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Epidemiological Concept of Coronavirus (COVID-19) And Measures for Eradication: The Perspective of a Health Economist

Augustine Adu Frimpong, Ph.D.
Southern University and A & M College, Department of Public Administration/Policy, Baton Rouge, Louisiana, USA

Abstract
The study discusses the Coronavirus (COVID-19) in context. By its nature, the Coronavirus (or COVID-19) is a respiratory disease caused by a novel (new) coronavirus, which was first detected in China but subsequently detected in almost 70 geographical locations internationally. The pandemic nature of COVID-19 has caused many countries, including the United States of America, to embark on stringent health measures. Consequently, all affected countries have utilized such preventive measures as travel restrictions, official and self quarantines, event postponements as well as cancellations, curfews and facility closures. In order to assist policymakers to combat this pandemic, my study has utilized the concept of epidemiology to assist all stakeholders to have a better understanding of the epidemiological concept of coronavirus (or COVID-19) and its possible eradication measures. Furthermore, the study strongly recommends that, for successful eradication to be effected, all COVID-19 preventive care must be free (or demand at a zero price), while COVID-19 treatment (or medication) must also be either free or at a subsidized rate and COVID-19 screening must be motivational for individuals to buy into the idea through public campaigns and, also, there should be adequate information flow about the COVID-19 and its prevalence rate. Above all, governmental or public interventions must outweigh private intervention measures in order to make COVID-19 eradication possible.
Keywords: COVID-19, Coronavirus, Epidemiology, Prevalence, Hazard, Eradication, Interventions, Subsidy, Health, Healthcare, Practitioners, Respiratory, Susceptible, Infected.
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INTRODUCTION

According to the available health and medical literature, Coronavirus (COVID-19) is a respiratory disease caused by a novel (new) coronavirus that was first detected in China but has now been detected in almost 70 geographic locations internationally, including the United States of America (Centers for Disease Control and Prevention, 2020). According to Centers for Disease Control and Prevention (2020), the virus has been named "SARS-CoV-2" and the disease it causes has been named as "coronavirus disease 2019" (abbreviated as "COVID-19"). On black Thursday (January 30, 2020), the International Health Regulations Emergency Committee of the World Health Organization (WHO) declared the COVID-19 outbreak as a "public health emergency of international concern external icon" (PHEIC) (CDC, 2020). The CDC (2020) further argued that on January 31, 2020, Health and Human Services Secretary Alex M. Azar II declared a public health emergency (PHE) for the United States in order to aid the nation's healthcare community in responding to COVID-19.

Historically, the argument of medical experts as well as academia and health literature is that coronaviruses are part of a large family of viruses, which are common in humans and many different species of animals and other non-humans, including camels, cattle, cats, bats and many others (CDC, 2020). Meanwhile, medical e and health practitioners have proven, in the available literature, that non-human (or animal) coronaviruses can infect humans and subsequently spread among people such as with the conventional viruses with MERS-CoV, SARS-CoV, and, now, with this new virus (named as SARS-CoV-2 or COVID-19) (CDC, 2020).

According to CDC (2020), the SARS-CoV-2 virus is a betacoronavirus, which can spread and infect people like MERS-CoV and SARS-CoV. Surprisingly, all such types of viruses as SARS-CoV-2 or COVID-19, MERS-CoV and SARS-CoV have their origins in bats (CDC, 2020). Therefore, it has been alleged in numerous reports that many of the patients at the epicenter of the outbreak in Wuhan, Hubei Province, China had some link to a large seafood and live animal markets, thereby suggesting that animal-to-person spreading of the virus is possible (CDC, 2020). It has also been observed by several citizens and physicians that a growing number of patients also did not have exposure to animal markets, indicating person-to-person spread of the virus (CDC, 2020).

Person-to-person spread of the virus was subsequently reported outside Hubei and in countries outside China, including in the United States of America, Italy, and many other countries. Some international destinations now have apparent communities spreading the virus that causes COVID-19, including in some parts of the United States (CDC, 2020). According to the epidemiological concept of the spread of diseases, being it viral or bacterial infectious diseases, a community spreading of the virus simply means that some people have been infected and it is not known how or where they became exposed to the disease. At this point, the susceptible individuals are exposed to the diseases, and they later get actively infected.

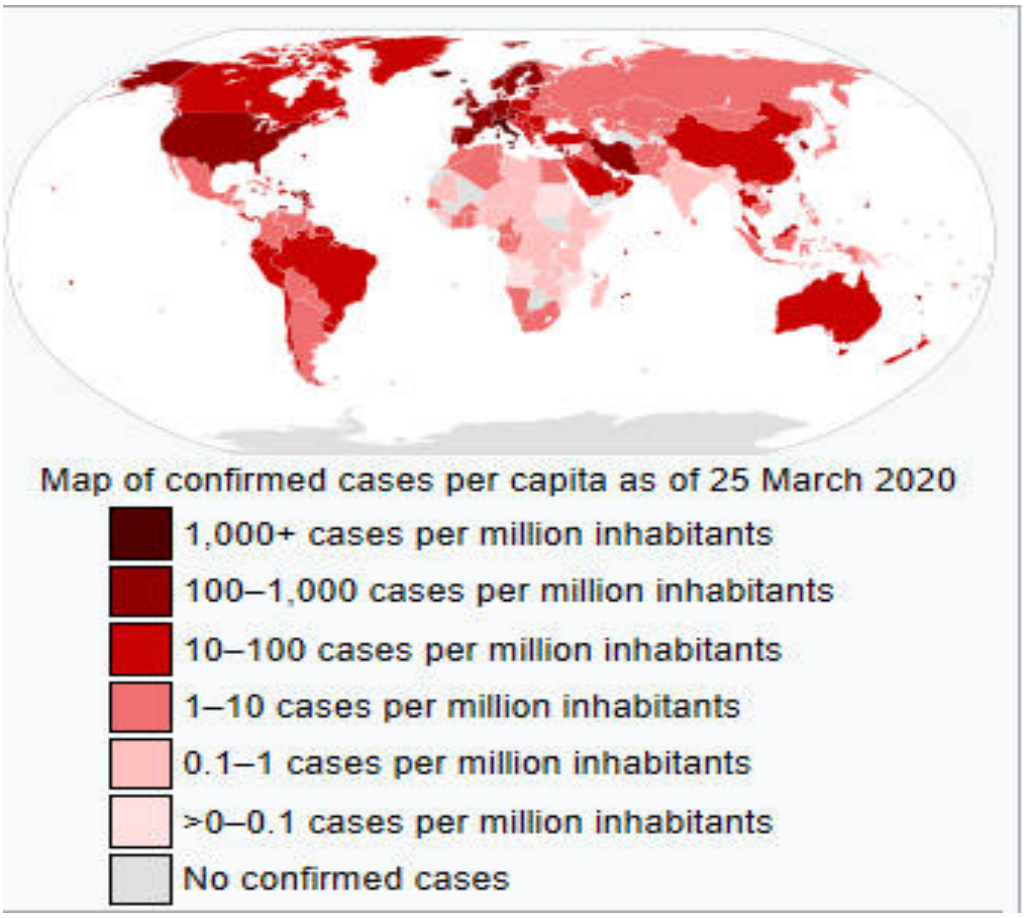

Figure 1: COVID-19 Pandemic Statistics

According to Huang et al.(2020), the 2019–20 coronavirus pandemic is an ongoing situation of coronavirus disease of 2019 (COVID-19), which is caused by severe acute respiratory syndrome, thus coronavirus 2 (SARS-CoV-2). The outbreak was first identified in Wuhan and Hubei in China in December of 2019, and it was recognized as a pandemic by the World Health Organization (WHO) on 11th March 2020 (Huang et al., 2020; Worldometer, 2020; World Health Organization, 2020). As of 25th March 2019 it was reported that more than 422,000 cases of COVID-19 had have been reported in more than 190 countries and territories, resulting in more than 18,900 deaths and more than 109,000 recovered patients (Huang et al., 2020; Worldometer, 2020; World Health Organization, 2020).

In the literature, the World Health Organization (2020) and Centers for Disease Control and Prevention (2020) concurrently have the argument that the virus is typically spreading during close contact and through respiratory droplets produced when people cough or sneeze. Whenever an infected person coughs or sneezes, it increases the prevalence and hazardous rate. Therefore, the respiratory droplets may be produced during breathing but it is not considered airborne (World Health Organization, 2020). Meanwhile, theses two agencies further argued that the COVID-19 may also spread when one touches a contaminated surface and then touches their face (World Health Organization, 2020; Centers for Disease Control and Prevention, 2020). It is most contagious when

people are symptomatic, although spread may be possible before symptoms appear (Centers for Disease Control and Prevention, 2020). It has also been observed in the literature that the time between exposure and symptom onset is typically around five days, but may range from two to fourteen days (Centers for Disease Control and Prevention, 2020; Rothan and Byrareddy, 2020).

The fourteen- day period is also known as the incubation period for COVID-19. The Centers for Disease Control and Prevention (2020) further argued that the obvious or most common symptoms for identifying a COVID-19 patient or infection include fever, cough, and shortness of breath. They have further indicated that the complications may include pneumonia and acute respiratory distress syndrome (Centers for Disease Control and Prevention, 2020). Currently, it is obvious that there is no known vaccine or specific antiviral treatment. As a result, it has been proposed by the numerous healthcare providers that the primary treatment is symptomatic and supportive therapy (Centers for Disease Control and Prevention, 2020). Also, recommended preventive measures include hand washing, covering the mouth when coughing, maintaining distance from other people, and monitoring and self-isolation for people, who suspect that they are infected (World Health Organization, 2020; Centers for Disease Control and Prevention, 2020).

The pandemic nature of COVID-19 has caused many countries to embark on stringent measures. All affected countries have utilized efforts to prevent the spreading of the virus to include travel restrictions, quarantines, curfews, event postponements and cancellations, self-isolation, and facility closures. These have included the quarantine of Hubei, nationwide quarantines in Italy, quarantine in USA, quarantine in Ghana, elsewhere in Europe, Africa and in India, curfew measures elsewhere in China, Ghana and South Korea (South China's Morning Post, 2020; Marsh, 2020; Nikel, 2020); various border closures or incoming passenger restrictions (The Straits Times, 2020; Nevada Public Radio, 2020); screening at airports and train stations (South China Morning Post, 2020; Marsh, 2020; Nikel, 2020;The Straits Times, 2020; Nevada Public Radio, 2020; Deerwester and Gilbertson,2020; The New York Times, 2020); and travel advisories regarding regions with community transmission (Deerwester and Gilbertson, 2020; The NewYork Times, 2020; The Government of the United Kingdom, 2020; UNESCO, 2020); Schools and universities have closed either on a nationwide or local basis in more than 124 countries, affecting more than 1.2 billion students across the globe (The New York Times, 2020).

The pandemic has led to global socio-economic disruption (The NewYork Times, 2020), the postponement or cancellation of sporting, religious, and cultural events (The NewYork Times, 2020; Scipioni, 2020), and widespread fears of supply shortages which have spurred panic buying (Scipioni, 2020;Council on Foreign Relations, 2020; Misinformation and conspiracy theories about the virus have spread online (Perper, 2020; Clamp, 2020), and there have been incidents of xenophobia and racism against Chinese and other East or Southeast Asian people (Tavernise, Oppel, and Richard, 2020). This current study is to assist public policymakers, politicians and academia as well as health care practitioners to better understand the epidemiological concept of corona virus (or COVID-19) and its eradication measures.

COVID-19 United States of America in the Context

Currently, the number of infected people is increasing everyday in the United States of America. Meanwhile, all the COVID-19 cases recorded in USA are imported cases of COVID-19 in travelers. Readers should note that the person-to-person spread of COVID-19 was first reported among close contacts of returned travelers from Wuhan in China (Centers of Disease Control and Prevention, 2020). During the week of February 23, 2020-- the CDC reported community spread of the virus that causes COVID-19 in California (in two places), to include Oregon and Washington States. The community spread in Washington resulted in the first death in the United States from COVID-19, as well as the first reported case of COVID-19 in a health care worker, and the first potential outbreak in a long-term care facility (Centers of Disease Control and Prevention, 2020).

In fact, the foregoing reported community spread of COVID-19 in parts of the United States raises the level of concern about the immediate threat for COVID-19 for those communities and other susceptible states. According to the Centers of Disease Control and Prevention (2020) the potential public health threat posed by COVID-19 is very high, to the United States and globally. In the absence of vaccination and remedial actions to combat this current pandemic COVID-19 deadly disease—the epidemiological concept of COVID-19 in United States of America has therefore increased from 80 confirmed cases of COVID-19 and 9 deaths as at January 12, 2020 to 60, 054 confirmed cases of COVID-19, 380 recovery, and 804 deaths as of March 25, 2020 (Centers of Disease Control and Prevention, 2020).

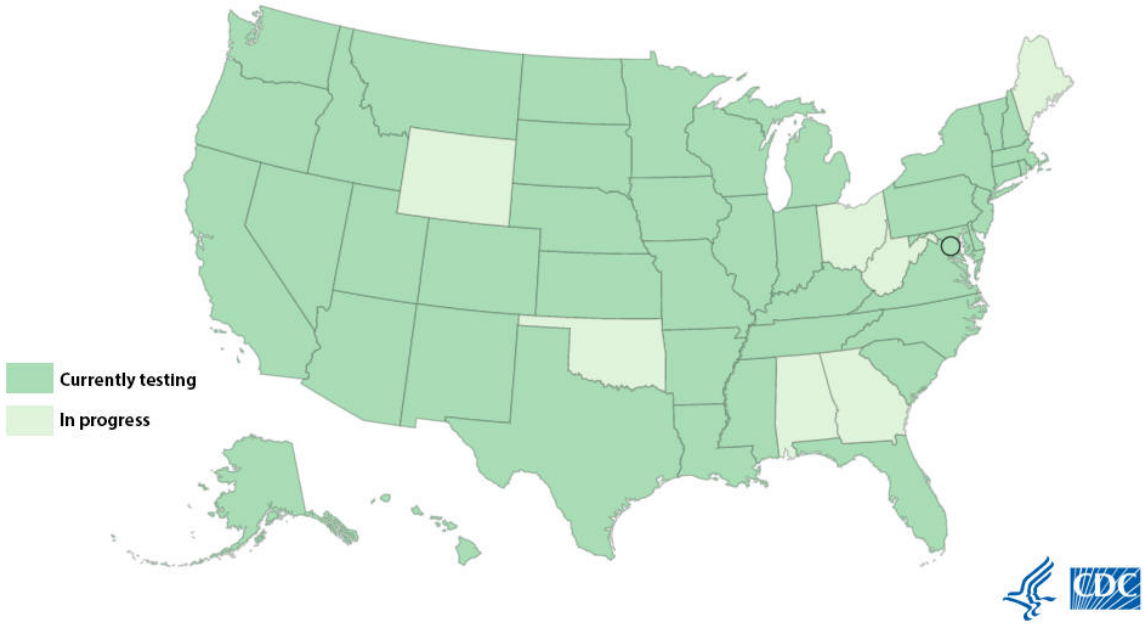

Figure 2: Currently Testing States and States in Progress (CDC, 2020)

Figure 2 reveals the states that have successfully verified and are currently using COVID-19 diagnostic tests. These states are currently testing for COVID-19 with the enabling help and support from the Association of Public Health Laboratories (APHL).

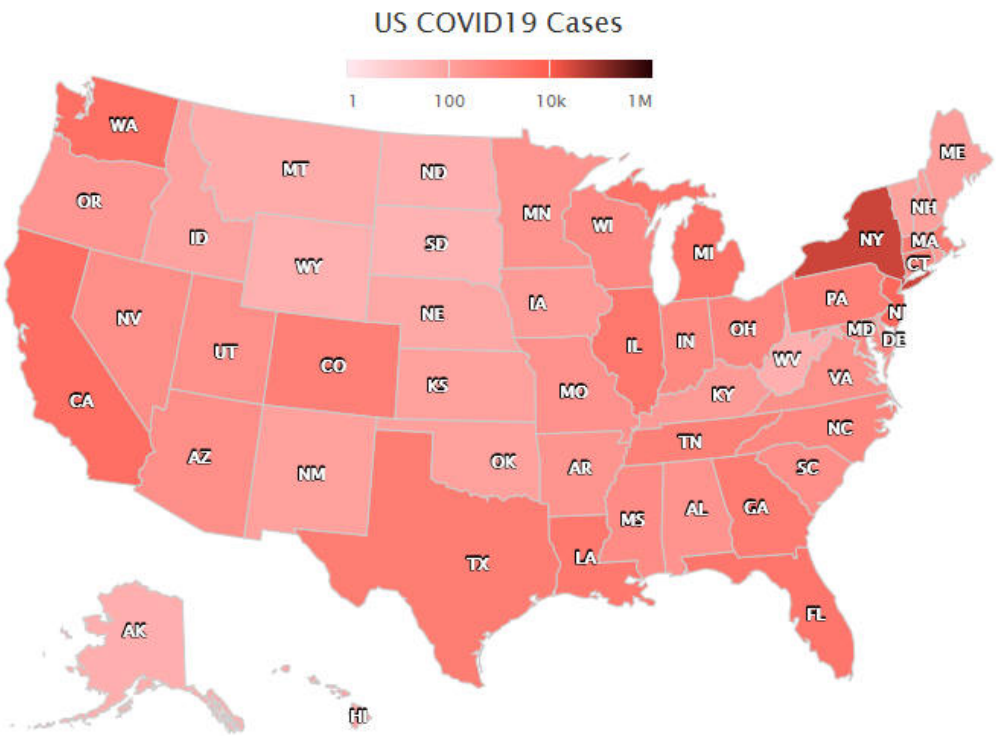

Figure 3: US COVID- 19 Cases as at March 25, 2020 23: 25:05 UTC+7 (Virusncov.com)

Figure 3 discusses the US COVID-19 cases as at March 25, 2020. According to the Virusncov.com (2020) the total cases of COVID-19 per 1 million populations is 181.6. This implies that given the entire American population of 330.43million as at March 25, 2020—on average, every 1 million people will have 181.6 people to be infected with the COVID-19, which -- in effect-- increases the hazardous and prevalence rate of the spread of COVID-19 disease in the country. This alarming rate motivated the researcher to conduct this particular study to better inform public policymakers on the epidemiological concept of COVID-19 in USA.

2. MODELING: EPIDEMIOLOGICAL CONCEPT OF CORONAVIRUS (COVID-19)

According to health and epidemiology literature, the term epidemiology is about the spread of diseases and how different policies can be used to prevent such diseases (Folland, Goodman, & Stano, 2004; Phillison, 2000; Adu-Frimpong, 2016). There are several principles, terminologies or concepts, which have utilized to explain the epidemiological concepts of COVID-19 to include the hazard rate, incidence rate, and prevalence rate. It is very important to know how disease spread. The author (Adu-Frimpong, 2016), hazardous rate refers to the probability of an individual getting the disease (COVID-19) or the rate of new cases (of COVID-19) among the uninfected population in a given period of time (Folland, Goodman, & Stano, 2004; Phillison, 2000; Adu-Frimpong, 2016). Also, incidence rate has been defined in the literature to refer to as the number of new cases of COVID-19 per defined population (USA citizens). The concept of prevalence rate is also defined in the literature to refer to as the fraction of those who has the disease of COVID-19 or the fraction of population that is currently infected by the COVID-19 disease (Folland, Goodman, & Stano, 2004; Phillison, 2000; Adu-Frimpong, 2016). It is to mention that there is a positive relationship between incidence and prevalence rates. Meanwhile, by assumption it is important to note that increase in prevalence rates falls as people develop immunity or adaptive behaviors (Folland, Goodman, & Stano, 2004; Phillison, 2000; Adu-Frimpong, 2016).

2.1 Predictions of the Spread of COVID-19 Disease in United States of America

At this juncture, the researcher discusses the things that scholars chave based on to predict the spreading and the extent of eradicating the diseases among a given population over a period of time to include both the private and the public intervention (see Figure 4 for details). For the case of private intervention, it is assumed to include the following: (a) the behavior of rational epidemics, (b) implications for private disease eradication, (c) the rational disease dynamic of epidemics, and (d) the positive effects of prevalence on assortative matching (Folland, Goodman, & Stano, 2004; Phillison, 2000; Adu-Frimpong, 2016). Meanwhile, the rational

epidemics and public health intervention includes the public price subsidies, mandatory vaccination and the public intervention into allocation of information are also equally critical to the prevention of the outbreak.

The Behavior of Rational Epidemic—it is part of the private intervention. It is micro-level strategy or methods to delay the outbreak or decompress the spread of the disease overtime. The following assumptions are used to model the behavior of the citizens or individuals. To better inform policymakers, the model assumes four classes of peoples according to health at time t (or year 2020) and they are as follow: S_t= Susceptible (those without the COVID-19 disease but likely to get); I_t= COVID-19 Infected people or group or prevalent rate; R_t= Immune peoples through recovery (immune after recovery from COVID-19) ; M_t= Mortality resulting from COVID-19 (those outside the system). The researcher further assumes the condition of the normalization of the American population to unity (or one). Again, the researcher assumes the future paths of the groups to be: (a) Prevalence: I_t= { I_s: s ≥t}; and Price: P_t= { P_s: s ≥t}. The model further assumes instantaneous demand for vaccine or preventive care for COVID-19 at time t (or year 2020) on the two such paths are $D(I_t, P_t)$; where the demand for vaccine or preventive care depends on the prevalence rate and the price level at time t i.e.

D= f (prevalence rate, price of vaccine, e.t.c.)

As a result the model further assumes that: b= Birth rate into the United States of America; m=Mortality rates out of the system or USA; w=Natural withdrawal rate from COVID-19 infection to immunity; and β=Probability of infection rate (hazard rate) due to COVID-19.

Therefore, the changes over time in the health status of the American citizens based on the assumptions are as follows;

- ✓ $\frac{\partial S_t}{\partial t} = b[1-D(I_t, P_t)] - \beta I_t S_t - m S_t$ …… (1)

Thus changes in the fraction of susceptible individuals or citizens over time $\left(\frac{\partial S_t}{\partial t}\right)$ depends on the entry of newborns who do not vaccine or take preventive care or precautions (b [1-D (I_t, P_t)]). But exit or mortality is due to new infections of COVID-19 ($\beta I_t S_t$) and non-COVID-19 disease related such as accident, flu, diabetics, e.t.c. (mS_t).

$\frac{\partial I_t}{\partial t} = \beta I_t S_t - (w + m)I_t$ …… (2a)

The equation (2) can be expanded to be written as

- ✓ $\frac{\partial I_t}{\partial t} = \beta I_t S_t - wI_t - mI_t$ …… (2b)

In fact, both equations (2a & 2b) elucidate that the changes in COVID-19 prevalence rate over time $\left(\frac{\partial I_t}{\partial t}\right)$ which is due to entry of new infection gotten through the violation of the preventive precautions—that is refusing to use the hand sanitizers, face-mask, social-distancing e.t.c. ($\beta I_t S_t$) and exits (or die) due to COVID-19 immunity (wI_t) and infection related mortality (mI_t). Here the new COVID-19 infection ($\beta I_t S_t$) is due to the interaction between the susceptible (S_t) and the infected (I_t) under random matching (that is refusing to obey the social distancing regulations or violating the other COVID-19 preventive care measures).

✓ $\frac{\partial R_t}{\partial t} = b[D(I_t, P_t)] + wI_t - mR_t$ …… (3)

Very importantly, the equation (3) also explains the changes in the fraction of the Americans' population that is immune $\left(\frac{\partial R_t}{\partial t}\right)$ which is due to new born who vaccinates or have purchased and used COVID-19 preventive care ($b[D(I_t, P_t)]$) and those recovering from infection of COVID-19 through proper care by healthcare practitioners' (wI_t) as well as those who exit (or die) through non-disease related (mR_t). To better assist policymakers, bureaucrats, and politicians to understand the growth or the spread of the COVID-19 equation 4 was as well utilized.

$\frac{\partial I_t}{\partial t} \geq 0 \quad \Longrightarrow \quad \frac{1}{w+m}\beta S_t \geq 1$ …… (4)

Here βS_t represents the rate of the susceptible who come into contact with the COVID-19 infected person, $\frac{1}{w+m}$ also represents the average time of infection and the equation (4) implies that, for infection to grow the infected individual should at least infect more than one individual before he/she exit (or die) from the infected population. That is why the self-quarantine or containment methods and other preventive care measures have been utilized to minimize the growth of the COVID-19 infection.

$\rho = \frac{\beta}{w+m}$ …… (5)

The equation (5) represents the secondary infection generated by a single new infection of COVID-19 (or COVID-19 case) when the entire American population or citizens are all susceptible. Thus the disease can take over this population only when the ratio is greater than one (1) as shown in equation (4) above.

Understanding the Implications for Private Disease Eradication—another important tool used to fight epidemic is vaccination or preventive care measures. In fact, with the exception of smallpox, vaccination has not been able to eradicate diseases. Now the question is: how do rational agents (infected and uninfected) behave in the face of epidemic or COVID-19?

It is expected that the susceptible rational individuals will demand preventive care in the face of an epidemic like COVID-19. The amount demanded and hence the ability of the private market to achieve eradication for COVID-19 is determined by the prevalence elasticity of demand for prevention. If the elasticity is low, only a small amount of prevention will be demanded resulting in higher future prevalence. A large elasticity then leads to a greater demand for preventive care for COVID-19 and a lower prevalence in future. Thus when the elasticity is sufficiently large, it can lead to a decline in the prevalence rate and slow down the progress of the epidemic in order to flatten

the curve (as shown Figure 3). Also, if the demand for prevention is prevalence dependent, then for a positive price, demand for prevention goes close to zero for low levels of prevalence. Thus, if demand for vaccine (or preventive care) is prevalence dependent then as prevalence falls demand also goes close to zero. However, this increases the susceptibility of the population. As a result an infection can regenerate itself in the long-run (i.e. $\rho \geq I$), for prevalence to increase again, making eradication impossible. This argument holds as long as price is positive. This implies that the COVID-19 disease cannot be eradicated regardless of the market structure (i.e., whether it is a monopoly or a perfect competitive market). Thus the difficulty of eradication comes from the demands side rather than the supply side of the market.

Understanding the Concept of Rational Disease Dynamics of Epidemics

Let assume the consumer of COVID-19 preventive care's utility function to be U (h, d) over a binary demand for protection. Where "d" represents the demand for protection or preventive care which is binary (Yes or No) and "h" also represents the healthy state whether susceptible (s) or infected state (i). Therefore the value function of the health state is given as in equation (6) and this value function is used to investigate into the demand for preventive care.

$$V(s) = \max \{U(s, 1) + \alpha V(s), U(s, 0) + \alpha[\beta I_t V(i) + (1- \beta I_t) V(s)]\} \ldots\ldots\ldots\ldots\ldots \quad (6)$$

Where; α represents discount factor (rate), β represents hazard rate, U(s, 1) represents utility with COVID-19 vaccination (i.e. with preventive care), $\alpha V(s)$ represents utility in the future period when the individual vaccinate {i.e. have preventive care or (with no infection)}, U(s, 0) represents utility with no COVID-19 vaccination (i.e. have no preventive care) in the current period and $\alpha[\beta I_t V(i) + (1- \beta I_t) V(s)]$ represents the utility in the future period with no vaccination (i.e. no preventive care). The utility with no COVID-19 vaccination can be attributed to the probability of infection, if you do not vaccinate ($\beta I_t V(i)$) and no infection when you do vaccinate $[(1- \beta I_t) V(s)]$.

The equation (6) means that, a continual protection in the current period implies susceptibility in the future but no protection leads to an increase in the probability of being infected and this probability increases with prevalence. The equation (6) can be maneuvered for further analysis as shown below to arrived at equation (7), by subtracting the vaccination state from no vaccination state;

$$U(s, 0) - U(s, 1) = \alpha[\beta I_t V(i) + (1- \beta I_t) V(s)] - \alpha V(s)$$

$$U(s, 0) - U(s, 1) = \alpha \beta I_t V(i) + \alpha V(s)] - \alpha \beta I_t V(s) - \alpha V(s)$$

$$U(s, 0) - U(s, 1) = \alpha \beta I_t V(i) - \alpha \beta I_t V(s)$$

$$U(s, 0) - U(s, 1) \geq \alpha \beta I_t [V(i) - \alpha V(s)] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

The equation (7) implies that the individual will remain exposing to the disease as long as the benefit exceeds the cost in the future due to the risk of infection. It is further assume that here the individual engages in protection after the reservation prevalence (K), has been reached. The reservation prevalence satisfies K as shown below;

$$d=0, \; I_t \leq K \equiv \frac{\alpha[U(s,1) - U(s,0)]}{\beta[U(s,1) - U(i,0)]} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

The equation (8) represents the threshold prevalence, below which there is no protection for COVID-19 but above it there is protections for COVID-19 ($I_t \leq K$). The threshold prevalence rises with the discount factor or rate (α) and the cost of COVID-19 protection [U(s, 1)], falls with the cost of infection [U(s, 0)] and the probability of transmission given the exposure or the hazard rate (β). Assume also a close population (a population without social distancing) and the reservation prevalence levels are distributed according to the cumulative density function F (K). Then the epidemic begins with prevalence level I(K, 0) in the population and takes off by infecting those with no protection and not yet infected as shown in equation (9) and (10).

$$I_o = \int I(K, 0)dF \quad \text{(9)}$$

$$I_t = \beta I_t Q_t G(I_t) \quad \text{(10)}$$

$$G(I_t) = \int_{I_t \leq K} [1 - I(K, 0)]dF \quad \text{(11)}$$

Where equation (11) is part of the population that are susceptible and choose to engage in transmissive activity at prevalence I_t and $Q_t = \exp[-\int_0^t \beta I_s ds]$ is the fraction of those not yet infected with COVID-19 despite exposure to infection.

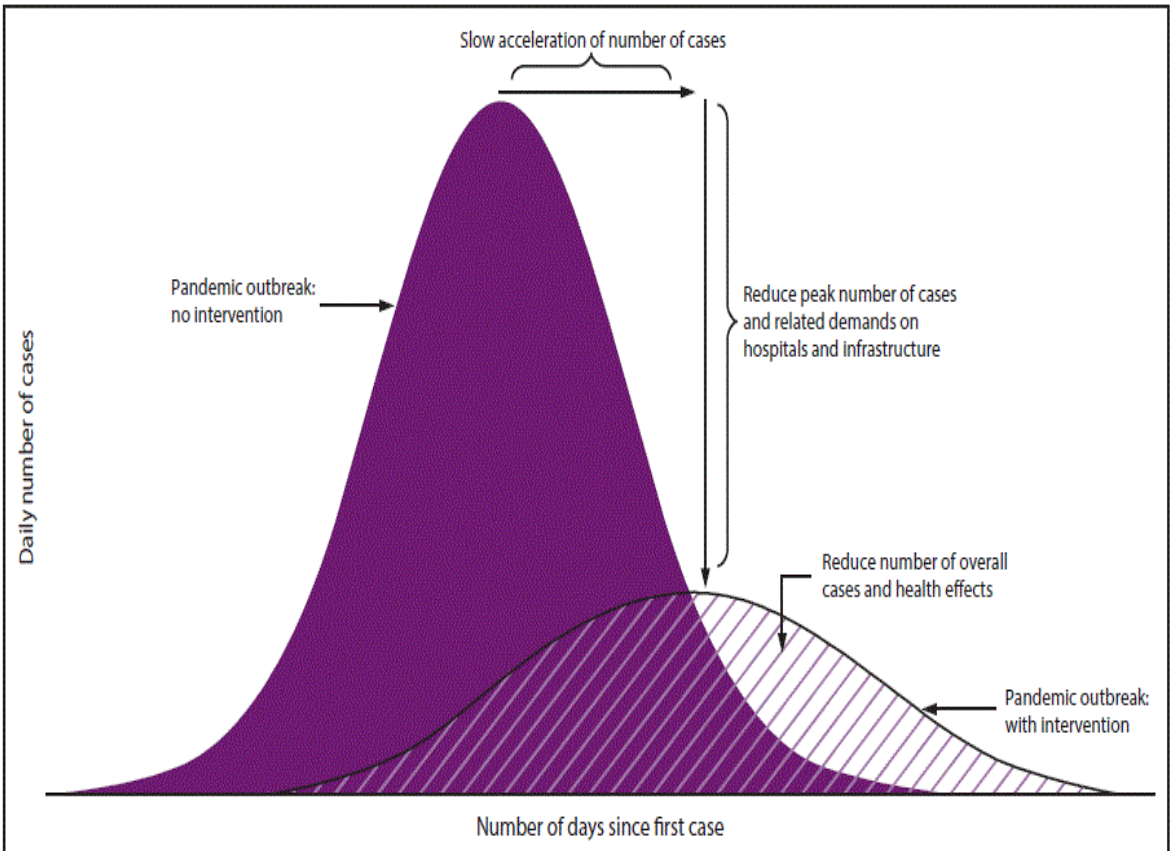

Figure 4: Flattening the Curve through Resource Allocation to Minimize Prevalence and Hazard Rate. (Source: Noreen Qualls, Alexandra Levitt and Co-authors, 2020).

According to Noreen Qualls, Alexandra Levitt and co-authors (2020), the goal of every community mitigation methods in the midst of pandemic include the following: (1) delay outbreak peak (2) decompress peak burden on healthcare, known as flattening the curve and (3) diminish overall cases, and health impact (see Figure 4 for more details). Meanwhile, *G* in the model shows the behavioral response of population to growth in prevalence (that is either to delay the outbreak or decompress peak burden). If the elasticity of prevalence is low or response is exogenous in the model (as in epidemiological models) then a change in prevalence will not affect protection behavior which are more likely to decompress the peak to diminish the overall cases and its associated health impact. Since the hazard rate tends to increase in the prevalence rate. Therefore, as the prevalence increases, the probability of susceptible individual and getting infected increases. That is why more people get infected in the next period thereby heading to the peak of the curve. It is important for readers, policymakers, politicians to note that the elasticity of prevalence determines the epidemic behavior of the outbreak of COVID-19 diseases. However, when *G* is allowed to vary then, it is possible for the hazard rate to be a decreasing function of prevalence due to a resulting increase in protective behavior. Thus the share of population that becomes infected falls even though more and more people become infected thereby flattens the curve. As the elasticity of prevalence gets larger and larger the hazard becomes a decreasing function of prevalence. The elasticity has to be larger, the larger the prevalence to ensure the counteractive positive effect (increasing in protective behavior) is more pronounced.

3. THEORETICAL APPROACHES OF ANALYZING THE BUDGETARY ALLOCATION OF A NATION'S RESOURCES TO TACKLE PANDEMIC BY STAKEHOLDERS: A CASE OF CORONAVIRUS (COVID-19)-GLOBAL CRISIS

As a fact, there exists a positive relationship between healthcare and health status (Adu-Frimpong, 2016; Grossman, 2010). But the relationship is subject to the law of diminishing marginal utility. This is because the individual do not desire (or crave) for healthcare. In actuality no one desire to do surgery, or take injection, vaccination, immunization, or buy wheel-chair—unless he/she is not feeling good or sick. Therefore, the desire for a person to feel good (or fine) then motivate them to invest into their health by either exercising more or taking in more drugs (medication). When one speaks of health and the provision of healthcare Practitioners are very central in healthcare market in terms of decision making because they determines the quantity level of healthcare to be consumed by patients and the kind of drug that is good for individual's consumption to maintain and improve upon the well-being of an individual. Meanwhile, the Health Economist is always interested in the efficient allocation of the nation's resources towards the healthcare financing to make available healthcare goods, for the individual consumption at the optimal level to improve and maintain the well-being of the human system.

When it comes to the entire budgetary allocation politicians and the bureaucrats play a key role in the decision making processes. In relation to the bureaucrats role in decision making process—the health economist advises the public policymakers or decision makers to ensure an efficient allocation of the nation's resources at a point where the marginal benefit derived from the individual is equal to the marginal cost incur on the treatment of the individuals in a given population (Adu-Frimpong, 2016). However, there has been series of conflicting theme between politicians and healthcare providers. The relationship between the healthcare decision by health practitioner and the health economist (or politicians) is view and explain from; Kink curve, Optimal upward sloping curve, the flat of the curve and the curve with the peak (Adu-Frimpong, 2016).

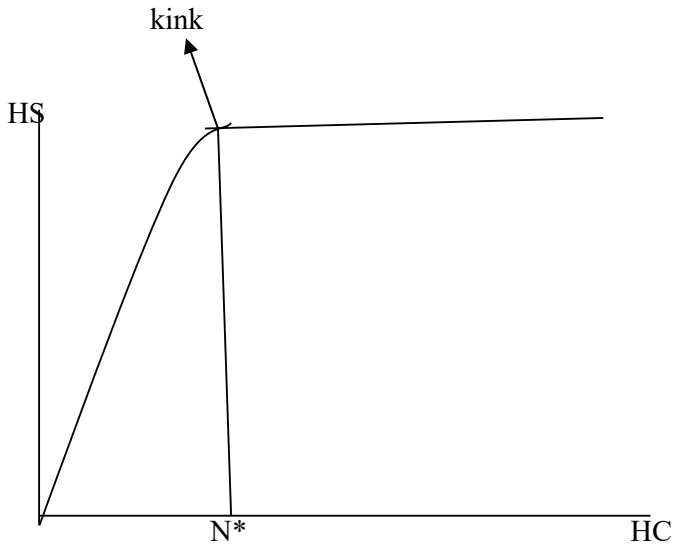

Figure 5: The Kink Curve

Figure 5 reveals the relationship between healthcare consumption and health status of a given population. Taking for the case of COVID-19, under Kink of the curve, theoretically the health practitioners will argue that the politicians should make available the funds to finance health care goods of the people such as free testing, treatment, protective measures, e.t.c as long as they improve the health status of the individuals. They believe that as long as healthcare i.e. medication or drugs improves the health of the person until it gets to N* continue to give it them. To the health practitioner the optimal point of healthcare consumption is the N*. However, the health economist will advise the politicians to compare the cost of producing the healthcare to that of the benefit the society will derive from the treatment of the outbreak. If the healthcare cost is very cheap relative to the benefit then, the health economist will agree to the usage of the nation's resources for healthcare production to make available for the treatment to the sick to improve upon their health status. Therefore the health economist will agree to the consumption of the healthcare until a point where the marginal cost is equal to the marginal benefit (Adu-Frimpong, 2016). But if the marginal cost is lower than the optimal healthcare in-take (N*), then consumption could continue until it gets to the optimal point (N*). Because the COVID-19 is a pandemic and benefit for treating this outbreak outweighs the cost, pain, and fears instill in the citizens, the politicians, healthcare practitioners, and health economists will agree to release funds to finance the outbreak. As result the relationship between health care consumption and improvement in the health status of the citizen will be expected to an upward sloping curve (see Figure 2 for more details).

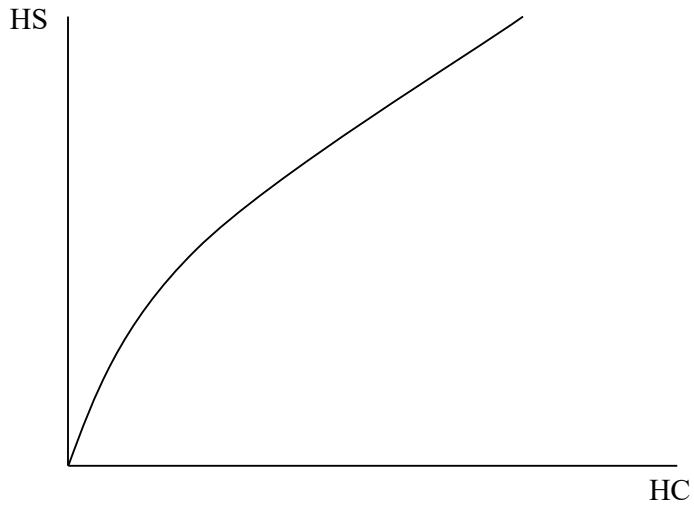

Figure 6: **Optimal Upward Sloping Curve**

Figure 6 reveals that all the stakeholders—politicians, health economists, and health practitioners will agree for testing kits, medication, treatment, and many other measures to be available to the citizens. All of the stakeholders will agree to the fact that the individual needs healthcare (HC) in order to improve on their health status. As a result they will all agree to release funds in order to permit the citizens to consume healthcare (HC) as long as healthcare is a normal good that improves the health status (HS) of the citizens. Here before the person gets to the optimal level a lot of resources would have been wasted by the health practitioner due to try and error in order to identify the right prescription for the patient. This is a typical case of the first phases of an outbreak where a quick solution or response is needed to assist the patients or the infected ones. At this stage there is no right or wrong approach to treatment as long as the method help to minimize the spread of the outbreak and also help the sick ones to recover, cases in point are Ebola, and COVID-19. This process in the longer flattens the curve of the upward sloping curve (see Figure 4 for more details).

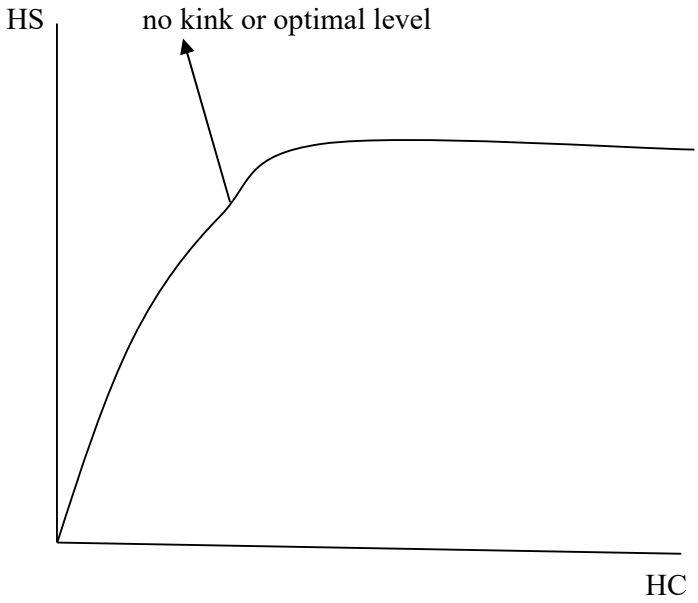

Figure 7: **Flat of the Curve**

Figure 7 discusses the flat of the curve—which reveals that in the face of a pandemic or virulent disease as COVID-19 there is no optimal level of health care consumption to prevent, treats, and minimize the spread of the outbreak in the short-run. This is because one key feature of the flat of the curve is that there is no optimal level or point for the consumption of healthcare by the health practitioner or the health economist as well as politicians. Above all, in relation to the nature of the diagram, the infected ones have to consumed medication or healthcare unnecessary—as a result there will be a great depletion of the nation's resource since all the stakeholders (politicians, policymakers, healthcare practitioners, health economists, citizens e.t.c) do not know the optimal level of healthcare consumption.

Meanwhile, a typical example in relationship to the flat of the curve analysis is associated with the treatment of standard malaria, Ebola, and COVID-19. In treating standard malaria patients, it is difficult to know the optimal level of medication needed or healthcare in-take to treat such sicknesses (Adu-Frimpong, 2016). So the health economist, politicians, citizens, and other bureaucrats will have the same opinion to the health practitioner's means of treatment. Therefore the health practitioner will agree to the try and error process of treatment to aid in eradication of the sickness. The health practitioner will continue giving the medication until they realize that the infected ones have been fully recovered.

4. MEASURES TO CONTROL AND PREVENT COVID-19 FOR SPREADING

It is obvious across the globe that almost all countries across the globe or the world are at a shut-down and in quarantine. Even though these initial approaches are very important to the benefit of the citizens, policymakers, healthcare economists, and practitioners in general. There are a number of strategies in the control of the COVID-19 outbreak: containment, mitigation, and suppression. Containment is undertaken in the early stages of the outbreak and aims to trace and isolate those infected as well as other measures of infection control and vaccinations to stop the disease from spreading to the rest of the population. When it is no longer possible to contain the spread of the disease, efforts then move to the mitigation stage, when measures are taken to slow the spread and mitigate its effects on the health care system and society. All these measures take into accounts the use of hand sanitizers, wearing of face- mask, and using protective clothe as well as regular washing of hands with soap or detergents are all equally important to the procedures of controlling the spread of the COVID-19 or the virulent disease (coronavirus). Meanwhile, giving the political will of the governing bodies, policymakers, lawmakers, and other stakeholders, the under-listed measures if well implemented by the stakeholders will help eradicate the outbreak.

The study recommends a Mandatory Vaccination for All Residents (Not Only Citizens). The expansion of a national healthcare insurance, including a Medicaid program, to cover the treatment of COVID-19 by law will help eradicate the pandemic in USA. The stakeholder should make a law for every resident to take COVID-19 shot or vaccination. The vaccination should be mandatory because the total demand for vaccination has two major components which include the mandatory demand in the program (i.e. Medicaid) and the private demand outside the program (insurance). The mandatory demand can crowd out private demand such that; there exist individuals who would vaccinate in the absence of the program but would not do so in its presence. Thus increasing the public coverage has two effects on demand. First it leads to an increase in vaccination as those who otherwise would vaccinate do so. Second it reduces demand by those not covered by the program (insurance or Medicaid). The second effect, which has a negative effect on the program, becomes larger, and therefore leads to larger prevalence elasticity. The increase in demand by those covered by the program reduces prevalence and hazard rate and so decreases demand for protective behavior by those not covered by the program.

The study further recommends public intervention into the allocation of information. In the case of COVID-19, the dissemination of information through screening, community awareness, partner notification, education and confidentiality reporting is a widespread public intervention. **What is the effect of such allocation of information?** The information structure of a disease determines its growth and prevalence. Also, in a case of a virulent disease like COVID-19, it can be regarded as imperfect information, since an infected person may not exhibit any symptoms of the disease until 14 days after the incubation period. Such asymmetric information problem, shown in trade models limits the volume of trade. Applying this to COVID-19 pandemic, it implies that, people with no infection may practice social distancing, using hand sanitizers, regular washing of hands and so would not engage in public gatherings for the fear of infection. For such a case, the health status of individuals is revealed through screening.

Indeed, the growth of the disease is likely to be lower or get to zero under perfect information. Studies on the private demand for information and public subsidies on information acquisition show that, the only individual that is likely to alter his/her behavior as a result of the acquisition of information are the low-risk HIV-

positive and the high-risk HIV-negative. The overall effect of the screening program is likely to be small because they offset each other. Empirical studies show that when the low-risk HIV-positive receives private information of their HIV status, it had little effect on their behavior. The high-risk HIV-negative individuals however were likely to increase the volume of sexual contact. Therefore if education programs target high risk groups, they do not lead to a favorable alteration of behavior. A public testing program can have unintended consequences when focused on high risk. Susceptible people are however likely to improve their chances of not being infected if they learn effective ways to avoid infection.

The study further recommends public price subsidy on all the COVID-19 protective tools or equipments. The public price subsidy is the application of the pigouvian subsidy theory. When the prevalence elasticity is taken into account, then the long supported pigouvian subsidy for vaccination cannot be effective in eradicating an epidemic disease due to low price elasticity in the prevalence responsive models for the case of COVID-19 pandemic. Under this model, an increase in the price of vaccination (preventive care—such as vaccination or gloves, sanitizers, face-masks, e.t.c) for eradicating, for example has two effects. First, it reduces the demand for vaccination which leads to an increase in prevalence. Second, the increase in the prevalence causes demand for preventive care (vaccination or gloves, sanitizers, face-masks e.t.c.) to increase. But the total counteracting effect of an increased in price of preventive care (vaccination, gloves, sanitizers, face-masks e.t.c) falls with the prevalence elasticity. Let's also consider the application of the pigouvian subsidy as a mechanism for eradication. Where the rate of subsidy depends on the prevalence rate, therefore let s (I) represent public subsidy. If $s^{I}(I) > 0$, then the public subsidy is pro-cyclical and if $s^{I}(I) < 0$, then it is counter-cyclical. However, in the real-world it is likely for subsidy to be pro-cyclical than the counter-cyclical. An increase in subsidy reduces price and the larger the prevalence elasticity the lower the equilibrium I, therefore the pro-cyclical subsidies are more likely to lower the equilibrium I, than a counter-cyclical subsidy.

Conclusion:

In a perfectly competitive market, the disease is likely to be eradicated as long as the subsidy covers the cost of production, hence it should ensure universal demand. Thus, if the price equals the subsidy, then it is free to consumers and so eradication is possible in the perfect competitive market where the subsidy covers the entire cost of production and distribution to the consumers. In a case of monopoly market or monopolist with a constant marginal cost, setting the price equals to the subsidy will lead to eradication proper but the monopolist would be rambling future profit after eradication and run-out of business. Due to the above reason, the monopolist would always set the price little or more above the average cost of production depending on the profit motive of the monopolist, such that the price sets would always exceed the subsidy. Here even though there is subsidy the consumer still pays some amount to access vaccination or preventive care, then there will be no universal demand and no eradication to COVID-19.

Note that with subsidy, the monopolist faces an inelastic demand, which implies that, a larger change in price brings about a no or little change in quantity demanded of the preventive care of COVID-19. The monopolist gets higher profit by charging higher prices and since the consumers are constraint with the output of the monopolist, eradication will not be possible due to a positive price of vaccination or preventive care of COVID-19 and no available substitute of preventive care of COVID-19 for the consumers. Again, since demand is also inelastic, then the high rate of elasticity of prevalence will not be profitable for the monopolist to aid in the eradication of COVID-19 in the face of this pandemic. In a nutshell, eradication will be possible when the preventive care are free, treatment are free or at a subsidize rate (or affordable), adequate information flow about the COVID-19 prevalence rate. Above all, the government and public intervention should outweigh the private intervention in order to make COVID-19 eradication to be possible.

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