thus high-skilled workers can be in any sector as they are mobile across sectors but there is a shift toward formal sectors (structural transformation) as a result of human capital investment. The assumption is that workers (low-skilled and high-skilled) in the formal sector are savers whereas workers in the informal sector are non-savers. Workers in the formal sector generally have access to the credit market, no matter if they are low-skilled or high-skilled but workers in the informal sector in Africa can find access to the credit market difficult.

The assumption on the user fees of infrastructure services is meant to reflect the fact that workers in the informal sector often do not have access to government-supplied infrastructures such as electricity and clean water. The assumptions somehow reflect African reality.
and for each sector $q$ with $q = j, n, x$:

$$(1 + g)k_{q,t} = i_{q,t} + (1 - \delta)k_{q,t-1}. \quad (7)$$

The term $AC_{q,t}$ in the budget constraint captures costs incurred in changing the capital stock in sector $q$ and expressed as $AC_{q,t} = \frac{\varepsilon}{2}\left(\frac{i_{q,t}}{k_{q,t-1}} - \delta - g\right)^2$. The term $\frac{\varepsilon}{2}\left(\delta - g\right)k_{q,t-1}$ measures portfolio adjustment costs associated with the deviations of foreign loans from their steady state level. $\mu$ is user fees charged for infrastructure services and $z_t$ is public infrastructure capital stock.

**Public sector**

The public sector collects revenues from different sources and spends them on investment in education, infrastructure, and transfers. The model allows for different government financing options. Grants, aid, foreign direct investment (FDI), concessional borrowing and other financial flows, and oil revenues are exogenously given, as is public investment in infrastructure and human capital.

Absent additional financing sources, the government adjusts taxes and/or transfers to finance the fiscal gap. Moreover, the model assumes that external commercial borrowing and domestic borrowing help meet the financing gap, with taxes and transfers responding to stabilize debt levels over time.

The public sector budget constraint is expressed as follows:

$$P \Delta b_t + \Delta d_{c,t} + \Delta d_t = \frac{r_d - g}{1 + g}d_{c,t-1} + \frac{r_d - g}{1 + g}d_{c,t-1} + \frac{r_t - g}{1 + g}P_i b_{t-1} + P_{i_t}i_{c,t} + P_{i_t}m_t + T_t + P_{i_t}i_{s,t} - \mu_t z_{t-1}$$

$$- h_t(P_h, c_{n,t} + g^j_{P_{j_t}}c_{j,t} + g_e c_{x,t} + g_m c_{m,t}) - \sum_{q=j,n,x} f_q (r_{q,t} - \delta P_{q,t})k_{q,t-1} + f_{wq,t} w_{q,t} L_{q,t}$$

$$- f_{wq,t} w_{x,t} S_{x,t} - f_{wq,t} h_{n,t} H_t,$$  \quad (8)

where $\Delta b_t = b_t - b_{t-1}$, $\Delta d_{c,t} = d_{c,t} - d_{c,t-1}$, $\Delta d_t = d_t - d_{t-1}$, $r_d$ and $r_{dc}$ are interest rates (in US dollars) on concessional debt $d$ and commercial debt $dc$, respectively, and $g_t$ is the interest rate on domestic debt $b$. $P$ is GDP deflator, $c_{n,t} c_{j,t}$, $c_{x,t}$ and $c_{m,t}$ are consumption of nontraded, informal-produced traded and imported traded goods respectively; $h_t$ is the consumption tax rate and the parameters $g_t$, $g_e$ and $g_m$ serve to broaden the consumption tax-base; $f_{wx}$ and $f_{wei}$ are ad valorem taxes on low-skill wage income; $f_{wq}$ is ad valorem tax on skill wage income; $f_q$ is ad valorem tax on capital income in the three sector and $f_{n,t}$ is ad valorem tax on land income. $P_{i,t}$ is supply price of public infrastructure capital and $P_{j,t}$ is the supply price of education capital. $i_{c,t}$, $m_t$ and $i_{s,t}$ are new investment in infrastructure, in maintenance and in education, respectively.

**Market-clearing conditions**

There are three markets in the economy: the market for skilled labor, the market for low-skilled labor, and the market for goods. Flexible wages equate demand to supply in the market for skilled labor, the market for low-skill labor in sector $x:n:j$ and flexible prices equate the demand and supply of goods in the non-traded and informally produced goods market.

$$S_t = S_{x,t} + S_{n,t} + S_{l,t}, \quad (9)$$

$$\bar{L}_t = L_{x,t} + L_{n,t}, \quad (10)$$

$$q_{n,t} = c_{n,t} + a_{kn}\sum_{q=i,n,x} (i_{q,t} + AC_{q,t}) + a_{2nt} (i_{z,t} + m_t) + a_{nt} i_{s,t}, \quad (11)$$

$$q_{l,t} = c_{l,t} + a_{kt}\sum_{q=i,n,x} (i_{q,t} + AC_{q,t}) + a_{2lt} (i_{z,t} + m_t) + a_{lt} i_{s,t}, \quad (12)$$

where (9) is the market-clearing condition in the market for skilled labor, (10) for low-skilled labor and (11) and (12) is market clearing conditions in the market for goods.

The model is closed by the accounting identity that growth in the country’s net foreign debt equals the current account deficit. Adding the public and private budget constraints produces the following:
$$\Delta d_t + \Delta dc_t + \Delta b_{f,t} = \frac{r_d - \theta}{1 + \theta} \Delta d_{t-1} + \frac{r_{dc} - \theta}{1 + \theta} \Delta c_{t-1} + \frac{r_f - \theta}{1 + \theta} b_{f,t-1} + \frac{\eta}{2} (b_{f,t} - \bar{b})^2 + P_{c,t}(i_{t,t} + m_t) + P_{f,t}k_{t,}$$

$$+ P_t(c_{1,t} + c_{2,t}) + P_{k,t} \sum_{q=j,n,x} (i_{q,t} + \Delta C_{q,t}) - P_{h,t}q_{n,t} - (d_{f,t}q_{f,t} - q_{x,t}), (13)$$

where $\Delta d_t = d_t - d_{t-1}$, $\Delta dc_t = dc_t - dc_{t-1}$, and $\Delta b_{f,t} = b_{f,t} - b_{f,t-1}$. 

### 3.1.2 Macro-modeling of COVID-19 shocks and fiscal policy responses

The supply-side shock is modeled as a sudden loss of productivity of the unwell workers as well as a decline in their work effort or an increase in involuntary leisure. The falling productivity along with the loss of work effort lead to a contraction of sector output and employment, which depresses real wages. If other components of households’ income remain unchanged, households would face a loss of income with some attendant effects on consumption. In addition to the shocks originating from direct human costs and the expense of implementing preventive measures, African economies are also being hit by global trends. In particular, the slowdown in global activity and disruption of global supply chains are affecting these economies through a contraction of trade, tourism, and financial flows. The degree of Africa’s exposure and vulnerability to global trends depends on how well the continent is integrated into the rest of the world as well as the contribution of each channel to individual economies.

We model these global trends—trade and financial flows (FDI, ODA and remittances)—as exogenous external shocks along with the health (or productivity) shock and assess their impact on African economies. However, although high frequency data provide some indicators, the uncertainty surrounding the depth and the breadth of the pandemic in African countries makes it difficult to assess with certainty the macro- and microeconomic impacts of COVID-19.

We therefore consider two possible scenarios regarding the depth and duration of the shock to these variables: the baseline and worst-case scenarios summarized in Table 1. Cognizant of these challenges, we caution that the results reported in this paper should be regarded as scenario analyses or simulations, and not as projections.

Furthermore, we study the impact of different fiscal policy adjustment instruments in the spirit of Faria-e-Castro (2020) to alleviate the effect of the pandemic on households and businesses, as well as stabilize the economy. We propose the following fiscal policy adjustments to close the gap or allow a temporary widening of the fiscal gap: (i) close the fiscal gap by reducing nonproductive public spending and thus improving allocation efficiency; (ii) create a temporary deficit; and (iii) introduce grants and concessional borrowing similar to those in rescue packages offered by multilateral institutions.

| Scenario                  | Duration and spread of COVID-19 outbreak | Scenario assumptions |
|---------------------------|-----------------------------------------|----------------------|
| Baseline scenario         | First half of 2020, with lockdowns ending by middle of the year | • Oil and commodity prices drop by 60% from their January 2020 level  
• Financial flows (FDI, loans, portfolio investments, and remittances) to Africa decline by 60%  
• Tourism to Africa declines by 80% as a result of travel restrictions  
• Capacity utilization and total factor productivity decline by 60% due to lockdown of cities, lockdown-driven absenteeism, postponement of construction activities, and disruption in supply chains |
| Worst-case scenario       | The whole year 2020, with lockdowns extending beyond the middle of 2020. | • Oil and commodity prices drop by 80% from their 2020 levels, following fall in global demand and excess supply; oil prices assumed to be $15–20/barrel  
• Financial flows (FDI, loans, portfolio investments, and diaspora remittances) to Africa decline by 80%, as a result of investor flight to safety and constrained liquidity  
• Tourism to Africa halts completely as a result of social distancing and a total ban on travel. Capacity utilization and total factor productivity decline by 80% due to lockdown of cities, lockdown-driven absenteeism, postponement of construction activities, and disruptions in supply chains |
3.2 | Linking macro- and micro-simulation models

In our micro-simulation approach, building on models developed by Bourguignon and Savard (2008) and Ferreira et al. (2008), we superimpose macroeconomic projections from the dynamic general equilibrium model on precrisis household data to forecast postcrisis household welfare and, thus, poverty levels. Formally, let \( w_{it} \) and \( w_{jt} \) be the welfare of a household \( i \) (approximated here by real per capita household consumption) in an African country \( j \) observed before and after the coronavirus pandemic outbreak, respectively. The corresponding welfare distributions \( D_{jt} \) of households in that country before and after COVID-19 can be defined as:

\[
D_{jt} = \{ w_{ij,t-1}; \ldots; w_{ij,t-N}; \ldots; w_{ij,t-M} \},
\]

(14)

where \( N \) and \( M \) are the total population of the country before and after the COVID-19 outbreak. The impact of the pandemic can then be obtained by comparing the welfare distribution in (14) and (15):

\[
I_{jt} = D_{jt} - D_{jt-1} = \{ w^*_{ij,t}; \ldots; w^*_{ij,t-M} \},
\]

(15)

where \( w^*_{jt} \) is the impact of COVID-19 on the welfare of household \( i \).

The micro-simulation approach consists of assessing how \( D_{jt-1} \) would change to \( D_{jt} \) due to COVID-19, given the parameters obtained from the DDGE model. To link the macro and micro models, we assume that growth of real per capita household consumption derived from household surveys is correlated with real per capital GDP obtained in national accounts and used in the macroeconomic model (Deaton, 2005; Pinkovskiy & Sala-i-Martin, 2016; Ravallion, 2003), so that:

\[
w_{ij,t} = (1 + \beta g_{jt}) w_{ij,t-1},
\]

(17)

where \( g_{jt} \) is the simulated real per capita GDP growth obtained from the DDGE model and \( \beta \) is the estimated passthrough between growth rates of per capita GDP and consumption using historical data. To get \( \beta \), we follow Ravallion (2003) and estimate the following equation:

\[
g_{jt} = \alpha + \beta g_{jt-1} + \gamma \mathbf{X}_{jt} + \varepsilon_{jt},
\]

(18)

where \( g_{jt} \) is the annualized growth rate of per capita consumption between two adjacent household surveys and \( g_{jt} \) is real per capita GDP growth from national accounts over the same period. \( \mathbf{X}_{jt} \) is a vector of control variables such as the annualized growth rate of GINI index or population growth. \( \varepsilon_{jt} \) is the error term. The intercept \( \alpha \) is constrained to 0 (Lakner et al., 2019; Ravallion, 2003). The coefficient \( \beta \), our parameter of interest, represents the estimated fraction of real per capita GDP growth that is passed through to the real per capita consumption growth obtained in the surveys.

With the growth rates obtained from the DDGE model under different scenarios, the estimated passthrough \( \hat{\beta} \), the precrisis household surveys and projected population by country, it becomes straightforward to simulate the impact of COVID-19 on poverty and number of poor. To do so, we take the difference between the simulated poverty rates and number of poor (defined as those living on less than US$1.90 a day) in the baseline and worst-case scenarios (COVID-19 scenarios) and the poverty rates and number of poor that would have been observed had the coronavirus not occurred (the no-outbreak or pre-COVID-19 scenario).

4 | DATA

Most of the parameters’ values used for the baseline calibration of the dynamic general equilibrium model are drawn from the existing literature. Moreover, the calibration of cost shares and factor shares builds on data from the Global Trade Analysis Project (GTAP), International Food Policy Research Institute (IFPRI), and World Bank databases (see calibration in the Online Supplementary Appendix for more details). To assess the poverty implications of COVID-19 in Africa, we use household surveys of 50 African countries from the World Bank’s PovcalNet datasets.\(^3\) These nationally

\(^3\)Data are not available for Equatorial Guinea, Eritrea, Libya, or Somalia.
representative data are standardized as far as possible with regard to the method of data collection and computation of welfare indicators and poverty measures. Our starting point is the latest available survey for each African country. The surveys span 2008–2018, with 2015 as the mean survey year.

5 | RESULTS AND DISCUSSION

5.1 | Macroeconomic impacts of COVID-19 in Africa

In Figure 2, we plot the response of key macroeconomic variables to the COVID-19 shock derived from the DDGE model under the scenario assumptions in Table 1. Under the baseline scenario, the combined COVID-19 shocks are estimated to cause in 2020 a 34%, 39.1%, and 26.2% drop in employment in the informal sector, the formal service sector, and the formal tradable sector, respectively. The contraction widens further in the worst-case scenario, with
close to a 43.2% drop in employment in the informal sector, 51.1% in the formal non-tradable sector, and 32.3% in the formal tradable sector. The loss of these jobs triggers a drop in consumption of non-savers by almost 8.3% in the baseline scenario and 16.4% in the worst-case scenario. Savers—who are assumed to behave in a rational and forward-looking manner and therefore prefer to save more and postpone consumption for precautionary reasons—see a more pronounced dip in their consumption levels by almost 18% in the baseline scenario and 24% in the worst-case scenario. Private investment decisions of businesses follow suit with a 13.4% drop in the baseline scenario or 17.2% in the worst-case scenario. These combined effects would lead to a contraction in Africa’s real GDP growth rate of –1.7% in 2020 in the baseline scenario and –3.4% in the worst-case scenario.

The combined COVID-19 shocks would squeeze fiscal space as fiscal deficits are estimated at 8% and 9% in the baseline and worst-case scenarios, respectively, in 2020. Indeed, the contraction of real GDP leads to a contraction in government revenues through lower foreign exchange receipts, especially for commodity exporters. The economic downturn also reduces the ability of governments to mobilize revenues through taxes as a result of the drop in GDP. On the expenditures side, governments face pressure to spend more to improve health infrastructure and protect and provide for vulnerable segments of the society. Therefore, governments increase health-related spending while setting up fiscal policy response packages for vulnerable households and businesses (see this section for details).

External balances would also be hit hard by the combined COVID-19 shocks, with the 2020 current account deficit estimated at 6.8% and 8.1% in the baseline and worst-case scenario, respectively. The important drivers of these estimated deficits are the weakening of Africa’s terms of trade with the rest of the world and loss of competitiveness of Africa’s exports. Together with the low demand for exports, the expected reductions in remittances, and the economic downturn, these combined effects explain the estimated widening of the current account balance.

A V-shaped recovery is expected in 2021 for the selected variables. The recovery is expected to be faster in informal low-skill employment and employment in service sectors, but slower in the tradable sector. Accordingly, consumption and investment behavior adjust, with consumption by both classes of households and private investment returning to positive territory by 2021.

5.2 Poverty effects of COVID-19 in Africa

In the absence of COVID-19, estimates from the micro simulations show that Africa’s extreme poverty rates (share of people living on less than US$1.90 per day) would have declined from 32.89% in 2019% to 32.18% in 2020% and 31.52% in 2021. This represents a reduction in extreme poverty rates of 0.71 and 0.67 percentage point in 2020 and 2021, respectively (Figure 3). However, when the effect of the coronavirus pandemic is accounted for, extreme poverty increased in 2020 by 2.14 and 2.84 percentage points in the baseline and worst-case scenarios, respectively. The poverty effect of COVID-19 would widen even further in 2021, to 2.51 and 3.63 percentage points in the baseline and worst-case scenarios, respectively.

![Impact of COVID-19 on Africa’s extreme poverty rates.](image-url)
Oil-exporting countries are expected to be hit the hardest due to declining oil prices. Collectively, these countries experienced in 2020 an increase of 2.5 percentage points in extreme poverty (or an additional 14.9 million poor) under the baseline scenario, compared with an increase by 1.9 percentage points (or an extra 13.3 million poor) in oil-importing countries. Due to travel restrictions, poverty in tourism-dependent countries such as Mauritius, Cabo Verde, and São Tome and Príncipe has also been significantly increased. In particular, simulations show, for instance, that in 2020, rates of extreme poverty had almost doubled in Mauritius in the baseline scenario and increased by 46.7% in Cabo Verde and by 37.4% in São Tomé and Príncipe.

Under the no-outbreak scenario, 425.2 million people were projected to be in extreme poverty in Africa in 2020. COVID-19 increased that figure to 453.4 million poor in the baseline scenario and as high as 462.7 million under the worst-case scenario, meaning an additional 28 million or 37.5 million extreme poor, respectively. In 2021, the number of poor could increase by up to 49.2 million due to COVID-19 as GDP growth continues to fall below population growth rates (Figure 4).

6 | ADDITIONAL EXPERIMENTS

6.1 | Fiscal policy responses to the pandemic

In the previous sections, the DDGE model exercise did not account for the effects of the different policy responses that various African countries are implementing to contain the spread of the virus and support their economies. In this section, we carry out additional experiments and study the impacts of activating the following fiscal policy response packages to mitigate the pandemic shock in the spirit of Anyanwu et al. (2013):

- Public transfer increases, $T_t$ (see Equation 4).
- Consumption tax cut, $h$.
- Low-skill wage income (in tradable and informal sector) and high-skill wage tax cut, $f_{w^c} - f_{wj}$ and $f_w$ (see Equations 4 and 6).

The immediate implication of the response package is a widening of the fiscal gap, unless there is an offsetting fiscal adjustment. For each instrument of the package, we adopt the following fiscal adjustments by countries: (i) allow a temporary fiscal deficit; (ii) close the fiscal gap by reducing public infrastructure spending; and (iii) finance the gap through grants and concessional borrowing similar to the rescue packages offered by multilateral institutions.

6.1.1 | Public transfer increases $T_t$

This experiment takes the form of direct transfer payments handed out by governments to the two classes of households. We calibrate the coefficient $a_t$ in Equation 4 such that non-savers are entitled to 60% of the transfers while their counterpart savers receive the remaining 40%. The intervention consists of a one-time increase in transfers of 4.6%,
similar to the percentage point increase of fiscal deficit in Africa under the worst-case scenario. The key finding is that public transfer increases of this size alleviate the impact of the pandemic on households’ consumption. We find that the contraction of consumption of non-savers in the worst-case scenario is reduced by 8.3 percentage points in 2020 from its 16.4% level such that the net fall in consumption is about 8%; for savers, the intervention lessens the contraction by 6.2 percentage points from its 24% level such that the net fall in consumption is about 18%.

The overall economic impact of this instrument depends on how the resulting fiscal gap will be closed. First, we assume that governments will close the deficit by reducing infrastructure spending by a corresponding amount. This substitution of productive spending with nonproductive spending (transfers) does not harm the overall economy, given the short time horizon of only 2 years. Within this time horizon, the overall impact on the economy is measured in terms of Keynesian spending effects, with attendant demand-related pressures and, accordingly, minimal pressure on prices. Our results show that the spending effect is the result of the positive impact of transfers in cushioning the pandemic’s effect on households’ consumption. Finally, we assume that governments are able to secure grants and concessional debt-financing to finance the fiscal deficit. We find that such alternative financing source goes a long way toward making the deficit fiscally viable. It indicates that the adjustment does not create any unintended effects on the economy in the short term. The qualitative results are similar to that with the previous fiscal adjustment. However, under this adjustment, private consumption is higher by another 0.24 percentage point for non-savers and 0.11 percentage point for savers.

6.1.2 | Consumption tax cut \( h \)

This experiment consists of a one-time lowering of the consumption tax rate by 20%. The effects of the consumption tax cut are found to be progressive between the two classes of households. It results in a 10.7 percentage point lessening of the contraction of non-savers’ consumption and 7.6 percentage point for savers. This finding is in line with the general belief that cutting consumption taxes tends to be progressive in countries where the poor spend a large share of their income on consumption goods compared with high-income households. The quantitative results remain unchanged, irrespective of the strategies used to close the fiscal gap.

6.1.3 | Low-skill and high-skill wage income tax cut

This intervention consists of a one-time 20% cut in the low-skill income tax and a 10% cut in the high-skill income tax. The rationale is to make the intervention as progressive as possible. The tax cuts help sustain households’ income, which in turn results in a higher consumption level. In particular, we find that a 20% cut in low-skill income tax reduced the decline in consumption observed in the worst-case scenario by 6.6 percentage points for non-savers. And a 10% cut in high-skill income tax reduced the drop in the consumption level of savers by 3.7 percentage points. The overall economic impact, including on GDP growth and employment, is mild thanks to the short time horizon.

6.2 | Changes in within-country welfare distribution

Our micro-simulation results have so far considered that COVID-19 would be distribution-neutral and therefore would equally affect poor and rich households. However, it is very likely that poor households will be more affected than others given their elevated risk of losing their jobs as a result of COVID-19 (AfDB, 2021). In addition, most poor households are subsistence farmers and/or are employed in the informal sector and thus have no access to public insurance schemes or other unemployment benefits.

One way of accounting for differential changes in the welfare distribution within countries is to assume that, given their higher vulnerability to economic shocks, real per capita consumption of the poorest will grow more slowly than that of the rest of the population. Formally, the mean welfare growth of households \( \bar{w}_{jt} \) in a country \( j \) can be written as a weighted sum of the mean growth among the poorest \( k \)% and the richest \( (100 - k) \)% such that:

\[
\bar{w}_{jt} = s_k \times w_{ktj} + (1 - s_k) \times w_{(100-k)tj},
\]

where \( s_k \) is the welfare share of the poorest \( k \)% used as weight, with \( k \in [0; 100] \) and \( s_k \in [0; 1] \).
If the poorest \( k \)% grows at a lower rate \( i \) than the growth \( j \) of the rest of the population without changing the weighted mean growth, then (19) can be rewritten as:

\[
\bar{w}_j = s_k \cdot w_{kt} + \frac{(1 + i(1 + p))}{1 + i}(1 - s_k) \cdot w_j(100 - k)t,
\]

(20)

where \( j = i(1 + p) \) and \(|j| > |i|\). \( p \) is the growth penalty of the poorest \( k \)%.

Figure 5 reports the results of the micro-simulation exercise when the real per capita consumption of the poorest 10%–40% grows by up to \( p = 20\% \) slower than the rest of the population in 2020 under the baseline scenario. This lower growth for the poorest—the growth penalty—amplifies the impact of COVID-19 for the same level of mean growth. For instance, if the welfare of the poorest 10% grew in 2020 on average 1%, 5%, and 10% slower than the rest of the population, then the impact of COVID-19 would increase in 2020 from 2.14% to 2.27%, 2.63%, and 3.08%, respectively. When we consider the poorest 40%, then the poverty impact of COVID-19 would rise to 2.38%, 3.16%, and 4.18%, respectively. This result underscores the importance of accounting for the differential effects of COVID-19 on the poor and rich segments of the African population when simulating its poverty implications.

7 | CONCLUSION

This paper simulates the impacts of COVID-19 in Africa using a sequential macro-micro simulation approach. It adopts two scenario assumptions on the size and persistence of COVID-19 shocks due to the uncertainties of the depth and duration of the pandemic both in Africa and globally. The simulation results show that the pandemic will slow Africa’s economic growth and exacerbate extreme poverty. In particular, depending on containment measures and their duration, the pandemic could push African countries into recession, with real GDP growth rates estimated at −1.7% or −3.4% in 2020 under the baseline and worst-case scenarios, respectively. As a result, the continent could record an increase in the rate of extreme poverty by 2.14% or 2.84% under the baseline and worst-case scenarios, respectively, which translates to an additional 28.2 million or 37.5 million people sliding into extreme poverty.

The paper also analyzes different types of fiscal policy packages being implemented by African countries to limit the impact of COVID-19 on their economy. We find that, irrespective of how the government closes the fiscal gap in response to each instrument, all policy responses succeed in increasing household consumption and income and therefore mitigating the effects of COVID-19. In addition, we find the consumption tax cut and differentiated low-skill and high-skill income tax cut to be progressive among poor and rich households. Finally, we find that a fiscal adjustment whereby the deficit is closed through grant financing is superior to an expenditure-switching strategy that entails a corresponding cut in infrastructure spending.

4If the growth penalty \( p = 5\% \) and \( k = 10 \), then growth of real per capita consumption of the poorest 10% is 5\% lower than growth of the remaining 90% of the population while keeping the mean growth unchanged.
There are, however, three important caveats to note in this study. First, the modeling exercise assumes a one-time rather than a persistent shock; if such persistence materializes, it could have serious implications for demand and supply disruptions. In addition, the shocks are assumed to be one-time perfect foresight fiscal impulses. In practice, fiscal policy packages are likely to be persistent and implemented over a certain horizon. Second, the size of the shocks is assumed to be fixed in each scenario. In practice, a range of values for the size and confidence interval is necessary. Finally, our model is grounded on fiscal policy, so we abstract from monetary policy and liquidity injections in the response package. As a result, firms are excluded from the response package. This could be an important area for future research.

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