

Egbuna, Ngozi Eunice et al.

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WHEN WILL NORMALCY RETURN? EXPLORING THE NOVEL COVID-19 SPREAD IN THE WEST AFRICAN MONETARY ZONE

Ngozi E. Egbuna (PhD), Maimuna John-Sowe, Santigie M. Kargbo (PhD), Ibrabima Diallo, Sani Bawa (PhD)
and Isatou Mendy¹

Abstract

The increasing uncertainties about the evolving pattern of the novel COVID-19 virus in the absence of a vaccine and the dampening economic effects associated with the containment measures, which have triggered a sharp fall in global commodity prices have raised concerns among policymakers in the WAMZ. This paper seeks to determine the likely time of containment of the pandemic in WAMZ countries and return to normalcy to guide decisions on measures to curtail transmission of the virus. Using three different scenarios and the traditional SEIR (susceptible, exposed, infectious and recovered) epidemiological model, this paper shows that under scenario 1 of continued government intervention and containment measures, all the WAMZ countries may contain the spread of new infections latest in December, 2020. Predictions from scenario 2, which assumes increased testing, contact tracing and isolation of infected and exposed persons suggest that all the six countries are likely to contain the outbreak around October, 2020. By comparison, scenario 3, which assumes increased number of infected cases, owing to weak preventive and control measures, points to delayed containment of pandemic latest by April 2021. The findings underscore the need for the government in the Zone to sustain budgetary spending on health, build capacity to minimise the impact of future pandemic, continue to support public sensitisation campaigns on personal hygiene and social distancing protocols, vulnerable households and businesses to facilitate economic recovery, and develop a regional health strategy to contain contagion across countries.

JEL Classification: C53, I15, N17

Keywords: Covid-19 pandemic, SEIR model, preventive measures, WAMZ.

¹ Authors are staff of West African Monetary Institute, Accra, Ghana. Corresponding authors: Santigie M. Kargbo (skargbo8@gmail.com) and Ibrabima Diallo (ib.diallo1@gmail.com).

1.0 INTRODUCTION

Since the outbreak of the novel Coronavirus (COVID-19) which started in December, 2019 in Wuhan, China and its subsequent declaration as a global pandemic by the World Health Organization (WHO) on March 11, 2020, several countries have been severely affected by the disease, particularly Brazil, China, France, Italy, Iran, Russia, Spain, United Kingdom and United States. The outbreak continues to put severe pressures on health systems across the globe, even in countries with apparently the most modern and sophisticated health systems. As at June 04, 2020, more than 6.3 million confirmed infected cases were reported worldwide and 383,262 deaths.² In the wake of the disease outbreak, individual countries as well as global organisations have responded using various intervention measures to mitigate the spread of the virus and limit the human and economic damage. The associated economic costs have reached unprecedented levels, with severe disruptions to global value chains and economic activities, while containment measures implemented at the national level to prevent the rapid spread of the virus, such as travel restrictions, closure of schools and colleges, lockdowns and quarantines, are continuously dampening economic activities and causing untold economic hardships.

Across the African countries, the prevailing low socio-economic levels and the nature of economic activities have raised questions about the ability of governments to cope with the rising infection rates, and the severe economic costs associated with the pandemic in the short-term, which pose a potential drag on short to medium term growth. There is a growing fear among policymakers in Africa about a potential health crisis, due to existing conditions such as weak health-care systems, including inadequate disease surveillance systems and laboratory capacity, dearth of human resources especially in the public health sector and limited financial capacity, coupled with existing health challenges such as the prevalence of HIV, tuberculosis and malaria (Nkengasong and Mankoula, 2020).

In the West African Monetary Zone (WAMZ), all member countries have recorded cases with the first case in Nigeria on 28th February, 2020 and Sierra Leone the last country on 1st April, 2020. Both Ghana and Guinea recorded their first cases on 14th March while Liberia and Gambia announced the first case on March 17 and 18, respectively. As at June 4, 2020 the Zone recorded a total of 24,898 confirmed infected cases and 452 deaths. Partly due to relatively large population size and contact tracing capability, Nigeria, Ghana, and Guinea recorded higher number of infected cases in the Zone with 11,166, 8,548 and 3933 confirmed infected cases, respectively as at June 4, 2020.³ Sierra Leone and Liberia, on the other hand, had confirmed 909 and 316 cases while the Gambia had confirmed 26 cases. In term of deaths, Nigera confirmed the largest number (315) followed by Sierra Leone (47) and Ghana (38), while Liberia, Guinea and Gambia recorded 28 deaths, 23 deaths and 1 death, respectively.

² COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE), Johns Hopkins University.

³ Figures collated from the WHO database.

Table 1: Number of infected cases and deaths in the WAMZ in 2020 as at June 04, 2020

Country	1st Case Recorded	# Infections	# Deaths	Death Ratio
The Gambia	18-Mar	26	1	3.8
Ghana	14-Mar	8548	38	0.4
Guinea	14-Mar	3933	23	0.6
Liberia	17-Mar	316	28	8.9
Nigeria	28-Feb	11166	315	2.8
Sierra Leone	01-Apr	909	47	5.2
WAMZ	---	24898	452	3.6

Source: WHO Health Organization (WHO) database as at June 04, 2020

Despite the relatively low rates of infections, a growing concern among public health experts in the WAMZ is the limited response capacity of countries in the Zone, should Member States experience a surge in infected cases. Most health systems in the WAMZ are critically weak due to prolonged low levels of investments in the health sector. This translates into chronic shortage of trained medical professionals, scarcity of medical supplies, protective equipments, and limited virus testing capacity. Equally, policymakers are concerned about the weak fiscal positions of governments, which continue to undermine the efforts to adopt appropriate mitigating measures to contain the disease and pave the way for gradual resumption of normal economic activities. This prevailing health situation coupled with increasing non-trivial economic costs associated with the containment measures adopted by the WAMZ countries have triggered uncertainties about the evolving nature of the disease and raised critical questions of policy relevance to governments in the Zone. Are the WAMZ countries likely to experience a flare up of infections in the coming months? Would countries be able to contain the transmission of the virus in the coming months to resume normal economic activities? Understanding the pattern of the spread of the disease is important in designing country strategies to contain the disease and mitigate the dampening economic effects.

This brief explores the pattern of the COVID-19 spread in the WAMZ, using three different government intervention scenarios to contain the spread of the disease. The overarching objective of this brief is not to predict with certainty the likely number of infected cases and mortality associated with the disease. Rather, it seeks to guide decisions on measures to prevent the transmission of the virus. The prediction exercise intends to provide fair assessment of the likely incidence of infected cases and mortality to help countries prioritize resources to ensure more timely and systemic response to a potential surge in infected cases. While few studies have conducted predictions for the WAMZ countries (Frost et al., 2020; Zhao et al., 2020), it is obvious that these studies may not have captured the outcome of recent preventive and control measures of the governments in the Zone. Given the strong infectiousness of the disease and various mitigating measures implemented by governments, it is imperative to undertake a new assessment of the transmission of the virus. In doing so, this brief contributes to the ongoing policy debate by exploring the evolving pattern of the COVID-19 virus. It also brings to the fore, critical policy issues to complement national efforts in preparation for the gradual resumption of economic activities to mitigate the economic costs of existing containment measures.

Among the factors explaining the emergence and prevalence of the virus are the virulence and infectivity of the virus, and several factors including population mobility, economic activities and social environment (Zhao et al., 2020). Amidst such severity in response capacity and growing uncertainties in the global economic and financial environment, commodity exporting countries such as Ghana,

Angola, Congo, Equatorial Guinea, Zambia, South Africa, Gabon and Nigeria continue to be severely affected by depressed global commodity prices. Similarly, non-resource rich African countries that rely heavily on tourism revenues, remittances flow and official development assistance equally bear profound economic burden of the disease. The continued dampening of commodity prices worsens fiscal balances, weakens the response capacity of countries in the Zone to embark on measures such as large-scale virus testing, contact tracing and quarantines, as well as other strategic health interventions in the absence of external assistance. As few countries across the globe are beginning to experience gradual reductions in infection rates due to the implementation of enhanced preventive and control measures, there are growing calls for countries to gradually open to normal business activities in order to mitigate the economic consequences of the containment measures.

In trying to predict the spread of the disease, we applied the traditional susceptible, exposed, infectious and recovered (SEIR) model widely used in epidemiological studies for characterising the epidemic outbreak in countries (Peng et al., 2020). The model allows us to take into consideration potential nonlinearities to capture the time-changing features of relevant parameters in response to the mitigating measures of governments to predict the pattern of the virus outbreak. Results suggest that infections are more likely to peak in the WAMZ countries from July to August, 2020. Under the scenario 2, all countries may be able to contain the spread of new infections around October 2020. Predictions under scenario 1 suggest that three countries; Ghana, Nigeria and Sierra Leone, may achieve same in October 2020, while Liberia in November 2020 and The Gambia and Guinea in December, 2020. Results further show that under the scenario 3, The Gambia, Guinea, and Liberia are likely to contain spread of the infections around April, February and January 2021, respectively, while Sierra Leone in December 2020, and Ghana and Nigeria around October 2020.

The rest of the brief is structured as follows. The next section reviews the literature on predictions on the COVID-19 pandemic. Section 3 briefly describes the epidemiological model and data used. Section 4 analyses country predictions, while section 5 concludes and offers some policy recommendations.

2.0 LITERATURE REVIEW

The novel coronavirus disease (Covid-19), which was first reported in China in December 2019, has spread quickly and became a global pandemic in March 2020. The outbreak of the novel virus had devastating effects on economies across the world, prompting the conduct of plethora of empirical works. While some of these works focused on simulations and projections of the number of infections across countries and predicting when the disease would be controlled and normalcy return, others dwells on the impact of the disease on economic and social activities.

The SIR/SEIR (susceptible, exposed, infectious and recovered) model, an epidemiological model for simulations and projections of infectious diseases, has proved effective in predicting the prevalence of Covid-19 infections across countries (Anastassopoulou et al. 2020; Annas et al, 2020; Carcione et al, 2020; Cooper, Mondal and Antonopoulos, 2020; Efimor and Ushirobira, 2020; He, Peng and Sun, 2020; Lopez and Rodo, 2020; Walker et al, 2020; You et al. 2020) even though some studies (Martelloni and Martelloni, 2020; Samui, Mondal and Khajanchi, 2020) applied mathematical models in making such predictions. Few studies predicted the Covid-19 infections in African countries and are analysed hereunder.

Frost et al (2020) indicated that the surveillance and reporting infrastructure of infectious diseases was underdeveloped in many countries in Africa while Covid-19 testing has been limited. Similarly, these countries have a high risk of morbidity and mortality from Covid-19 owing to weak immune systems of individuals in the continent due to prevalence of malnutrition and diseases as well as the difficulty in

the implementation of curfews, lockdowns and other social distancing measures owing to socio-cultural, economic and political factors. Utilizing the SECIR model (S = Susceptible individuals, E = Exposed, C = Contagious, Asymptomatic, IN = Infected mild symptoms, IS = Infected with severe symptoms, R = Recovered), their baseline results showed that WAMZ countries could have more than 29 million infections around June/July 2020. However, these could be lower if transmission is reduced due to the implementation of lockdowns and social distancing measures.

Utilizing a covariate-based instrumental variable regression model, Achoki et al (2020) predicted that around 16.3 million in Africa may contract Covid-19 by June 30, 2020. The cases are expected to reach 8.5 million in Northern Africa, 2.9 million in Southern Africa, 2.8 million in Western Africa and 1.2 million in Central Africa. However, less urbanised countries with the least connection to the world are likely to register lower and slower transmission at the initial stage, but could experience devastating consequences owing to lower access to interventions that have lessened the impact of the virus elsewhere.

Zhao et al (2020) used the modified SEIR model to simulate and predict the spread of the novel coronavirus in six severely infected African countries – South Africa, Egypt, Algeria, Nigeria, Senegal and Kenya. The study showed that the virus can basically be controlled in late April if strong government measures, adequate medical supplies and good personal protective behaviours are in place. However, the control time would be delayed by about 10 days and number of infections would increase by 1.43 – 1.55 times the first scenario if government interventions and the supply of medical supplies are constrained. The infection rate could double with the hospitals being overstretched while recording a large number of death cases and can only be contained in late May if public self-protection consciousness is weak and there were poor medical conditions (such as lower virus testing efficiency).

Sinkala et al (2020) predicted that Africa have reached the peak of the covid-19 pandemic on 24 July 2020 and the continent would be at the last stage of the pandemic in November 2020. Utilizing the SIR model, the study indicated that at the end of the pandemic, about 2.2 million people would have been infected with the virus in Africa.

The World Health Organisation (WHO, 2020a) also estimated that about 29 – 44 million people in Africa could get infected with the novel coronavirus in the first year of the pandemic if containment measures, including contact tracing, isolation, improved personal hygiene practices and physical distancing fails. However, about 80 percent of the infections could be mild or asymptomatic (WHO 2020b) but only 15 percent may have severe infection requiring Covid-19 hospitalisations, even though this could severely strain the health capacities of countries in the continent.

3.0 METHODS AND DATA DESCRIPTION

This brief uses the widely adopted traditional SEIR epidemiological model⁴ for simulations and projections of infectious diseases. The model uses a stochastic dynamic modelling process, which allows us to quantify uncertainties in predicting the evolution of the disease. It shows the progression of disease in four stages, viz susceptible, exposed, infectious and recovered persons. In addition, three parameters are important in simulating and predicting disease outbreak; the rates at which susceptible persons become exposed (β), exposed persons become infectious (σ) and infectious persons recover from the virus (γ) (Thomas, 2020).

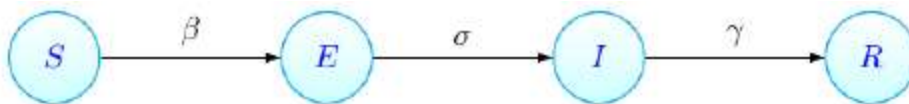
⁴ The basic SIR (susceptible-infected-recovered) model was developed by Ronald Ross and William Hamer in 1910

The SEIR model is based on a system of differential equations.⁵ The SEIR model considers that for a given disease, at any time during the epidemic/pandemic, all individuals of the population (N) are assigned to one of the following states (see Radyakin and Verme, 2020):

- S: number of susceptible persons, implying the number of people who can potentially become infected;
- E: number of exposed persons but not yet infectious. This corresponds to persons exposed to the virus during the incubation period of the disease;
- I: number of infectious individuals who can potentially transmit the virus to others;
- R: number of recovered people. These are persons who have been infected and have recovered from the disease.

The SEIR model assumes that natural births and natural deaths cancel each other out; population growth remains constant and international migration is ignored; or infection rates are not increased through international migration. Thus, the SEIR model can be represented as follow:

$S + E + I + R = N$. Expressed as a proportion of total population (N), these four components of the model are equivalent to $s + e + i + r = 1$. The schematic representation of the components of the model is given as:



In this model, susceptible (S) persons may contract the disease with a given rate (β) from infectious individual and thus move from the susceptible state to the exposed (E) when one become infected (but not yet infectious). This mean that β is equivalent to the number of contacts per day per infected individual. The exposed individuals then become infectious (I) at a rate (σ), with σ^{-1} corresponding to the average incubation period (day). Finally, infectious individuals enter the recovered (R) phase at a rate (γ) when they acquire a permanent immunity to the disease. In other words, γ^{-1} is the average period of infectiousness. The value of each of the four (4) variables can be estimated using the above method at any point in time based on the value of the three (3) parameters chosen.

We used online data sourced from the COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE), Johns Hopkins University (<https://coronavirus.jhu.edu/map.html>) for each Member State of the WAMZ. This data allows us to obtain information on the total confirmed infected cases, deaths, number of persons recovered from the disease and the active number of infected cases. Complementing this source, we obtained data collated by WHO on daily cumulative infected cases and deaths across countries in the WAMZ.

A useful first step in the prediction of the COVID-19 spread using the SEIR model is to obtain values of the susceptible population (S), exposed (E), infectious (I) and recovered (R) persons, and estimates of the parameters of interest (β, σ, γ). The susceptible population is obtained by subtracting total confirmed infected cases (comprising active infections, recovered persons and deaths) and exposed persons from total population. There is lack of data on the number of persons exposed to the virus. Due to the limited capacity for disease surveillance and laboratory tests, limited health professionals and financial resources to carry out wide COVID-19 testing, contact tracing and quarantining infected persons or those exposed to infected contacts, therefore, we argue that the number of confirmed

⁵ For brevity of presentation, the differential equations were not derived. However, those interested could refer to: <https://www.idmod.org/docs/biv/model-seir.html> and <https://ideas.repec.org/c/boc/bocode/s458764.html>

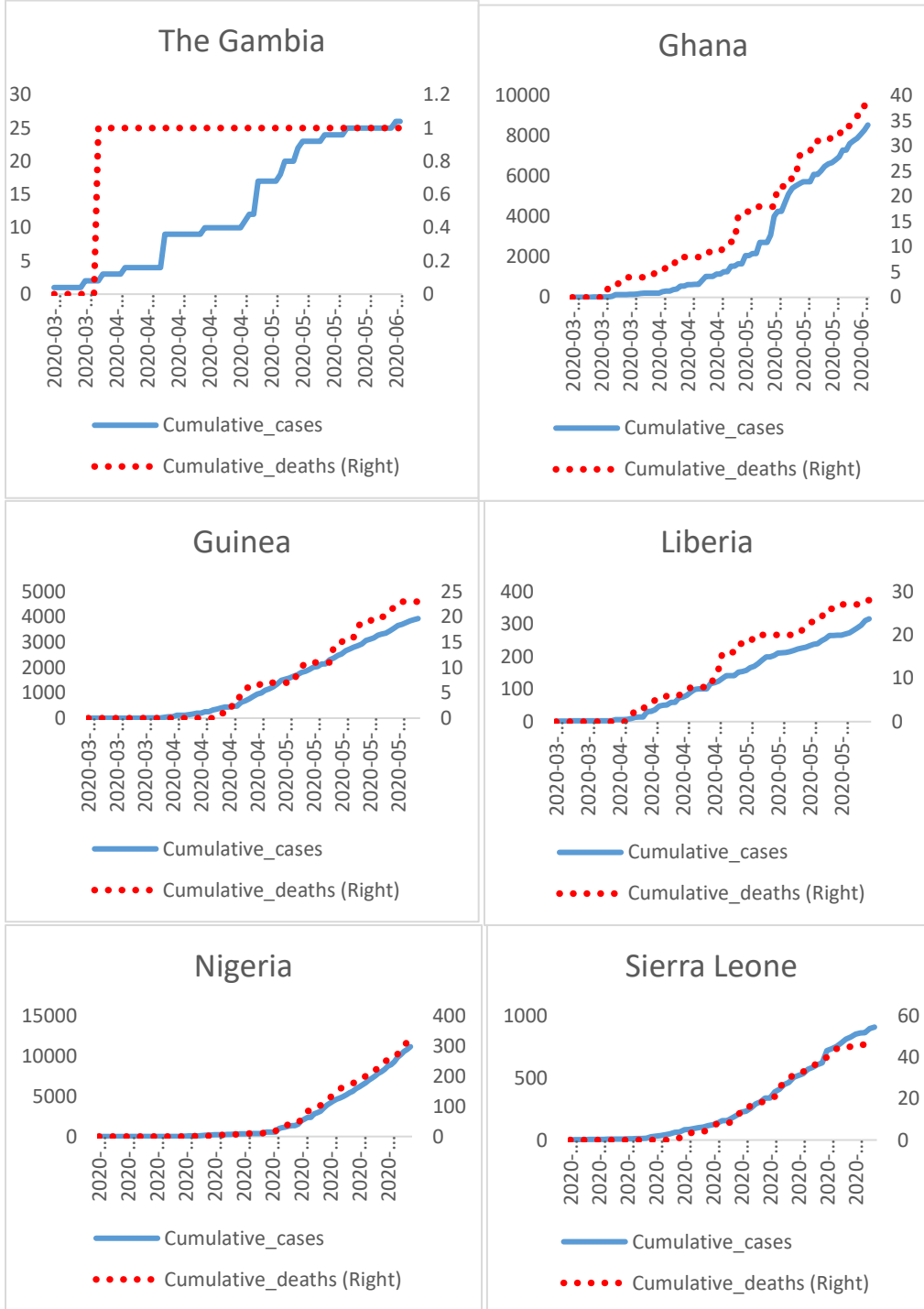
infected cases in the WAMZ is more likely to be grossly underestimated. To this end, we assume that in all WAMZ countries, 0.5 percent of the population are likely to have been infected and exposed to the virus. Thus, the number of persons exposed to the virus was obtained by subtracting the total confirmed infected cases from the estimated 0.5 percent of the population. Accordingly, 99.5 percent of the population is assumed to be susceptible to the virus.

4.0 ANALYSIS OF RESULTS AND INTERPRETATION

4.1 Preliminary analysis

We begin our preliminary analysis by taking a cursory look at the patterns of reported COVID-19 deaths across the WAMZ. As noted, the figures sourced from the WHO as at June 4, 2020 suggests that Nigeria, Ghana and Guinea have been the most affected in the Zone with 11166, 8548, and 3933 confirmed infected cases, respectively. Sierra Leone and Liberia, on the other hand, have confirmed 909 and 316 cases while The Gambia has 26 confirmed cases. Regarding the number of deaths, Nigera recorded 315 deaths followed by Sierra Leone (47) and Ghana (38) while Liberia, Guinea and Gambia recorded 28, 23, and 1, respectively. Drawing from these statistics, Liberia, Sierra Leone, The Gambia and Nigeria have recorded relatively high death ratios of 8.9 percent, 5.2 percent, 3.8 percent and 2.8 percent, respectively, while Ghana and Guinea have the lowest death ratios of 0.4 percent and 0.6 percent, respectively. The statistics on confirmed infected cases show that the WAMZ countries, like many other African countries, have relatively been successful in managing the spread of the disease, in spite of the poor health and economic infrastructure that characterize these countries. All countries have taken drastic measures in trying to control the spread of the disease including, among others, social distancing, complete lockdown (5 weeks in Nigeria and 3 weeks in Ghana), few days of lockdowns in the Gambia, Liberia and Sierra Leone, as well as the imposition of cross-border travel ban and restrictions on internal movement of persons to and from the capital cities (COVID-19 hot spots) in these countries.

Figure 1: Cumulative number of confirmed infected cases and deaths



Source: WHO

Figure 1 shows that the spread of the COVID-19 has been accelerating since the beginning of May, 2020. This might be due to the increasing number of daily tests which has significantly increased the detection of infected persons, allowing the recording of more symptomatic and asymptomatic cases, as well as the gradual opening of countries after lockdowns. Equally, the rising number of cases could also be explained by the low socio-economic levels of these countries that make strict enforcement of containment measures ineffective, such as social distancing, lockdown and restrictions on internal movement of persons in some areas.

4.2 SEIR model projections

As discussed, predictions are undertaken based on three scenarios of the interventions of government to prevent and contain the spread of the disease using the SEIR model. The predictions are analysed for all countries, starting with The Gambia, using these three different scenarios.

Considering the number of susceptible, exposed, infections and recovered persons, the spread of the virus is predicted based on three scenarios that reflect different epidemic interventions implemented by governments in the Zone. These scenarios are captured through the parameters; β , σ and γ . The parameter β , infection rate, denotes the number of contacts per day per infected person. In modelling the new COVID-19 virus outbreak in China, Peng et al. (2020) illustrated that the parameter β should be very close to or equal to 1, owing to the extremely strong infectious nature of the virus that causes every unprotected person to be infected when in direct contact with an infected person. Along these lines, we assume for all the three scenarios that, an infection rate of ($\beta = 1$), implying that one COVID-19 infected person is likely to infect one person in a day. Our assumption is motivated by the close social interactions among people in the WAMZ and associated problems in practicing strict social distancing, the prevalence of large informal economic activities that promote more close interactions among people and ultimately make it extremely difficult for governments in the Zone to enforce strict lockdowns to reduce new infections.

4.2.1 Scenario 1 assumptions

The predictions of the spread of the virus using the SEIR model are analysed for all countries, starting with The Gambia. Scenario 1 assumes that the effects of government interventions to prevent and contain the spread of the virus are reflected in the observed data. The mitigation measures adopted in these countries include social distancing, imposition of outright ban on international travels, restricting internal movement of persons, closure of schools, colleges and places of worship and varying degrees of health interventions. Due to the absence of comprehensive official data at the early stage of the epidemic on the number of persons who had recovered from the virus in the previous months/days from the Johns Hopkins at the time of modelling the spread of the virus, as well as the absence of country-specific information on the quarantine status and intervention measures, this brief could not explore separately the likely effects of the different government intervention measures on the virus transmission as they were implemented in the respective countries. In the absence of a vaccine or treatment and considering the prevailing mitigating measures, it is anticipated that the current trend in new infections and mortality associated with the virus will continue in the next few months.

The parameter γ , recovery rate of infected persons, is measured by the ratio of recovered persons (R) to the total number of confirmed infected cases, while σ , incubation rate is calculated as the inverse of

the duration of incubation period of the disease. To reflect the time-changing feature of γ as mitigating measures are being implemented, we considered the average value of γ , computed by considering the recovery rate as at May 22 and June 4, 2020. Under this scenario, we further assume an average duration of incubation of four days ($\sigma = 0.25$) in all the WAMZ countries, which implies that exposed persons become infectious over four days (see Radyakin and Verme, 2020). This assumption is consistent with the observed average duration of incubation of 4-6 days for Ghana, which is assumed to be applicable in all the WAMZ countries. Table 2 presents the estimated population of the respective countries as at June 4, 2020 and the assumptions underlying option 1 (parameter values) applied to predict the spread of the disease. Due to lack of official data at the early stages of the disease on the number of infected cases across States or Provinces in WAMZ countries, it was difficult to determine accurately the size of the population exposed to the virus. To this end, we assumed that 0.5 percent of the population in each country had been infected and exposed to the virus. As such, the number of persons exposed to the virus was computed by subtracting the total number of confirmed infected cases sourced from the COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE), Johns Hopkins University (<https://coronavirus.jhu.edu/map.html>) from the estimated 0.5 percent of the population. Accordingly, 99.5 percent of the population is assumed to be susceptible to the virus. Data on the number of persons who had recovered from the virus and active infected cases was obtained from the Johns Hopkins COVID-19 Dashboard.

Table 2: Summary of Scenario 1 Assumptions

Details	GAMBIA	GHANA	GUINEA	LIBERIA	NIGERIA	SIERRA LEONE
Estimated population	2,420,000	30,955,202	13,132,795	5,057,681	206,139,589	7,976,938
Susceptible (S)	2,407,900	30,800,426	13,067,131	5,032,393	205,108,891	7,937,053
Exposed (E)	12,074	146,228	61,731	24,972	1,019,532	38,976
Active infections(I)	5	5,378	1,578	119	7,522	371
Recovered (R)	20	3,132	2,332	169	3,329	491
Confirmed infected cases	26	8,548	3,933	316	11,166	909
Infection rate (β)	1	1	1	1	1	1
Average recovery rate (γ)	0.6446	0.3325	0.5532	0.5405	0.2873	0.4599
Average duration of incubation (σ)	0.25	0.25	0.25	0.25	0.25	0.25

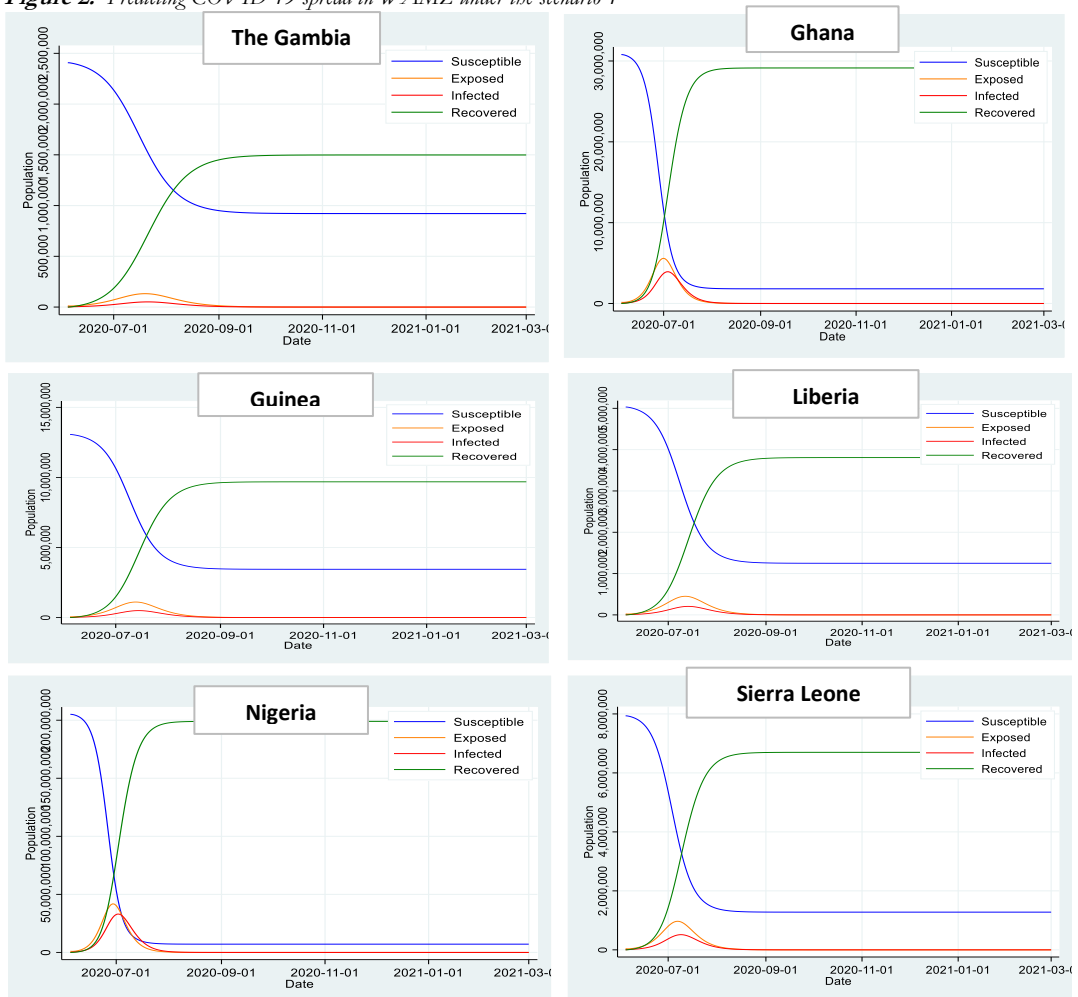
Source: WAMI Staff assumptions and CSSE COVID-19 Dashboard, Johns Hopkins University (June 4, 2020).

Figure 2 displays the plots of the corresponding predictions of the disease in the WAMZ using the traditional SEIR model, considering the underlying assumptions of the scenario 1 of government interventions. Taking these assumptions, predictions were derived for susceptible, exposed, active infected and number of persons that could recover from the disease for the next one year. Starting with The Gambia, looking at Figure 2 shows a predicted inflection point of total infected cases as July 20, 2020 associated with a peak of total infected cases of 50,982 persons. The infections curve gradually flattens thereafter and depending on whether current mitigating measures in the country are sustained or further enhanced, it is projected that The Gambia will contain the spread of new infections in the week of December 18, 2020.

Ghana is projected to reach its peak of confirmed cases of infections around July 3, 2020. It is projected that the country may record its maximum number of confirmed infections of 3,928,096 persons if appropriate mitigating measures are not strengthened. Considering the current prevention and control measures in place, Ghana is predicted to contain the spread of COVID-19 infections around October 14, 2020.

Guinea may experience a surge in confirmed reported cases in July, 2020 if appropriate mitigating measures are not pursued. This is projected to reach a point of inflection of 495,535 cases on July 14, 2020. New infections are expected to be contained around December 1, 2020 if the government continues to sustain current preventive and control measures.

Figure 2: Predicting COVID-19 spread in WAMZ under the scenario 1



The inflection date of confirmed infected cases for Liberia is predicted to occur around July 13, 2020, associated with projected 206,124 infected cases if current mitigating measures are not sustained. Liberia is predicted to achieve sustained reduction in new infections around November 17, 2020 if current measures are sustained.

Nigeria may experience a spike in the number of confirmed infected cases around July 2020, projected to reach a maximum of 33,085,840 infected persons. Depending on the mitigating measures pursued, its point of inflection is predicted to be attained around July 1, 2020. While the country is expected to witness a gradual flattening of the infections curve after the peak in July, the predictions suggest that the spread of the virus could be contained around October 19, 2020 if the government continues to implement current mitigating measures.

Sierra Leone may experience a sudden jump in the number of infected cases on July 8, 2020, predicted to reach an inflection point of infected cases of 514,949 should the government suddenly relax the implementation of current containment measures. It is predicted that with deliberate efforts by the government to strengthen current mitigating measures, Sierra Leone is likely to contain the spread of the epidemic around October, 30 2020. Table 3 shows the maximum number of projected infected cases, likely dates of peak of infected cases and containment of infections in the WAMZ countries.

Table 3: Summary of spread of COVID-19 Virus in 2020 (scenario 1)

Country	Estimated date of peak of infections	Estimated peak of infected persons	Estimated date of containing the COVID-19 virus
The Gambia	20-Jul	50,982	18-Dec
Ghana	03-Jul	3,928,096	14-Oct
Guinea	14-Jul	495,535	01-Dec
Liberia	13-Jul	206,124	17-Nov
Nigeria	01-Jul	33,085,840	19-Oct
Sierra Leone	08-Jul	514,949	30-Oct

Source: WAMI Staff Estimates.

Looking at the prediction results shows relatively higher predicted number of infected cases in the WAMZ compared to a previous study in selected African countries that employed the modified SEIR model (Zhao et al, 2020). The magnitude of these prediction results could be mainly attributed to two factors. First, the absence of official data at the early stages of the pandemic can significantly influence the magnitude of the estimated number of susceptible persons and those already exposed to the virus, as well as the calibration of the parameters (β , σ and γ). Second, the traditional SEIR simulation model adopted does not explicitly capture the effects of the various government intervention measures to mitigate the spread of the virus, such as lockdowns, contact tracing and isolation of infected and exposed persons, etc. Because of lack of comprehensive official data on the various measures of governments interventions in the WAMZ during the simulation period, we did not adopt an improved version of the SEIR model, which allows for the calibration of additional parameters to capture the responses of government such as quarantine status and intervention measures (see Peng et al, 2020).

However, considering the prediction of WHO (2020) that 80 percent of infections in African countries are mild or asymptomatic, it is anticipated that a large number of persons could be infected although not captured by the official number of reported infected cases. Given the high prevalence of mild or asymptomatic cases, low socio-economic levels in the WAMZ and the limited testing, contact tracing and isolation capacity, a large number of infected cases are likely to be excluded from the confirmed number of reported infected cases in the Zone.

4.2.2 Scenario 2 assumptions

Under this scenario, we assume that countries in the Zone may witness a 30 percent reduction in the average recovery rate of infected persons. This is expected to occur through increase in the number of reported infected cases owing to the expected adoption of strong mitigating measures such as improved testing, contact tracing and isolation of infected and exposed persons to contain the disease. While the number of persons recovering from the virus would undoubtedly increase as these intervention measures are implemented, it is obvious from the observed disease patterns that recoveries occur with a time lag. In the absence of treatment therapy to significantly increase recoveries, it is anticipated that with increased testing and contact tracing, the increase in the number of infected cases would exceed the gains realized from the number of persons recovering from the virus, resulting in a decrease in the recovery rate as these mitigating measures are strengthened. Under this scenario, the brief further assumes an infection rate parameter ($\beta = 1$) and an average incubation period of 4 days ($\sigma = 0.25$) as discussed above.

Table 4: Summary of scenario 2 assumptions

Details	GAMBIA	GHANA	GUINEA	LIBERIA	NIGERIA	SIERRA LEONE
Estimated population	2,420,000	30,955,202	13,132,795	5,057,681	206,139,589	7,976,938
Susceptible (S)	2,407,900	30,800,426	13,067,131	5,032,393	205,108,891	7,937,053
Exposed (E)	12,074	146,228	61,731	24,972	1,019,532	38,976
Active infections(I)	5	5,378	1,578	119	7,522	371
Recovered (R)	20	3,132	2,332	169	3,329	491
Confirmed infected cases	26	8,548	3,933	316	11,166	909
Infection rate (β)	1	1	1	1	1	1
Average recovery rate (γ)	0.4512	0.2328	0.3872	0.3784	0.2011	0.3219
Average duration of incubation (σ)	0.25	0.25	0.25	0.25	0.25	0.25

Source: WAMI Staff assumptions and CSSE COVID-19 Dashboard, Johns Hopkins University (June 4, 2020).

Building on these assumptions, the resulting predictions of the infection rates are reported in Table 5 and associated plots of the respective countries are displayed in figure 3. Under this scenario, the predictions suggest that Ghana and Nigeria could possibly reach the peak in the number of infected cases relatively earlier, that is, around June 2020, while The Gambia, Guinea, Liberia and Sierra Leone could witness same around July 2020 at varying dates. Specifically, it is projected that Ghana may reach an inflection point of infected cases of 6,579,185 persons around June 30, 2020 and likely to contain the spread of the virus around October 5, 2020. Similarly, Nigeria may experience its peak of infected cases estimated at 51,818,565 persons around June 29, 2020 and possibly control the transmission of

the virus around October 18, 2020. By comparison, the predictions reveal a peak of infected cases of 163,803 persons around July 8, 2020 in The Gambia, 1,253,029 persons around July 5, 2020 in Guinea, 505,301 persons around July 4, 2020 in Liberia and 1,069,973 around July 2, 2020 in Sierra Leone. The results show that the outbreak is predicted to be controlled around October 2020 in The Gambia (October 18), Guinea (October 18), Liberia (October 10) and Sierra Leone (October 4).

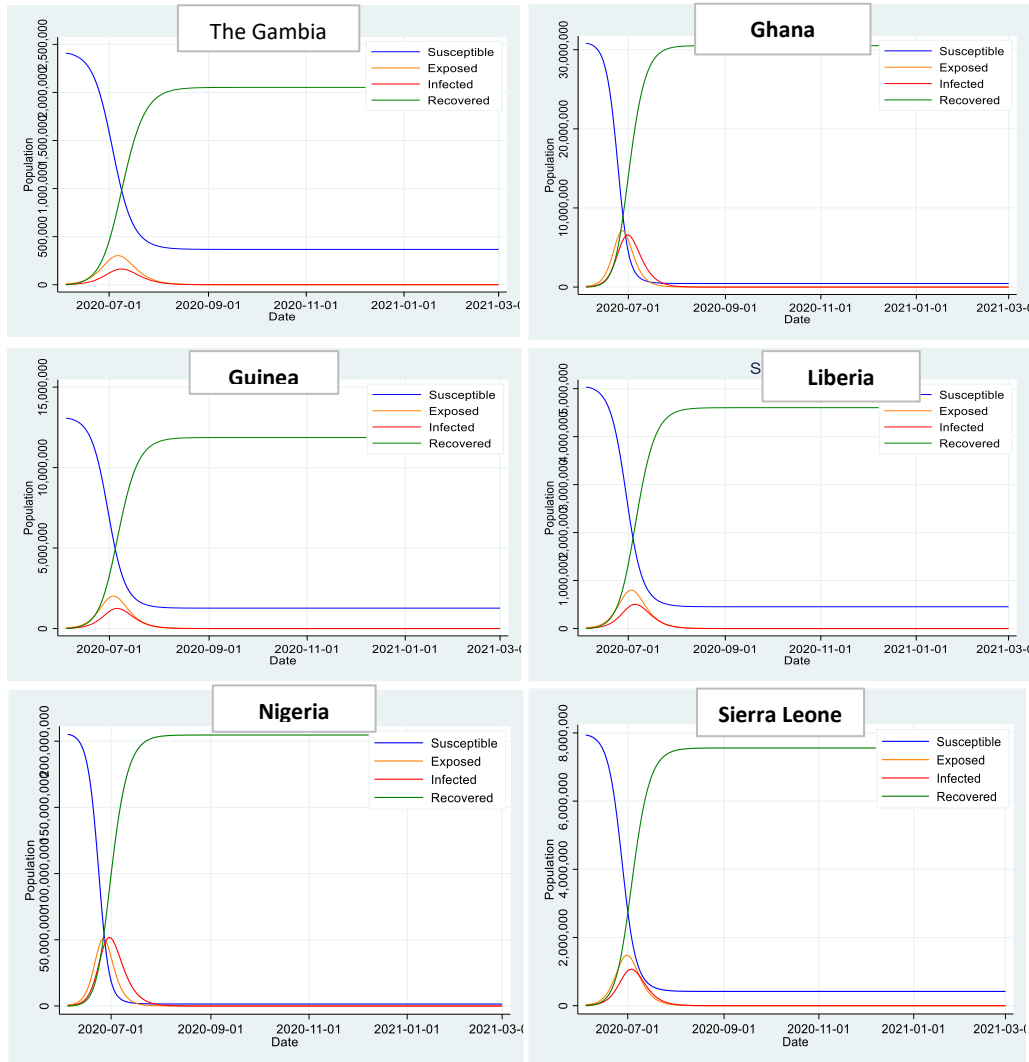
Interestingly, this scenario shows a relatively higher predicted number of infected persons at the peak than scenario one, with the latter assuming the case of continuation of the current mitigating measures pursued by countries in the WAMZ. Such predictions are expected given that the implementation of strong mitigating measures such as enhanced testing, contact tracing and guaranteeing of infected persons would increase reporting of infected persons and consequently break the community transmission chains in the respective countries, which ultimately would ensure that countries contain the spread of the virus at a relatively early stage of the pandemic compared to the other scenarios.

Table 5: Summary of spread of COVID-19 Virus in 2020 (scenario 2)

Country	Estimated date of peak of infections	Estimated peak of infected persons	Estimated date of containing the COVID-19 virus
The Gambia	08-Jul	163,803	18-Oct 2020
Ghana	30-Jun	6,579,185	05-Oct 2020
Guinea	05-Jul	1,253,029	18-Oct 2020
Liberia	04-Jul	505,301	10-Oct 2020
Nigeria	29-Jun	51,818,565	18-Oct 2020
Sierra Leone	02-Jul	1,069,973	04-Oct 2020

Source: WAMI Staff Estimates

Figure 3: Predicting COVID-19 spread in WAMZ under the scenario 1



4.2.3 Scenario 3 assumptions

To predict the spread of the disease under this scenario, we assume an increase in the average recovery rate of 25 percent in all the WAMZ countries. In the absence of a vaccine or cure and due to limited capacity to undertake testing, contact tracing and isolation of infected persons, one would imagine that such an ‘official’ increase in recovery rate could also stem from gross underreporting of the actual number of infected cases, especially where there are high number of asymptomatic infected cases. Such a phenomenon is likely to occur soon, as countries gradually open to resume normal economic activities, in the absence of strong mitigating measures to continually test and isolate infected and exposed persons from the rest of the population. Specifically, we consider a pessimistic scenario of weak mitigating measures following the lifting of restrictions on both domestic and international travels and enforcing

of social distancing, contact tracing and isolation of exposed persons to an extent that the number of infected persons may be grossly underestimated and the recovery rate could be ‘misleadingly’ high. These assumptions are summarized in Table 6, while maintaining the infection rate parameter at ($\beta = 1$) and an average incubation period of 4 days ($\sigma = 0.25$).

Table 6: Summary of Scenario 3 Assumptions

Details	GAMBIA	GHANA	GUINEA	LIBERIA	NIGERIA	SIERRA LEONE
Estimated population	2,420,000	30,955,202	13,132,795	5,057,681	206,139,589	7,976,938
Susceptible (S)	2,407,900	30,800,426	13,067,131	5,032,393	205,108,891	7,937,053
Exposed (E)	12,074	146,228	61,731	24,972	1,019,532	38,976
Active infections(I)	5	5,378	1,578	119	7,522	371
Recovered (R)	20	3,132	2,332	169	3,329	491
Confirmed infected cases	26	8,548	3,933	316	11,166	909
Infection rate (β)	1	1	1	1	1	1
Average recovery rate (γ)	0.8058	0.4156	0.6915	0.6756	0.3512	0.5749
Average duration of incubation (σ)	0.25	0.25	0.25	0.25	0.25	0.25

Source: WAMI Staff assumptions and CSSE COVID-19 Dashboard, Johns Hopkins University (June, 4, 2020)

Using these assumptions, we repeated projections of the spread of the disease in the respective countries. The predictions suggest that five countries; Ghana, Guinea, Liberia, Nigeria and Sierra Leone, are likely to experience a surge in the number of infected cases around July at varying levels of predicted points of inflection of infected cases (Table 7). It is projected that the Gambia can potentially experience a jump in confirmed infected cases of the virus around August 4, 2020 with total infected cases potentially reaching an inflection point around 13,884 persons. In the absence of strong mitigating measures, the outbreak is expected to be contained at a relatively longer time, that is, around April 4, 2021. Table 7 summarizes the likely pattern of infected cases, associated dates of peak of infections and control of the outbreak under the scenario 3.

Table 7: Summary of Spread of COVID-19 Virus under the Scenario 3

Country	Estimated date of peak of infections	Estimated peak of infected persons	Estimated date of containing the COVID-19 virus
The Gambia	04-Aug	13,884	04-April 2021
Ghana	06-Jul	2,540,942	29-Oct 2020
Guinea	25-Jul	197,347	04-Feb 2021
Liberia	23-Jul	85,640	12-Jan 2021
Nigeria	04-Jul	22,786,274	30-Oct 2020
Sierra Leone	15-Jul	264,047	03-Dec 2020

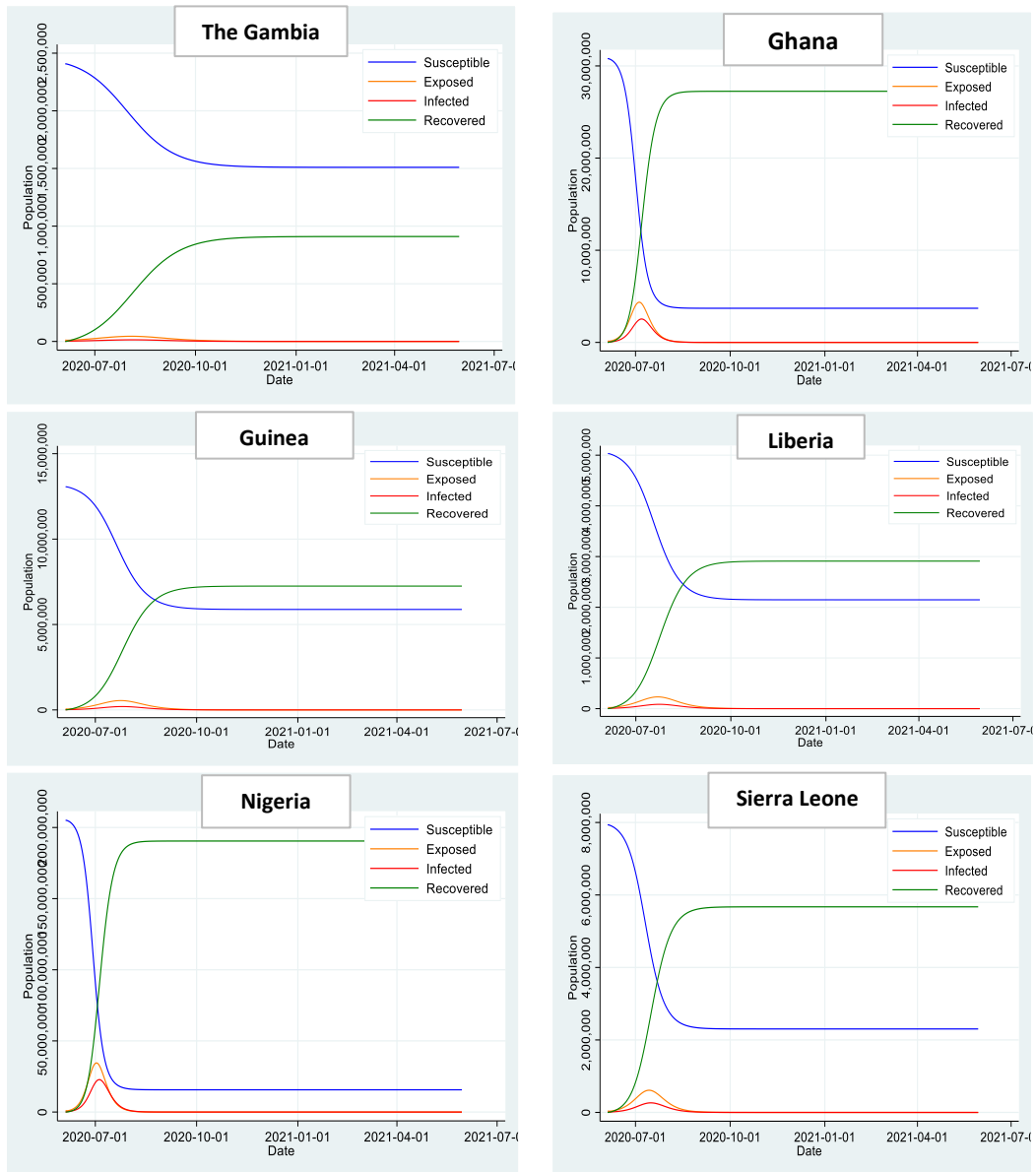
Source: WAMI Staff Estimates

In the case of Ghana, the country may potentially witness a surge in the number of confirmed infected cases around July 6, 2020 with a projected inflection point of infected cases expected as large as 2,540,942 persons. Regarding the disease containment, the projections reveal relatively early response in controlling the spread of the virus to around October 29, 2020. This outcome could be attributed to the gains already achieved through increased testing, contact tracing and isolation of persons exposed to the virus.

In a similar vein, it is projected that Nigeria could possibly reach a peak at relatively large number of 22,786,274 infected persons, with the country expected to contain the transmission of the virus around October 30, 2020. The Gambia, Guinea, Liberia and Sierra Leone are more likely to experience gradual reduction of infected cases, with infected cases expected to peak at 197,347 persons around July 25, 2020, 85,640 persons around July 23, 2020; and 264,047 persons around July 15, 2020; respectively. The results suggest that the three countries may possibly contain the spread of disease around February 4, 2021, January 12, 2021, and December 3, 2020, respectively. The predicted delayed response in The Gambia, Guinea, Liberia and Sierra Leone is not surprising given the relatively limited response capacity in terms viral testing and financial resources to trace contacts and isolate a large number of infected and exposed persons in these countries.⁶ Overall, the absence of strong mitigating measures implies that countries would not be able to contain community transmission at early stages of the disease or they are likely to experience prolonged transmission of infections in the population.

⁶ Alternative predictions were conducted by assuming that 1 percent of the population in all the WAMZ countries are infected and exposed to the virus, with all three parameter values calibrated as described under the respective scenarios. Compared to the assumption that 0.5 percent of the population have been exposed to the virus and infected, the predictions show that under all three assumptions, countries may reach the peak of infections and contain the transmission of the virus one week earlier. For brevity of presentation, these predictions were not reported in this brief.

Figure 4: Predicting COVID-19 spread in WAMZ under the scenario 3



5.0 CONCLUSION AND POLICY RECOMMENDATIONS

In this brief, we adopted the traditional SEIR model to explore the pattern of the COVID-19 spread in WAMZ countries (The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone) using three intervention scenarios that reflect the different responses of governments in the Zone. Comparing the prediction results of these scenarios, the brief shows that scenario two, which reflects increased number of reported infected cases owing to enhanced capacity in testing, contact tracing, and isolating infected and exposed persons, would lead to early break in community transmission of the virus and the early containment of the spread of the virus in all six countries around October 2020.

As regards scenario one, which assumes that the current mitigating measures will be continuously pursued in the respective countries, outperformed scenario three that assumes the case of weak mitigating measures. The predictions generated under scenario one reveal that Ghana, Nigeria, and Sierra Leone are more likely to contain the outbreak around October 2020, while Liberia in November 2020 and The Gambia and Guinea around December 2020. By comparison, results of scenario three show that only Ghana and Nigeria are likely to contain the transmission of the virus relatively early around October 2020, owing to gains already realized through testing, contact tracing and isolation of infected and exposed persons. It is projected that The Gambia, Guinea, Liberia and Sierra Leone are likely to experience prolonged flattening of the infection rate curves and containment of the spread of infections to around April 4, 2021; February 4, 2021; January 12, 2021; and December 3, 2020, respectively.

This finding suggests that as countries gradually ease restrictions to mitigate the economic burden of existing containment measures, governments should simultaneously allocate adequate resources to the health sector to ensure that health systems are not overwhelmed by increases in the number of infected cases. It further underscores the need for governments in the WAMZ to ensure efficient and effective use of resources allocated to the novel COVID-19 pandemic under precarious fiscal conditions. Undoubtedly, fiscal pressures would emanate from continuous allocation of resources to support strategic interventions to sustain and strengthen mitigating measures in order to contain the transmission of the virus and prevent further deterioration in health conditions that could potentially undermine efforts of the WAMZ countries to resume normal economic activities.

As countries across the globe gradually ease containment measures in preparation for resumption of normal economic activities, it is anticipated that the external budgetary support from donor partners to governments in the WAMZ is likely to be drastically reduced or completely eliminated in the near future. Amidst the declining global commodity prices, governments in the WAMZ would have to rely heavily on internally generated revenue to continue to support health interventions that seek to mitigate the transmission of the virus.

Given the prevailing state of depressed economic activities in the WAMZ, owing to the non-trivial economic costs of the containment measures already implemented, it is unlikely that some governments would generate much needed domestic revenue without scaling up interventions in the first place to revamp economic activities. Fiscal stimulus packages are needed to support growth, especially in sectors adversely affected by the slump in the global commodity prices and containment measures pursued at the national level. It is inevitable that governments in the WAMZ countries would have to stimulate growth through intervention in key sectors to strengthen capacity, support vulnerable businesses such

as small and medium enterprises (SMEs) and strategic government enterprises to facilitate economic recovery and prevent significant job losses, which would have a knock-on effect on consumption of goods and services.

The predictions further suggest that the WAMZ countries are not likely to contain the transmission of the new COVID-19 virus around the same time. This suggests that infections are likely to be transmitted across borders, especially as countries anticipate to re-open borders to facilitate cross-border transactions and support economic activities. It underscores the need for governments in the WAMZ to develop a regional strategy to ensure that the gains achieved in containing the virus are not eroded as restrictions on cross-border activities are lifted, including enforcement of health checks at points of entry and exit. Lastly, the Authorities in the WAMZ countries are encouraged to sustain budgetary spending on healthcare to build strong capacity to forestall against future pandemic, continue to support public sensitization campaigns on social distancing, hand washing, wearing of face masks and timely reporting of suspected cases of infections to health authorities.

As a caveat, the predictions illustrate that the evolving nature of infected cases and deaths would depend on the response of governments to mitigate the transmission of the virus. It is worth noting that these predictions were not conducted to accurately predict the likely number of infected cases and deaths in the respective countries. The predictions are likely to have been affected by the absence of official data at the early stages of the pandemic, which can potentially undermine the accuracy our estimates of persons susceptible and exposed to the virus, as well as the parameters of the model. Equally, due to lack of comprehensive official information on the various interventions of governments, we could not compute additional parameters to simulate using the improved version of the SEIR model introduced by Peng et al. (2020). To this end, this brief was primarily conducted to determine whether Member States were likely to experience a surge in infections in the coming months, as travelling restrictions were eased to mitigate the damaging economic effects of the containment measures. In doing so, it emphasizes the need for continuation of appropriate mitigating measures and ensure fiscal prudence in the face of the slump in global commodity prices to enable governments cope with the fiscal challenges associated with the implementation of various containment measures. Future research work could consider the possibility of applying an improved version of the SEIR model to explore the dynamics of the pandemic in the WAMZ.

REFERENCES

- Achoki, T., Alam, U., Were, L., Gebremedhin, T., Senkubuge, F., Lesego, A., . . . Kinfu, Y. (2020). COVID-19 pandemic in the African continent: Forecasts of cumulative cases, new infections,. doi: <https://doi.org/10.1101/2020.04.09.20059154>.
- Anastassopoulou, C., Russo, L., Tsakris, A., & Siettos, C. (2020). Data-based analysis, modelling and forecasting of the COVID-19 outbreak. *PLoS One*. 2020; 15(3): e0230405. doi: 10.1371/journal.pone.0230405.
- Annas, S., Pratama, M. I., Rifandi, M., Sanusi, W., & Side, S. (2020). Stability analysis and numerical simulation of SEIR model for pandemic COVID-19 spread in Indonesia. *Chaos, Solitons and Fractals* 139 (2020) 110072, 1-7.
- Carcione, J. M., Santos, J. E., Bagaini, C., & Ba, J. (2020). A Simulation of a COVID-19 Epidemic Based on a Deterministic SEIR Model. *Frontiers in Public Health* 8 (Article 230), 1-13.
- Cooper, I., Mondal, A., & Antonopoulos, C. G. (2020). A SIR model assumption for the spread of COVID-19 in different communities. *Chaos, Solitons and Fractals* 139 (2020) 110057, 1-14.
- Efimov, D., & Ushirobira, R. (2020). On an interval prediction of COVID-19 development based on a SEIR epidemic model. [Research Report] Inria. 2020. hal-02517866v6 available at <https://hal.inria.fr/hal-02517866v6>.
- Frost, I., Osen, G., Craig, J., Hauck, S., Kalanxhi, E., Gatalo, O., . . . Lin, G. (2020). COBID-19 in West Africa: National Projections of total and severe infections under different lockdown scenarios. *Center for Disease Dynamics, Economics and policy*, available at https://cddep.org/wp-content/uploads/2020/05/West-Africa_06-May.pdf.
- He, S., Peng, Y., & Sun, K. (2020). SEIR modeling of the COVID-19 and its dynamics. *Nonlinear Dyn* (2020) available at <https://doi.org/10.1007/s11071-020-05743-y>.
- Lopez, L., & Rodo, X. (2020). A MODIFIED SEIR MODEL TO PREDICT THE COVID-19 OUTBREAK IN SPAIN: SIMULATING CONTROL SCENARIOS AND MULTI-SCALE EPIDEMICS. doi: <https://doi.org/10.1101/2020.03.27.20045005>.
- Martelloni, G., & Martelloni, G. (2020). Modelling the downhill of the Sars-Cov-2 in Italy and a universal forecast of the epidemic in the world. *Chaos, Solitons and Fractals* 139 (2020) 110064, 1-8.
- Nkengasong, J. N., & Mankoula, W. (2020). Looming threat of COVID-19 Infection in Africa: act collectively, and fast. *Africa Centres for Disease Control and Prevention*.
- Peng, L., Yang, W., Zhang, D., Zhuge, C., & Hang, L. (2020). Epidemic analysis of COVID-19 in China by dynamical modelling. doi: <https://doi.org/10.1101/2020.02.16.20023465>.
- Radyakin, S., & Verme, P. (2020). COVID-19 Modelling: The SEIR Model. *World Bank*.
- Samui, P., Mondal, J., & Khajanchi, S. (2020). A mathematical model for COVID-19 transmission dynamics with a case study of India. *Chaos, Solitons and Fractals* 140 (2020) 110173, 1-11.

- Sinkala, M., Nkhoma, P., Zulu, M., Kafita, D., Tembo, R., & Daka, V. (2020). The COVID-19 Pandemic in Africa: Predictions using the SIR Model. *doi: <https://doi.org/10.1101/2020.06.01.20118893>*.
- Thomas, L. (2020). Reproduction number of COVID-19 and how it relates to public health measures. *medRxiv*.
- Walker, P., Whittake, C. W., Baguelin, M., Ainslie, K. E., Bhatia, S., Bhatt, ..., & Ghani, A. C. (2020). The Global Impact of COVID-19 and Strategies for Mitigation and Suppression. *Imperial College COVID-19 Response Team, London. available at <https://www.imperial.ac.uk/media/imperial-college/medicine/spb/ide/gida-fellowships/Imperial-College-COVID19-Global-Impact-26-03-2020v2.pdf>*.
- World Health Organisation. (2020a). New WHO estimates: Up to 190 000 people could die of COVID-19 in Africa if not Controlled. *<https://www.afro.who.int/news/new-who-estimates-190-000-people-could-die-covid-19-africa-if-not-controlled>*.
- World Health Organisation. (2020b). Coronavirus disease 2019 (COVID-19) Situation Report – 46. *available at https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200306-sitrep-46-covid-19.pdf?sfvrsn=96b04adf_4*.
- You, C., Deng, Y., Hu, W., Sun, J., Lin, Q., Zhou, F., . . . Zhou, X. (2020). Estimation of the time-varying reproduction number of COVID-19 outbreak in China. *Int J Hyg Environ Health*. 2020; 228: 113555.
- Zhao, Z., Li, X., Liu, F., Zhu, G., Ma, C., & Wang, L. (2020). Predicting of the COVID-19 spread in African countries and implications for prevention and control: A case study in South Africa, Egypt, Algeria, Nigeria, Senegal and Kenya. *Science of the Total Environment* , 729, 1-10.