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Lockdown Policies, Social Distancing Behaviour, and Literacy: An Empirical Analysis of the Role of Literacy on the Spread of Covid-19

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Abstract

The major concern of the world in the wake of COVID 19 is how to mitigate the severity of the infection with effective policies and making sure of the overall welfare of the society. Social distancing should be mandatory through *strict* government policies because *unaware* people do not internalize all its benefits. Individual's *awareness* about social distancing behaviour is vital to reduce the spread of the disease given the huge externalities that social and economic activities create. The awareness of the importance of social distancing behaviour, is largely affected by the education or literacy of people as it helps public to understand the nature of a disease which, in turn, make authorities to implement *stringent* policies to reduce the infection. As there is notable variance across countries both in the stringency of public policies and social distancing behaviour against COVID-19, this study aims to explain the mechanism behind literacy causing the variation of in both policies and preventive behaviour of people through the lens of political and welfare economics. Data on mobility patterns, literacy rate, government response stringency policies, and some socio-economic characteristics of 188 countries were collected from multiple sources (e.g. WB, OWID, UN, Google etc) for the study. A Structural Equation Modelling (SEM) framework is used to examine the direct effect of literacy on people's mobility pattern and the indirect effect of literacy on the mobility pattern through the intervening factor government stringency policy. Results show that literacy has significant effect both on the *stringency* of political policies and citizen's social distancing behaviour aimed to reduce the spread of COVID-19.

Keywords: Externalities, Literacy, Stringency of Government Policies, Social Distancing, COVID-19

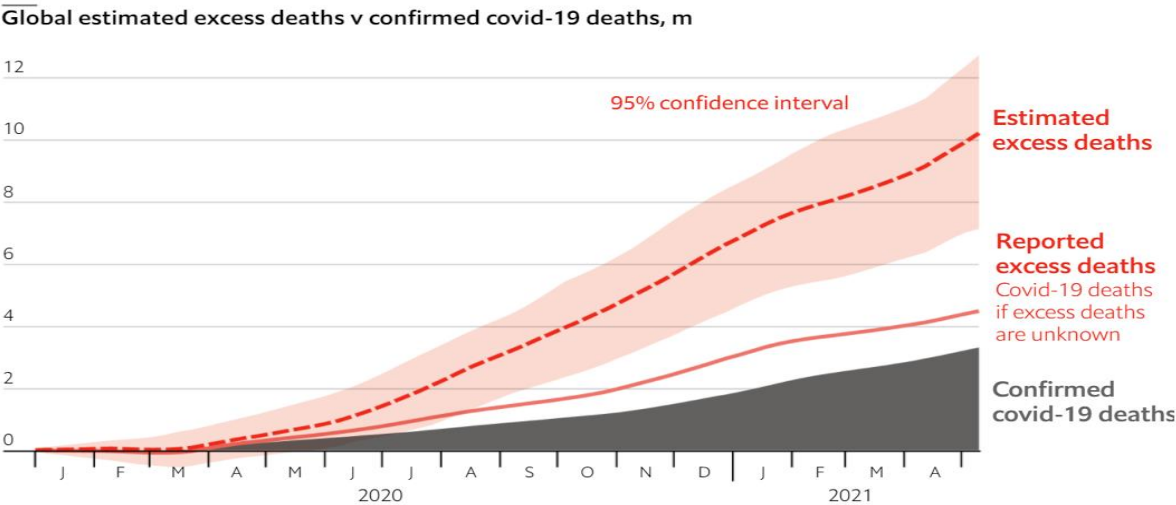
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1. Introduction

The respiratory disease COVID-19 outbreak originated in late December 2019 in Wuhan province, China. It has spread throughout and outside of China since mid-January 2020 and the number of confirmed COVID-19 cases and deaths worldwide have been increasing exponentially since then. World Health Organization declared this as a public health emergency of international concern (PHEIC) on 30 January 2020 and a pandemic on 11 March 2020 as the outbreak of COVID-19 spread around the world within a few weeks.

Similar to SARS-CoV and MERS-CoV, the COVID-19 can be transmitted from person to person (Qiu, Chen, & Shi, 2020). As of 29 April 2021, there are more than 150 million infections worldwide and more than 3 million deaths (Worldometers, 2021). However, due to poor reporting of the covid related deaths, this number falls well short of the true total. A report from 15th of May 2021 claims that there is a 95% probability covid-19 has led to between 7 million and 13 million excess deaths worldwide according to global excess-death-toll estimate (see figure 1), which shows the true burden of this pandemic (The Economist, 2021).



Sources: Johns Hopkins University CSSE; *The Economist* excess-deaths model

Figure 1: Global estimated excess deaths vs. confirmed COVID -19Deaths. (Source: The Economist)

This pandemic poses huge threats on public health, economy, lifestyle, and wellbeing of populations. The negative impact it caused in global economy is inevitable. Global stock markets collapsed by 50% and unemployment rate in the US rose up to 14.7% in April 2020 which is the highest rate since the Great Depression (Rahman, Thill, & Paul, 2020). COVID-19, henceforth, has generated a massive social, health, and economic crisis.

Infectious diseases like Covid-19, involve externalities: by engaging in social and economic activities, infected individuals impose significant externalities on those with whom they interact and whom they put at risk of infection. A model calibrated to capture the main features of COVID-19 in the US economy illustrates that individuals perceive the cost of an additional infection to be around \$80k whereas the true social cost is around \$286k which is more than three times higher (Bethune & Korinek, 2020). *Massive* Public health measures therefore are essential because of these huge externalities. The study shows that in the initial outbreak of the disease when 1% of the population is infected, the government reduces social activity close to zero that leads to sharp reduction in the number of infected (Bethune & Korinek, 2020). Although economists have recognised the negative externalities that infectious diseases cause that gives importance to the call for public health interventions, but the degree of severity of such externalities that the ongoing COVID-19 pandemic involves is unprecedented in modern times (Bethune & Korinek, 2020). Many empirical studies have shown that travel restrictions dramatically reduce mobility during the COVID-19 pandemic (Anzai et al., 2020; Chang et al., 2020; Gao, Rao, Kang, Liang, & Kruse, 2020; Linka, Peirlinck, Sahli Costabal, Kuhl, & Engineering, 2020; Tian et al., 2020). Thus, *massive* lockdown measures are very effective means of social distancing that consequently eradicates pandemic severity and promotes social welfare. Stringency of orders requiring staying at home to control the virus transmission is found to have bigger effects on mobility than for less stringent orders (Brodeur, Grigoryeva, & Kattan, 2020). However, notable variation is observed in both the *stringency* of stay-at-home orders, lockdown policies and in the social distancing behaviour of people suggesting that some countries are far less strict in implying the shelter-in-place policies, and some individuals are far less inclined to maintain the social distancing rules than others. Such findings raise important questions: What characterizes the countries who are least strict in implying stay-at-home orders? What is the character of people that leads to their ignorance in maintaining social distancing practice during the COVID-19 pandemic in present and in the long run? My thesis tries to answer these questions through the lens of political and welfare economics with the help of empirical analysis.

Education can raise awareness among citizens about the externalities created by social and economic activities during the COVID-19 pandemic and make them understand the importance of government interventions to control such activities. Due to general lack of awareness caused by low literacy, people tend to be inconsiderate in adopting the risk averting measures like social distancing, and therefore people's health seeking behaviours are different (Noreen et al.,

2020). Literacy rate of a country can be used as a proxy for people's education level to examine how aware they are about the disease. One might think that literacy is the ability to read and write, but literacy means more than that. One of the definitions of literacy provided by OECD and cited by the UNESCO is as follows, "Literacy is understanding, evaluating, using, and engaging with written text to participate in the society" (UNESCO, 2018). Elaborate definitions of literacy are presented in table 2 in the appendix. There are reasons to focus on literacy in the outbreak of COVID-19. First, functionally literacy helps in understanding the information regarding the extent of the risk of COVID-19 as well as the greater social cost it imposes. There is a significant need for citizens to understand this information and accept it as advice which ultimately affect their social distancing behaviours in the time of the pandemic. In a lot of the cases what happens is either a distrust of reliable information from health institutions or governments, or an overreliance on unreliable information, leading to, for example, the belief that COVID-19 may be a hoax or part of a wider conspiracy (Van Bavel et al., 2020). The most import challenge that governments and health agencies face to ensure the safety of citizens around the world is understanding how people trust information and misinformation (Fell, 2021). Literacy raises people's ability to evaluate the trustworthiness of the information, including its origin, credibility, accuracy, and the motivation behind its dissemination. Literacy enables people to differentiate valid health advice from misinformation or information leading to unsafe health practices during the COVID-19 pandemic. Lower literacy among people would result in their overreliance on non-reliable sources that may give them the false idea that social distancing is not very much important to get rid of the pandemic and thus can negatively affect their social distancing behaviours. Health literacy generates competencies among people to obtain, understand and process information about health and make decisions effectively (Washington, 2004). This is how literacy keeps citizens well informed and well-aware about the COVID-19 pandemic and the importance of social distancing to reduce the associated social cost. Second, literacy can affect the public policies regarding restrictive measures aiming at reducing the spread of COVID-19 since well-informed citizens can motivate authorities to implement effective policies (in this case, strict "shelter-in-place" orders). With the way the virus spreads, social distancing might not be a personal choice but rather an ethical duty for establishing social welfare. That ethical responsibility could be understood well by people who are well-literate. Thus, when it comes to collective decision making such as policies against COVID-19, literacy level of a state plays important role in making efficient policies since governments as well as the public are involved in those decision-making process. Literate people, being well-informed about the disease, can hold the authority accountable for their

policies by assessing the responsibilities of specific political actors for service breakdowns. In a democratic system, politicians take actions to protect (informed) populations because they are accountable to them (Bosancianu, 2020). One study states that well-informed voters about certain policies can take greater resources and better performance from political authorities (Keefer & Khemani, 2003).

My paper therefore argues that literacy level of people has huge impact on both the deviation of political policies and stay-at-home practice of people across nations during this pandemic. Many factors (e.g. social, economic, environmental etc) have been claimed by researchers (Abed & Lashin, 2021; Rahman, Thill, & Paul, 2020) to have impact on adoption of strict stay-at-home orders, lockdown policies and preventive behaviour aiming to reduce mobility to mitigate the disease outbreak. Nevertheless, the role of literacy on political policy formulation and self-isolating practice during the COVID-19 pandemic remains poorly discussed. There is no literature, as far as my knowledge is concerned, that studied the effect of literacy on stringency of public policies such as lockdowns and stay-at-home orders in response to the COVID-19 pandemic.

More precisely, this paper tries to untie the complex relationship between literacy rate of a country, its public policies to restrict social interactions, and people's self-isolation behaviour in response to the outbreak of COVID-19 through the lens of political and welfare economics. For this study, a double effect (direct and indirect) framework is employed comparing countries' mobility before and after stay-at-home orders based on their social capital and literacy-levels, i.e. comparing high-literacy vs. low-literacy countries. The following research questions are at the core of this paper

Research Questions:

- How does literacy rate affect articulation of strict stay-at-home orders to reduce the COVID infection?
- How is the indirect effect of literacy through stringent policies on people's mobility pattern?
- How does literacy rate of a country directly affect people's stay-at-home practice in response to the COVID outbreak?

Empirically, this thesis focuses on the indirect effect of literacy on people's stay-at-home preferences through a mediating factor, stringency of government policies aiming to eliminate the corona virus. It also tries to examine the direct effect of literacy on self-isolating behaviour

of the citizens in response to the COVID-19 outbreak irrespective of those policies. Structural equation modelling is used to do the whole analysis. For the analysis, first it is tested if literacy affects stringency of public policies against COVID-19, and second, the effect of such policies on people's mobility pattern is compared to the time before corona.

Data of literacy rate, government response policy index for COVID-19, and people's mobility pattern in response to the pandemic was collected for the study. Also, data of some socio-economic characters of countries was collected and used as control variables in the model for the study. It is hypothesized that nations with higher human capital acquired by literacy exhibits stricter stay-at-home orders and lockdowns resulting in efficient reduction of mobility of people, and thus, decline in the COVID pandemic severity.

This research contributes not only to public health management but also to political economy, welfare economics and resource economics. It shall deepen our understanding of the links between the pandemic, political policies, individual resource, choices and behaviour, and overall economy by providing insights to improve public health policies to reduce the transmission of COVID-19 to sustain economic well-being of the society.

2. Theoretical Framework

In my thesis, I use Olson's (1965) theory about collective action and public goods and exemplified it with the recent case in India, the country that got hit hardest by COVID-19 in April 2021. Olson's theory and the example of India would be presented in this section.

Olson's Theory

When infected by a communicable disease like COVID-19, a person can spread it to others, who in turn can spread it further and so on. Therefore, it is inevitable to lessen social and economic activities to reduce transmission of corona virus to promote overall social well-being. From the perspective of social and behavioural economics, it would not be wrong to say that unless people are altruistic and include the wellbeing of others in their considerations, self-interested individuals will tend to underestimate the social costs of engagement in social and economic activities by overestimating their private costs of decreasing their social and economic activities as they don't get any incentives by lessening such activities. Private decision-making thus leaves the market far from socially optimal amount of risk mitigation which is why it leads to some risk mitigation but less than the socially optimal amount (Boettke & Powell). The true social cost of getting infected by a person is three times higher than an

individuals perceive as the cost of becoming infected (Bethune & Korinek, 2020). When individuals are free to choose their own activities, they would engage in inefficiently too much risk taking activities resulting in inefficiently too much negative externalities by incurring disease spread and deaths, and this classic situation shows how private marginal costs diverge from the full social marginal costs (Boettke & Powell). This is why it is not efficient to rely on individuals' incentives to protect themselves to achieve overall well-being of the society and therefore, public health measures are essential because individually rational agents do not internalize that they impose transmission externalities upon others (Bethune & Korinek, 2020). Therefore, to control the transmission of this airborne disease, it is very helpful to have political interventions in the way of imposing restrictive measures such as travel bans, and high level of social distancing, and reduction in mobility is an effective measure to reduce transmittable diseases (Rahman, Thill, & Paul, 2020). The cost of infection is an increasing function of infected people because more infections imply greater risk for the susceptible as well as more externalities and a higher cost of reducing the activity of infected agents for political actors who plans policies to reduce the spread of the virus (Bethune & Korinek, 2020). Therefore, political policies should put major restrictions on social and economic activities as the externalities are huge. Countries across the globe, however, shows divergence in their stringency of policies that are undertaken to stem the flow of COVID-19.

Olson's (1965) theory can provide some insights to understand the divergence in political policies in response to Covid-19 outbreak observed across countries. Olson (1965) argues that in the system of collective decision making of the purposive actors in a democratic process, there would be a bias that the system will produce in the short run that creates incentives for the well organized and well-informed groups to benefit on the costs of unorganized and ill-informed groups. This theory parallels my hypothesis that the political actors, being the well-organized and well-informed groups, can benefit from the policies by putting costs on unorganized and ill-informed or illiterate people which consequently causes the divergence in policy reforms across states with different literacy level. Olson further explains that the basis for Common's thinking was the view that the market mechanism did not by themselves bring fair outcomes to the different groups in the economy and this unfairness was a result of disparities in the bargaining power of these different groups. My study argues that people have poor bargaining power due to lower literacy, and this gives incentives to the government who have higher bargaining power to exploit the illiterate people through self-beneficial public

policies. Thus, political policies are collective decision of a society where the members of the society affect this collective decision.

India's Case in line with Olson's Theory

Here, we can draw the very recent example of the deadly second wave in India as it is an emerging economy with lower literacy rate. In April 2021, India has become the global epicentre of the COVID-19 pandemic. A report published by Reuters on May 3, 2021 states that despite scientists warned the ruling government in early March about their findings of a deadly mutated versions or variant of the virus that could more easily enter a human cell and counter a person's immune response to it, government did not seek to impose major restrictions to stop the spread of the virus. "The ministry made the findings public about two weeks later, on March 24, when it issued a statement to the media that did not include the words "high concern" (Reuters, 2021). The same report states that there were three major reasons that caused the horrific surge in the disease outcomes, a Hindu religious festival where millions of Hindus gathered without maintaining distance and wearing masks, the rallies held by dozens of politicians of the ruling and opposition parties for the upcoming election throughout the country, and the protest of tens of thousands of poor farmers against new agricultural law. This exemplifies the theory of my hypothesis of the consequence of the lack of awareness of people that leads to relaxed shelter-in-place policies from which political parties gets profits. Lower literacy hinders people's understanding about the precautions measures necessary to adopt to avoid getting infected and reduce the risk of transmission for overall welfare of the society. Poor farmers are generally illiterate people in India which could be the reason why they were not aware about the risk of their protests and the social cost they would impose. Similar argument can be put for the religious festival. Lack of awareness due to lack of literacy among people resulted in huge public gathering by them without the adoption of preventive measures. Government, on the other side, took advantage of the illiteracy of the people by not imposing strict lockdown policies to be able to run rallies for election. It was possible for the government to free-ride on the cost of other people because many people, being unaware of the importance of stricter lockdown policies, did not held the ruling political party accountable for imposing relaxed lockdown that served their interest. This was the role of the people in India, the world's largest democracy, that contributed to the formulation of socially inefficient policies against COVID-19 that led to the deadly second wave in the country which is still ongoing causing hundreds of thousands of deaths across the country. The death toll from the starting of the

second wave till now in India is around 143, 821 from April 2021 till now date (May 25, 2021) (Worldometers, 2021).

3. Literature Review

Many researchers have written articles on social distancing, lock down rule in response to COVID-19. Centre for Economic Policy Research (CEPR) has even opened a free online publication in the name of “Covid Economics” that publishes the ongoing academic research based on the infectious disease COVID-19. In this section, findings, and thoughts from other literatures regarding restrictive policies and social distancing behaviour in alleviating COVID-19 and the importance of literacy on social distancing behaviour are presented.

Importance of Restrictive Policies and Social Distancing

There are many literatures that talk about the impact of lockdown policies, and social distancing on the reduction of COVID-19 pandemic severity (Anzai et al., 2020; Gao, Rao, Kang, Liang, & Kruse, 2020; Linka, Peirlinck, Sahli Costabal, Kuhl, & Engineering, 2020; Pietro Garibaldi, 2020; Tian et al., 2020). “Given the clear externalities that are created when individuals ignore social distancing guidelines, there is a compelling case for government regulation of such behaviour during the COVID-19 pandemic” (Pedersen & Favero, 2020). COVID-19 virus has spread fast because of the transmission from infected regions to uninfected regions through the movement of people (Craig, Heywood, Hall, & Infection, 2020). A positive correlation of case importation has been found with the frequency of flights, buses, and trains from infected cities (Zheng et al., 2020). Thus, mobility is significantly correlated with the airborne disease COVID-19. Social distancing or stay-at-home practice is therefore inevitable to reduce the transmission of the infection. Empirical results show that social distancing directives (e.g., travel ban, school, and public transport closure, restriction on public gathering, stay-at-home order) imposed by governments can mitigate community transmission of the COVID-19 by reducing the mobility of people which consequently shows high correlations with the death rates 1 month later highlighting the importance of government action for population behavioural change (Bryant & Elofsson, 2020). Authorities in most countries hit by this pandemic have responded with policies such as travel bans through national lockdown, stay-at-home order, restriction on mass gathering, non-essential travel, and many economic activities which further affected people’s mobility and social distancing practices. Travel restriction prevented 70.4% coronavirus infections in China from 28 January to 07 February 2020; reduction of intercity and air travel can effectively reduce the COVID-19 pandemic in Taiwan and Europe claimed

by studies using the susceptible-exposed-infectious-recovered (SEIR) model; travel restriction resulted in the delay of a major epidemic by two days in Japan, and the probability of a major epidemic reduced by 7 to 20% proved by study using count data model (Rahman, Thill, & Paul, 2020). Thus, these lockdown measures indirectly influence pandemic severity by changing people's mobility (Rahman, Thill, & Paul, 2020). Google has started publishing a GPS-location based mobility data from April 2020 to illustrate the change of movement from home and other places in response to lockdown measures across countries during COVID-19 pandemic and based on the analysis of these data, it is proved that constant restriction on travel and migration is an effective way to mitigate the transmission of the infection (Rahman, Thill, & Paul, 2020). This data from google has been increasingly used for many COVID-19 related research works as it gives insights of people's social distancing practice during this pandemic. The analysis of this data shows that a reduction of mobility of 2.31 % resulted in change in infection rate of 0.003% at the county level in the US whereas stay-at-home orders reduces mobility by 7.87% (Rahman et al., 2020). Social distancing (SD), and government directives restricting social interactions are therefore the key to avert the disease. A higher perceived understanding of COVID-19 is associated with a higher degree of social distancing practice (Kwok et al., 2020). There are externalities that justifies government intervention such as imposing more restrictions on actions outside the home than a decentralised equilibrium would yield (Pietro Garibaldi, 2020).

Literacy, Social Distancing and Covid-19 Spread

There are evidences from countries that shows that the willingness of maintaining social distancing depends on the awareness of people about the COVID-19 (Brodeur, Grigoryeva, & Kattan, 2020; Hwang et al., 2017; Kim, Kim, & Health, 2020; Kwok et al., 2020; Noreen et al., 2020). From the ways the COVID-19 virus spreads, it is blatantly clear that strict stay-at-home orders, lockdown policies and social distancing are inevitable to reduce the transmission of the infection. However, countries across the globe show divergence in implementing strict lockdown policies and social distancing behaviours against COVID-19. This could mostly be the result of lack of awareness among people. Raising awareness and knowledge in people through education (proxied by literacy in my paper) can help them understand the importance of social distancing to promote social wellbeing and reduce the transmission of COVID-19. Decrease in mobility after the implementation of a policy order is remarkably larger in counties above median poverty and education (Brodeur, Grigoryeva, & Kattan, 2020). An empirical analysis shows that knowledge along with some other explanatory factors, has positive direct

and moderating roles in inducing preventive action and shows that education level moderates the relationship of perceived severity, self-efficacy, and family health with preventive action (Kim, Kim, & Health, 2020). Knowledge induced by literacy plays a vital role in amplifying risk perception of COVID-19. A literature proves that social distancing increases when people have better knowledge of COVID-19 (Kwok et al., 2020). If people have specific knowledge about the risks or causes of COVID-19, preventive actions can be taken frequently. According to a study, knowledge was significantly related to behavioural change that shows 99.3% of respondents were aware of COVID-19, and 88% had good knowledge (Hwang et al., 2017). Those with high knowledge of COVID-19 followed recommendations suggested by the authorities to avoid infection (88%), engaged in good practices (93.8%), and were more likely to take a vaccine (81.8%) (Kim, Kim, & Health, 2020). A study suggests that the moderating effects of education level in preventive actions should be considered when implementing policy (Kim, Kim, & Health, 2020). Hence, it is expected in my analysis that knowledge, as proxied by literacy, will have some effects on policy formulation as a collective action of a state that aims to reduce the spread of COVID-19.

Literacy and Public Policy

Given the observed variance in the stringency of political policies to ensure social distancing, economists stress that it is important to understand from the perspective of promoting overall societal well-being that why governments across the globe made mistakes in policy making to reduce the spread of COVID-19. Actors with different rules create different outcomes and this difference should be explained by the variation in institutions than in people (Buchanan & Economics, 1959). Insights from political economy and social welfare economics may prove helpful in understanding how nations charge in the outbreak of COVID-19 if disease outcomes prove to be a function of appropriate government responses, and the ability and willingness of groups in diverse societies to comply with government health directives. Although political scientists do not usually focus on disease outcomes, they do examine the mechanism in which societies and governments behave, how individuals overcome (or fail to overcome) problems of collective action, sometimes in the wake of crises that represent correlated risks, such as economic collapse or natural disasters (Bosancianu, 2020). Most theories of the breakdown of political markets claim incomplete information as the main reason for such failures (Keefer & Khemani, 2003). Politicians have huge opportunity to free ride on the cost of welfare of uninformed voters and can be vigorous in the pursuit of their own private interest which makes them accountable to these uninformed voters who cannot easily identify the effect of the

politician's rent-seeking on their welfare (Persson & Tabellini, 2000). Based on this empirical research, in my thesis, I expect to see literacy affecting the policy formulation in response to reduce COVID-19 infection. In the case of COVID-19, it is possible for politicians of the states with lower literacy to take advantage of ill-informed or illiterate people by imposing policies that serves their best interest on the cost of the welfare of the illiterate group which consequently fails to reduce social distancing and the spread of COVID-19.

As shown, many economists have done researches on the surveillance and control of COVID-19, as well as their impact on economic development. However, the role of literacy on COVID-19 is not discussed yet, and my thesis tries to fill this hole. My contribution to the existing literatures related to COVID-19 is the introduction of the impact of literacy on COVID-19 using perspectives from political, welfare and resource economics.

4. Method

We draw on a simple path analysis and mediation framework designed to organize thinking about literacy rate of a society and its socioeconomic structures might matter for the ultimate outcome of interest: the degree of strict policies imposed by government and social distancing behaviour of people. Conceptually, a mediation model depicts mediating variable M influencing through the magnitude of the causal effect of X on Y . Mediation analysis is a statistical model that contains two consequent variables (M) and (Y) and two antecedent variables (X) and (M), with X causally influencing Y and M , and M causally influencing Y (Hayes, 2013). In a simple mediation model there are two pathways by which X variable is proposed as influencing Y , one pathway leads from X to Y without passing through M that is called direct effect of X on Y through M and the second pathway from antecedent X to consequent M and then from antecedent M to consequent Y (see figure 3). M , in this model, is called a mediator variable or intervening/intermediate variable. Mediation analysis is appropriate for this study because this type of analysis is extremely popular in virtually all disciplines where researchers are interested in examining questions about mechanism resort to process modelling to empirically estimate and test hypotheses about the two pathways of influence one direct from X to Y and the other indirect through M (Hayes, 2013). Since this research aims to explore the direct and indirect effect of literacy along with some other socioeconomic variables on people's mobility pattern during the pandemic through public policies, the mediation analysis is convenient to use as it allows simultaneous estimation of multiple causal relationships between one or more independent variables and a dependent variable.

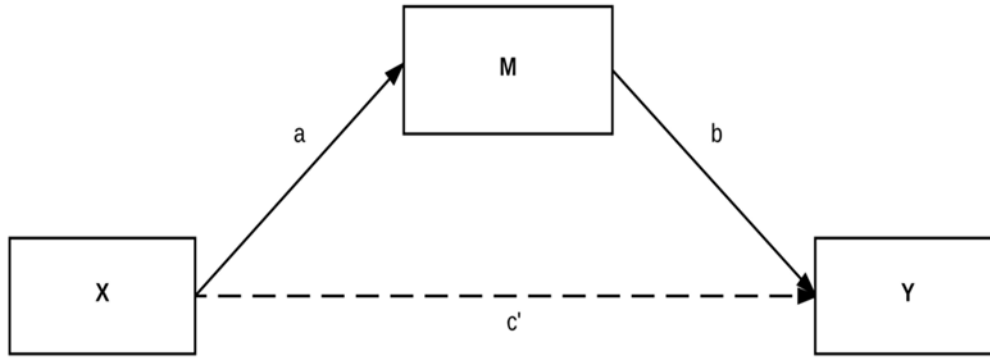


Figure 3: A Conceptual Diagram of Simple Mediation Model

Equation:

The linear models for our analysis are of following

$$M = i_1 + a_1X_1 + a_2X_2 + \dots + a_kX_k + e_M \quad (1)$$

$$Y = i_2 + c'_1X_1 + c'_2X_2 + \dots + c'_kX_k + b_M + e_Y \quad (2)$$

Where i_1 and i_2 are regression intercept, e_M and e_Y are errors in the estimation of M and Y , respectively, and a_k 's, b and c'_k 's are the regression coefficients. Here the a_k 's in equation (1) represents the effect of X variable on the intervening variable M . The c'_k 's represent the direct effect of variable X on the dependent variable Y . The indirect effect of X on Y through M is the product of a 's and b .

5. Empirical Approach

5.1 Data

Data on people's mobility patterns, stringency of lockdown measures imposed by countries, and socioeconomic and demographic characteristics of countries is collected from different sources for the study (e.g., Oxford University, Google, World Bank, The Economist, Our World in Data). After collecting data for 188 countries they were integrated to create a sample of the data from March 2020 till December 2020.

Literacy rate: Literacy is the main explanatory variable of this study that might explain the variability both in the stringency of political policies and in preventive behaviours that ensure social distancing to reduce the spread of COVID-19. We include literacy as a proxy for education and knowledge. For my data, I have collected adult literacy rate which is the

percentage of people ages 15 and above who can both read and write with understanding a short simple statement about their everyday life.

Government Response Stringency Index: The Oxford Coronavirus Government Response Tracker (OxCGRT) project calculated a Stringency Index, a merged measure of nine of the response metrics: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls. The index on any given day is calculated as the mean score of the nine metrics, each taking a value between 0 and 100. A higher value indicates a stricter response. This index simply records the strictness of government policies. This index is used to measure how strict the governments' restrictive policies are to combat the COVID-19 pandemic. This data is used as the intervening variable of this study which means variability in literacy can explain the variability in the stringency of political policies in response to the pandemic which can further cause variability in the stay-at-home practice of people.

Residential Mobility: This data shows the stay-at-home (residence) practice of people in response to the COVID-19 outbreak. Google has published community-based mobility data that depicts movement trends of people over time by geography, across different categories of places such as residential or home to provide insights into what has changed in terms of the mobility of people in response to work from home, shelter in place, and other policies aimed at flattening the curve of this pandemic. Residential mobility data is used in this research to see if people are more at home or not in response to policies aimed at reducing the COVID-19 outbreak. This data shows how visits and length of stay of people at residential areas or home changed as of April 17 compared to a baseline value which is the median value of the corresponding week during the 5-week period from 3 January to 6 February 2020 (Rahman, Thill, & Paul, 2020). This residential mobility data is the dependent variable of this study which means this paper will try to examine how the variation in literacy will cause the variation in residential or people's stay-at-home practice directly and indirectly through the intervening variable government response stringency index. It shows how abilities and willingness of people to go outside home across countries differ and thus affects COVID cases. This is used to investigate to what extent people across countries are following the stay-at-home orders and lockdown policies and why there is difference across countries when it comes to following these policies. Figure 2 below illustrates the change in stay-at-home practices of people worldwide in response to COVID-19 outbreak.

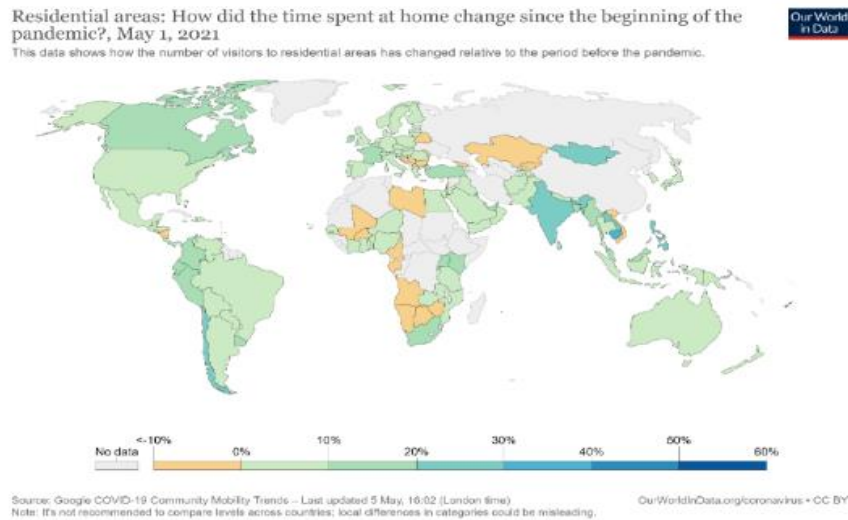


Figure 2: Depiction of how number of visitors to residential areas has changed compared to baseline days (the median value for the 5-week period from January 3 to February 6, 2020). Source: OWID

Controls

Several relevant socio-economic variables have been incorporated as controls to see if they have effect on lockdown policies and on public compliance to these policies aimed to reduce the COVID-19 outbreak. These variables have been widely used in other COVID-19 related literatures. Studies claim that socio-economic factors have significant impact on pandemic severity (Khalatbari-Soltani, Cumming, Delpierre, & Kelly-Irving, 2020; Kim, Kim, & Health, 2020; Rahman, Thill, & Paul, 2020; Stojkoski, Utkovski, Jolakoski, Tevdovski, & Kocarev, 2020).

Government Expenditure on Health: Lower expenditure in the health care indicates that the health care system cannot handle an outbreak that may require extensive self-isolation. Countries with lower government expenditure on health may have insufficient personal protective equipment (PPE) or specialists and need more time to handle a health care shock such as COVID-19 in terms of securing a supply of equipment or qualified staff members. This can cause varying degree of strictness in implementation of stay-at-home orders due to lack of capacity in health and variance in the social distancing behaviour of the citizens because the self-isolating behaviour of the citizens is affected by their confidence in health care system. Societies with low levels of health care confidence primarily shows a more substantial reaction and stay home, this reaction increases more quickly with time than does mobility in high health care confidence societies, and declines with greater magnitude (Chan et al., 2020). Compared to the regions with lower health care system confidence, people of higher confidence in health care system are more likely to reduce mobility after government directives for staying at home

is mandated (Chan et al., 2020). This research therefore used government expenditure on health to see its impact on public policies and social distancing behaviour required to reduce COVID-19 infection.

Median Age: As of December 2020, it was reported by WHO and many other press-releases that old people are the most vulnerable to get the disease than young people. It is assumed that protective behaviour also increases with age as people's health weakens as they grow older and it is natural that older people's chances of defensively pursuing health-related behaviours are greater. In their defence, older population thus can put pressure on the authority to tighten stay-at-home orders and lockdown policies and can adopt more preventive behaviour by staying more at home. This study tries to see if this assumption is true or not. Counties with higher number of elderly people are observed to have higher mobility reduction (Rahman, Thill, & Paul, 2020). If that is the case, then median age can have impact on the public policies, behavioural changes, and COVID-19 disease outcome.

Democracy Index: Democracy as an institutional factor is included based on the assumption that more democratic countries would have stricter lockdown measures as governments are accountable to their people for the effectiveness of their policies. The type of electoral system of a state can play an important role on stay-at-home orders and preventive behaviours and thus on pandemic severity. Amartya Sen emphasized that democratic institutions (and a free press) are associated with the occurrence of famines (Sen, 1982). Disasters like this might be caused by natural occurrences but their scale and effect depend on government responses. Politicians in democratic contexts take actions to protect (informed) populations because they are accountable to them (Bosancianu, 2020). This paper tries to see the truth of this claim by investigating the association of government restrictive policies and democracy and how it affects COVID-19 spread.

Corruption: Corruption is used as a proxy for institutional trust to investigate whether there is any association between people's trust, government policies and stay at home preferences in response to the pandemic. Corruption weakens trust in government and along with it, citizen's willingness to comply with public policies. The pervasive corruption endanger trust in the political system that affects compliance to social distancing policies, as it "involves the capture of political and economic power for the elites and for those on the 'inside' of the circle of influence, destroying morale, reciprocity and the motivation to take collective action in providing any public good" (Chan et al., 2020). The overall trust in government thus influences policy implementations, mobility pattern of people and thus COVID-19 pandemic.

Average Household Size: We added average household size in the model with the assumption that larger household size means more people in the family and thus more chance to get infected as one person can infect more people in a larger household. Therefore, this paper assumed that people from larger average household size will try to be more protective about their family members by reducing their mobility from home. This makes people or countries with larger household size more vulnerable to the COVID-19 disease because the chances of an individual getting infected increases with the increasing number of people s/he is exposed to. I therefore employed this demographic feature of countries to see if it affects behavioural reactions of people as well as self-isolation policies and pandemic severity.

Population Density: More densely an area is populated means more chance of human interaction which raises the chance of infection. It is assumed that authorities in countries with high population density would impose strict “shelter-in-place” policies and lockdowns to prevent the spread of corona virus as densely populated countries have higher risk to spread the virus for having higher number of population. Since daily supplies or social network support are more easily accessible in countries with higher population density, they might have more elastic mobility (Chan et al., 2020). Therefore, to see how population density of a country affects the shelter in place policies and mobility of its people, I used population density in the model

GDP Per Capita/1000: Countries with higher GDP per capita can have higher socio-economic status. This means countries with higher GDP per capita can have much more resources, larger health care capacity and affordability to fight against the COVID-19 pandemic which can have positive impact in the reduction of the infection. I divided the GDP per capita by 1000 to measure its greater effect on residential mobility. The aim of the paper is to see if wealthier or developed nations are taking stricter stay-at-home policies and if public of these nations are more at home or not than the developing or underdeveloped nations. We have divided GDP by 1000 to see its greater effect on the dependent variables.

Table 1: Description of the Variables and Data Sources

Variables	Descriptions	Source
Residential (Dependent Variable)	Percentage change in visits to places of residence compared to a baseline in response to the pandemic	Google
Literacy Rate (Main explanatory Variable)	The percentage of people ages 15 and above who can both read and write with understanding a short simple statement about their everyday life	World Development Indicators
Government Response Stringency Index (Intervening Variable)	An index that measure the stringency of government policies aiming to flatten the curve of COVID-19 rescaled to a value from 0 to 100 (100 = strictest)	University of Oxford
Government Expenditure on Health (Control variable)	Current expenditure on health care system by general government	World Bank
Median Age (Control Variable)	Single indicator of the age distribution of a population showing the age midpoint of the population	Our World in Data
Democracy Index (Control Variable)	An index measuring the state of democracy of countries based on a scale 0=Authoritarian to 10=Full Democracy	The Economist
Corruption (Control Variable)	Bribery incidence (percent of firms experiencing at least one bribe payment request)	World Bank
Average Household Size (Control Variable)	Number of inhabitants per house	United Nations Household Size & Composition 2019 report
Population Density (Control Variable)	Indices that shows population concentration of a country	World Development Indicators
GDP per capita/1000 (Control Variable)	GDP per capita divided by 1000 to see the larger effect of it on residential mobility	Our world in Data

Table 2: Descriptive Statistics of the Variables N=188

Variable	Vars	Mean	SD	Min	Max
Literacy Rate	18	17.81	14.84	2.58	75.40
Government Response Stringency Index	5	57.73	13.58	13.77	84.55
Residential	11	9.64	5.25	-0.30	25.13

Government Expenditure on Health	14	939.90	1254.78	4.371	5245.54
Average Household Size	17	4.01	1.42	2.05	8.67
Corruption	19	17.21	14.59	0.10	64.70
Population Density	21	346.91	1625.29	1.98	19347.50
Median Age	22	30.30	9.24	15.10	48.20
GDP Per Capita/1000	24	18.63	19.76	0.66	116.94

5.2. Model Specification

We have used a structural equation modelling (SEM) based path analysis to see how the effect of independent variable(s) on a final consequent variable can be partitioned neatly into paths of influence, direct and indirect. SEM can examine the mediating effects of the exogenous variables through some intervening variables on the dependent variables by exploring interrelationships among these variables using regression analysis, factor analysis, and path analysis (Rahman, Thill, & Paul, 2020). Here in this study we tried to examine the causal relationship of literacy rate along with some other socio-economic variables and people's social distancing behaviour through a single intervening variable stringency index. In this model Psych package is used to do the path analysis that investigates the interrelationships of the variables of interest. When it comes to using mediation analysis, psych package is a very useful tool to run the multi variate regression for which this package is used to run the analysis. Moreover, a path diagram is built to graphically illustrate interdependencies of the independent variables, mediator, and dependent variable in the model specification (see figure 4).

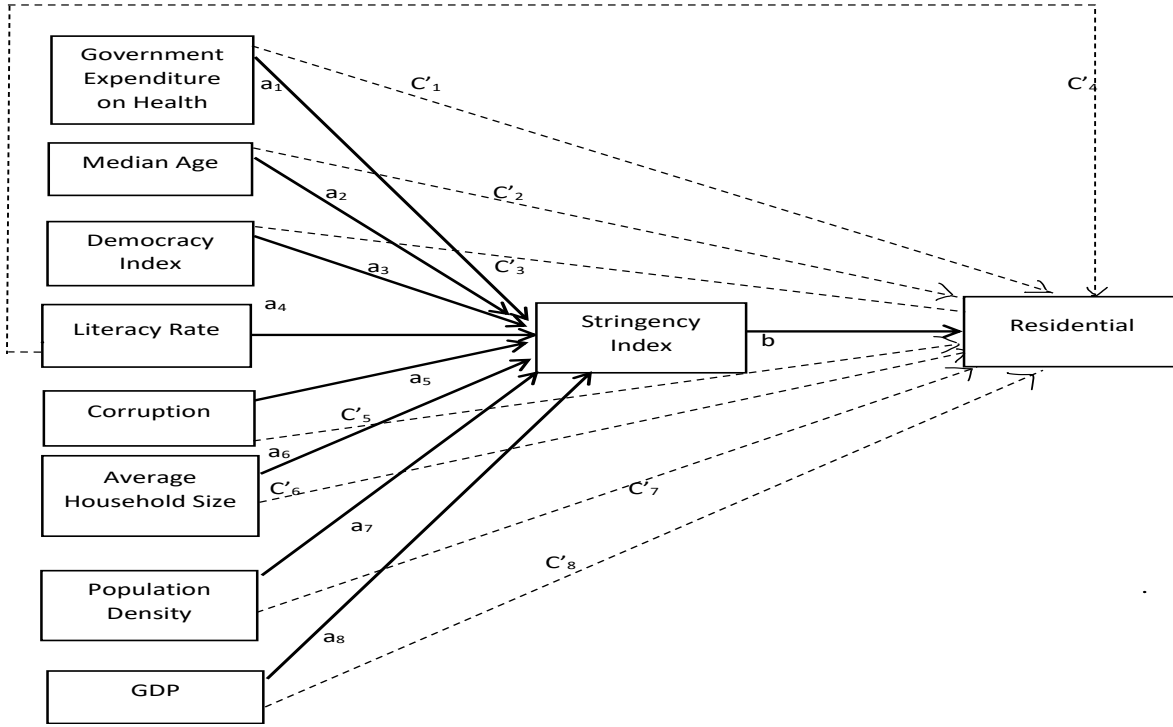


Figure 4: Path Diagram with the Direct and Indirect Effects

The path diagram shows the direct and indirect effects of literacy and other control variables on people's stay-at-home practice defined as residential in the analysis. *Solid arrows* represent indirect (mediating) effects whereas *dashed arrows* represent direct effects.

To look at the way in which citizens' literacy translates into different behavioural reactions to the pandemic outbreak, we first show the change in mobility patterns. Next, we estimate the effect of literacy in the degree of strictness of stay-at-home policies that leads to changes in mobility due to the outbreak using a structural equal modelling approach. Specifically, we estimate the following model as shown in the method section before

$$Stringency (M) = i_1 + a_1 \text{ Government Expenditure on Health} + a_2 \text{ Median Age} + a_3 \text{ Democracy Index} + a_4 \text{ Literacy Rate} + a_5 \text{ Corruption} + a_6 \text{ Average Household Size} + a_7 \text{ Population Density} + a_8 \text{ GDP}_{1000} + e \quad (3)$$

$$Residential (Y) = i_2 + c'_1 \text{ Government Expenditure on Health} + c'_2 \text{ Median Age} + c'_3 \text{ Democracy Index} + c'_4 \text{ Literacy Rate} + c'_5 \text{ Corruption} + c'_6 \text{ Average Household Size} + c'_7 \text{ Population Density} + c'_8 \text{ GDP}_{1000} + b \text{ Stringency} + e \quad (4)$$

Our main coefficients of interest are a_4 , the affect of literacy on stringency of government policies and c'_4 , the direct effect of literacy on residential mobility of people.

6. Results

We now turn our attention to the result of my analysis that may explain the variation both in social distancing behaviour and in the stringency of political policies aimed to stem the flow of COVID-19. Results from the estimations are presented in a graphical path diagrams (see figure 5) referring to the investigation this paper is doing. Now we discuss the model results by observing the relationships among the dependent, mediator and independent variables. Statistical results are also presented in Table (4,5,6,7,8,) in the appendix.

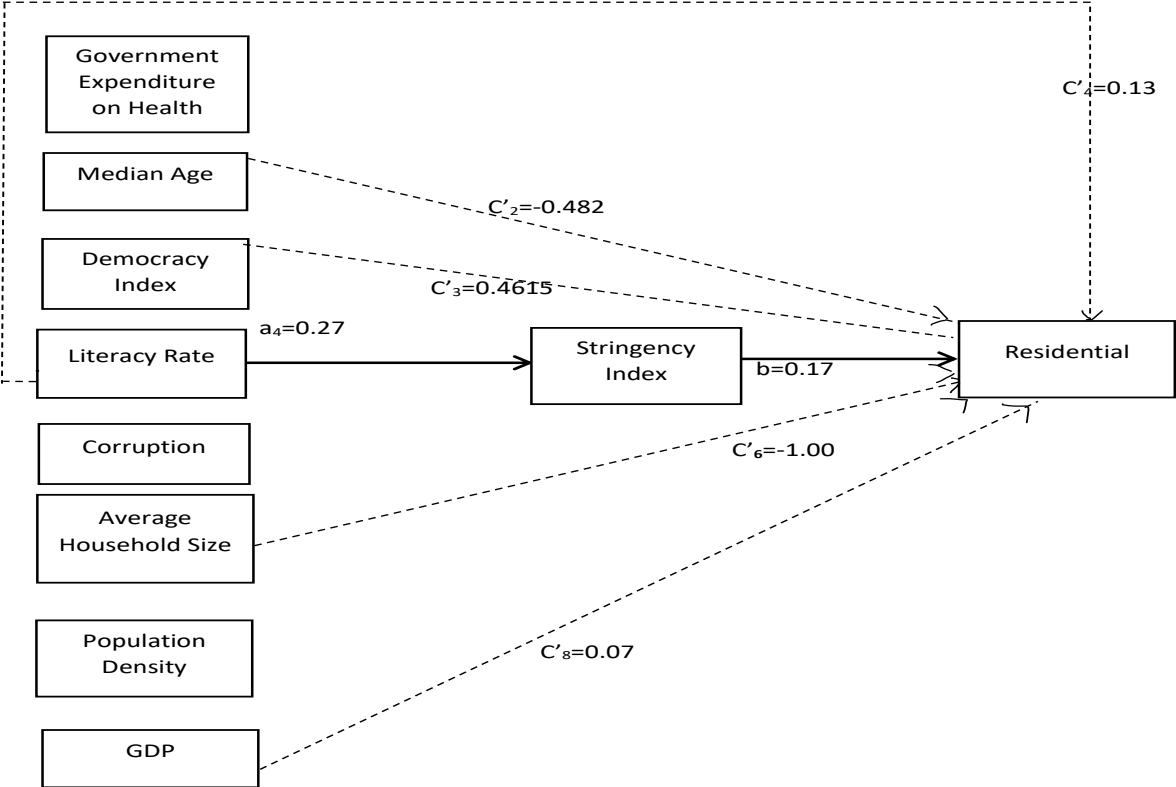


Figure 5: Significant Results of the mediation analysis

Literacy Rate: It is the main independent variable expected to affect the public policies and social distancing behaviour of people. The empirical result shows that one unit increase in literacy leads to an increase of 0.27 units in stringency index. This is the “a” effect from literacy rate to stringency index which is highly significant. This result answers the first question of our research regarding the association between literacy and strict lockdown policies to mitigate the transmission of COVID-19. This result lends support to my assumption that countries with higher literacy ends up with stricter “shelter-in-place” policies to reduce the transmission of COVID-19 as the result shows positive associations between literacy and government response stringency policies. This result goes in line with Olson’s theory which states that well organized

and well-informed groups will benefit on the costs of unorganized and ill-informed groups in the system of collective decision making. Literacy keeps people well-informed about the pandemic which motivates any state to impose restrictive policies to reduce infection. Well-aware people make it difficult for governments to impose less- restrictive policies (which is considered less efficient) that serves their interests but put cost on other people of the society.

To answer the second question, result shows that the indirect effect of literacy rate on residential is statistically different from zero ($ab=0.047$, with a 95% bootstrap confidence interval from 0.0211 to 0.0829). The mediating effect of government response stringency index is highly significant and is positively related with residential. This indirect effect may reflect a bona fide causal sequence of events in which higher literacy rate leads to higher stringency in political policies aimed at reducing COVID-19 transmission, which leads to higher social distancing practice among people. It shows that literacy rate indirectly affects people's social interaction practice, but its effect depends on government policies adopted to control the pandemic. The mediating effect of stringent policies is remarkable on individual preventive behaviour against COVID-19. Result shows that out of the total effect of literacy (direct+indirect) on residential mobility, the share of indirect effect of literacy through government stringent policy response on residential mobility is 26% . In other words, when literacy level is high, a high level of strict stay-at-home order and lockdown policies lead to more stay-at-home practice to reduce the infection. This result goes in line with Olson's theory of collective action and public goods and using this theory I argued that literacy increases peoples knowledge about the social cost of COVID-19 and thus increases their bargaining power to hold the governments accountable for policies regarding this pandemic that are not socially efficient. Also, the result proves that when people are well informed (caused by literacy) about the risk associated with the pandemic, it is difficult for governments to free ride on literate people by imposing policies of their interests that are not efficient (less stringent).

To answer the third question, result shows that literacy is directly and positively associated with residential mobility. Holding all other variables constant, one unit increase in literacy rate of a country significantly increases people's stay-at-home practice or social distancing behaviour by 0.13 unit in average which consequently reduces the risk of exposure to other individuals infected by the COVID-19 virus. The share of direct effect of literacy on residential mobility is 74% out of its total effect on residential mobility. This result proves the expectation that countries with higher literacy rate have higher social distancing behaviour among the citizens and thus have impact on the COVID-19 outbreak. The result is consistent with the claim that

higher literacy enhances people's self-isolating behaviour and thus directly affects their stay-at-home practice. This result reassures my expectation that literacy, by increasing knowledge and awareness about risk mitigation of COVID-19, enhances people's stay-at-home practice to lessen the spread of the infection and thus can help reducing COVID severity.

Government Response Stringency Index: This variable that measures the strictness of public policies aiming to control the pandemic is positively associated with residential mobility, the variable which measures people's stay at home practice. The empirical result shows that one unit of increase in the stringency index leads to an increase of 0.1712 unit in residential and the association is highly significant. This implies that strict lockdown measures (e.g. restriction on public gathering, workplace closing, and stay-at-home order) that entails people to stay at home to reduce their mobility significantly increases time spent near one's home and thus reduces the spread of the disease. This result further supports the expectation that strict stay-at-home orders and lockdown policies can remarkably reduce people's mobility from home and reduce the transmission of the COVID-19 infection which is why strict policies against COVID-19 are socially efficient measure to promote social wellbeing during this pandemic.

Government Expenditure on health: The association between government expenditure on health and stringency index is statistically insignificant. On the other hand, there is no direct association between government expenditure on health and residential. The indirect effect of government expenditure on health on residential is also statistically insignificant. These findings suggest that strict policy implication and preventive actions against COVID-19 are not influenced by expenditure on health but by other factors. Countries with lower government expenditure on health may create awareness among people that the state cannot handle an outbreak—or even that their own access to health care is not guaranteed which may lead to rapid and extensive self-isolation. The question of why we observe no relation between government expenditure on health and stay-at-home practice in societies is more difficult to understand. A potential reason for this could be that people in societies may not consider about the resource allocation in the health sector while deciding for engaging in social interactions.

Median Age: The direct association between median age and residential is significantly negative (-0.4282). This means that with one-year increase in median age of the population of a country, people's stay at home practice decreases by 0.4 unit. With a similar finding that shows younger respondents with the highest level of restricted movement, (Cvetković et al., 2020) suggests that this is probably because younger people's higher reception of messages from media and experts and the perception of greater penalties imposed. The social marginal benefit of

decreased activities that creates risk for transmitting COVID-19 are substantially greater as the health consequences of the transmission to others are much higher than in a market of young and healthy people (Boettke & Powell). On the other side, there is no association between median age and stringency index. Besides, there is no indirect effect of median age on residential through stringent policies. This could possibly mean that in the process of making collective decisions such as political policies to control COVID-19 pandemic, the median age of citizens is not taken into consideration.

Democracy Index: Results shows that the direct effect of democracy index on residential is significantly different from zero (0.4615). This could be because strict lockdown policies or the effectiveness of any policy does not depend on the democratic rights of the citizens rather it depends on the individual's and society's assets and capital such as income, resources, human capital. If we talk about individual's capital such as human capital, then this result supports my claim on the impact of literacy on political policies against COVID-19 since human capital is generated by literacy. It is emphasized by resource theory that assets of individuals, organizations, communities, and countries, more specifically invisible assets that include of not only individuals' networks and support, material wealth, and physical environments but also their knowledge and social capital, are the ones by which individuals can respond to infectious disease (Kim, Kim, & Health, 2020). On the other side, the association between democracy index and stringency index and the indirect association between democracy and residential is insignificant.

Corruption: This variable is included as a proxy of institutional trust. When there is an increase in corruption, there is a decrease in trust and residential (stay-at-home practice). The flip side of this argument is that lower corruption entails higher trust in the society resulting in higher stay-at-home practice. Policy compliance is higher with higher level of trust which reduces transaction cost in coordinating responses to problems at the state level (Chan et al., 2020). However, my result shows that the direct and indirect effect of corruption is not significant on residential. This implies that institutional trust does not affect preventive behaviour of people. There is no substantial association between corruption and government response stringency. This means trust does not significantly affect policies against COVID.

Average household size: Result shows that the direct effect of average household size on residential is significantly negative (-1.0075) implying that people in countries with larger average household size stay less at home in response to the COVID outbreak. A potential

implication of this could be that people's willingness to stay at home is lesser in larger household size. The indirect effect of average household size on residential through stringency is statistically insignificant. Average household size is not significantly associated with stringency index either.

Population Density: Empirical result shows that the effect of population density on stringency index is not significant but the indirect effect through stringency is highly significant although the effect is very little (0.0001). This means population density does not solely affect strict policies and stay-at-home practice. The relation between population density and residential is not that significant which might mean population density does not affect formulation of strict lockdown policies against COVID-19.

GDP per Capita/1000: The direct effect of GDP per capita on residential is significant and it is positively associated with residential (0.0706). It means that a 1000 unit increase in GDP per capita can increase the stay-at-home practice by 0.0706 unit. Countries with higher GDP per capita have affordability to attain resources to fight against the pandemic which people can easily excess (Kim, Kim, & Health, 2020). It is probably for this reason people feel secure to maintain preventive behaviour against COVID in countries with higher GDP per capita. With a positive correlation with literacy (0.2766405) this could also mean that countries with higher GDP per capita have higher literacy. Therefore, citizens in higher GDP per capita countries are aware of the importance of social distancing to reduce the spread of COVID-19. Higher GDP per capita shows higher resources of a country to battle against COVID-19. People from higher income households are less likely to have an increased risk of illness from COVID-19 than people from lower income households (Raifman & Raifman, 2020). However, my result shows that GDP per capita does not have significant effect on stringency index which means that the economic status of a country does not affect the political policies against COVID. This could also mean that countries with higher GDP per capita have adequate resources to deal with the disease outbreak for which they don't want to put strict lockdown policies. The indirect effect of GDP per capita on residential is also not significant which implies the same possible explanation.

7. Discussion and Conclusion:

Given the massive externalities that are created when individuals ignore social distancing guidelines, there is a compelling circumstance for strict government regulations of such behaviour to stem the flow of COVID-19. This paper investigates the causal effect of restrictive

stay-at-home orders on social distancing trend of people for countries with different socio-economic standards, such as literacy and affiliations since social distancing is inevitable to reduce the transmission of the infection. Whether and how public comply with government decisions is crucial to understand for policy makers, health officials, economists and other public authorities to be able to come up with appropriate policies to combat the COVID-19 pandemic and associated negative externalities (Brodeur, Grigoryeva, & Kattan, 2020). The purpose of this study was to examine the double effect of literacy, direct and indirect, on citizen's social distancing behaviour that can be caused mostly by restrictive political policies and by voluntary actions aimed to mitigate the COVID-19 pandemic. The empirical result of this study shows that literacy positively affects both formulation of strict stay-at-home orders and lockdown policies and stay-at-home practise of people that helps reducing the transmission of COVID-19. The direct and indirect effect of literacy on social distancing behaviour is remarkably significant which proved my hypothesis that countries with higher literacy shows stricter lock down policies and higher preventive behaviour during this COVID-19 pandemic. These results provide a broader understanding of how nations with different literacy levels and different government policies are doing in terms of reducing COVID-19 severity to establish social welfare. Besides, these results emphasize the need to pay more attention to achieve overall literacy to be able to eradicate COVID-19 pandemic in the long run.

Literacy is fundamental for development and growth as it enables humans to achieve overall welfare, from reducing health risk to imposing optimal public policies. Results from my analysis shows that, countries should focus on the role of literacy to reduce the spread of the disease and overcome the unprecedented challenges imposed by this deadly virus. The role of awareness that can be generated by literacy is vital especially in the context of infectious disease outbreak like COVID-19. Literacy in a time of infectious disease outbreak like COVID-19 increases people's willingness to reduce mobility and transmission to ensure overall welfare of the society. Besides, governments tend to make policies to promote overall welfare of the society when citizens are aware of the cost and benefits of those policies since literate people can hold the governments accountable for any political market failure. Besides, literacy will not only help reduce the spread of COVID-19, but also for any emergency in the present and future, be it economic, environmental, public health, or public administration related. Literacy of people thus helps a state to effectively overcome any challenge and works as an effective tool for achieving long run development goals.

In addition, illiteracy is particularly problematic in developing countries, and therefore requires special attention. Due to lack of awareness caused by illiteracy, people will not take the risk of the pandemic seriously and therefore will not follow preventive measures like social distancing which will lead to huge increase in the severity of the disease. The situation can get even worse, particularly in developing countries because they have comparatively poor access to hospital beds and oxygen tanks, and both rural and urban health systems will get overwhelmed much faster just like the case in India. To avoid the devastation that India is currently experiencing, it is very important to educate and aware people about the externalities and social cost of this airborne disease to increase their willingness to take preventive measures like social distancing to reduce the disease outcomes and avoid massive pressure in the healthcare system. Widespread vaccination coverage is still months away in many countries, so our best line of defence remains preventative strategies, like social distancing and strict policies that ensures social distancing among people to stem the flow of COVID-19. The key suggestion of this paper is to provide support for better education to get better health outcomes, and to support political party development and the development of political institutions by achieving overall literacy of the people of a society as the political policies are collective action of the groups of a society. This is challenging though especially in the developing countries, but my study proves that until overall literacy is achieved, it is very difficult to overcome any economic, social, or public health related threat like COVID-19.

My study has some limitations that can be addressed at future research. First, due to time limit of my master's thesis, I had to limit the length of my data from March 2020 till December 2020. It does not cover the very recent data of the variables affecting the pandemic. Second, it is difficult to conduct international studies because of the differences in the standard of the quality of the data in different national context that may not provide the exact picture of certain situation.

Although my analysis suggests that literacy, strict lockdown policies and social distancing are inevitable to stem the flow of COVID-19, there are things to be considered for future research that was out of scope for my research. Many countries especially in the developing ones, “lockdowns put livelihoods at risk through job loss, increased household expenditures, rising prices and limited availability of consumption goods to meet basic needs and people who earn their living in the informal economy and lack resources to store food must leave their homes regularly to maintain a daily food supply and may need to disobey quarantine orders, depressing the effectiveness of lockdowns in stemming disease spread” (Bosancianu, 2020). Therefore,

strict lockdown measures may not be the best solution in the long run. Besides, stay-at-home orders have been shown to increase domestic violence incidents, mental health distress and the unemployment rate (Béland, Brodeur, & Wright, 2020; Brodeur, Clark, Fleche, & Powdthavee, 2021; Leslie & Wilson, 2020) which makes it difficult to continue these policies for a long period of time. COVID-19 pandemic has also affected the learning process of 91 percent of students of all age worldwide due to the lockdown measures taken in most of the countries that may jeopardize hard won gains made in improving global education (UN). Therefore, we need to form broader coalitions to be maximally effective and find a cost-effective way to ensure overall literacy in all societies if we want to reduce not only the risk of the present COVID-19 pandemic but also any upcoming threat for the economy in future. We need to come up with more innovative solutions until we get 100% effective vaccines for all variants of COVID-19 and until all people get vaccinated. Nevertheless, literacy helps in overcoming any developmental threats. Also, restrictive governmental policies are proved to be effective up until now given the clear externalities caused by social interactions. Therefore, we do not have any better option up till now than imposing strict stay-at-home orders and lockdown policies and promote literacy to stem the flow of COVID-19

Last but not the least, further research can be done on the impact of literacy on vaccination intake across countries especially in the developing ones. Literacy not only helps mitigating the disease transmission by ensuring strict policies and social distancing behaviour but also may help in ensuring the overall intake of vaccinations. Due to lack of awareness, many people, despite of having access to vaccinations, are not willing to take vaccination. This will leave some people in the society un-vaccinated. Vaccinations will not work properly if overall intake of vaccination is not ensured. Literacy can increase awareness about the importance of taking vaccination and thus may increase willingness of taking vaccination among people which consequently can eradicate the noble coronavirus from the world.

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Appendix

Table 2: Defining Literacy (Source: UNESCO)

International Organization	Defining Literacy	Note
European Literacy Policy Network: European Declaration of the Right to Literacy	Literacy refers to the ability to read and write at a level whereby individuals can effectively understand and use written communication in all media (print or electronic), including digital literacy	A multi-layered definition of literacy, from baseline literacy to functional and multiple literacy
OECD: Survey of Adult Skills (PIAAC)	Literacy is understanding, evaluating, using, and engaging with written text to participate in the society, to achieve one's goals and to develop one's knowledge and potential.	It measures adult's proficiency in key information-processing skills – literacy, numeracy, and problem solving in technology-rich environments
World Bank: Skills towards Employability and Productivity (STEP)	Cognitive skills are defined as the “ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought”	<ol style="list-style-type: none"> 1. It assesses the skills (cognitive, technical, and non-cognitive) of adults in urban areas. 2. The scales of the test are the same as those used in the PIAAC

Table 3: Sample of Data

Rstudio Code:

```
#The following package has been used to run the analysis
install.packages('psych')
install.packages('psychTools')
library(psych)

library(psychTools)

#Importing the data

Final_Data <- read_excel("C:/Users/Bruker/Downloads/OneDrive/Courses/Final Thesis/Data
File/Final Data.xlsx")

#Converting the data into numerics

is.factor(Final_Data$govt_exp_health)

Final_Data$govt_exp_health<- as.numeric(Final_Data$govt_exp_health)

is.numeric(Final_Data$govt_exp_health)

Final_Data$Corruption<- as.numeric(Final_Data$Corruption)

is.numeric(Final_Data$Corruption)

is.factor(Final_Data$Country)

Final_Data$Country<- as.factor(Final_Data$Country)

is.factor(Final_Data$Country)

Final_Data$median_age<- as.numeric(Final_Data$median_age)

is.numeric(Final_Data$median_age)

Final_Data$dem_index<- as.numeric(Final_Data$dem_index)

is.numeric(Final_Data$dem_index)

Final_Data$literacy_rate<- as.numeric(Final_Data$literacy_rate)

is.numeric(Final_Data$literacy_rate)

Final_Data$avrg_hh_size<- as.numeric(Final_Data$avrg_hh_size)

is.numeric(Final_Data$avrg_hh_size)
```

```

Final_Data$population_density<- as.numeric(Final_Data$population_density)

is.numeric(Final_Data$population_density)

Final_Data$gdp_100<- as.numeric(Final_Data$gdp_100)

is.numeric(Final_Data$gdp_1000)

Final_Data$residential<- as.numeric(Final_Data$residential)

is.numeric(Final_Data$residential)

Final_Data$stringency_index<- as.numeric(Final_Data$stringency_index)

is.numeric(Final_Data$stringency_index)

is.data.frame(Final_Data)

#Descriptive statistics of the data

psych::describe(Final_Data)

summary(Final_Data)

# Correlation between gdp per capita/1000 and literacy rate

cor.test(Final_Data$gdp_1000, Final_Data$literacy_rate)

# Psych code for the mediation analysis

mod6.2 <-
mediate(residential~govt_exp_health+median_age+dem_index+literacy_rate+Corruption+avr
g_hh_size+population_density+gdp_1000+(stringency_index), data = Final_Data, n.iter =
5000)

# Summary of the result

summary(mod6.2,digits=4,signif=TRUE)

```

Rstudio Result:

```

mod6.2 <-
mediate(residential~govt_exp_health+median_age+dem_index+literacy_rate+Corruption+avr
g_hh_size+population_density+gdp_1000+(stringency_index), data = Final_Data, n.iter =
5000)

```

> summary(mod6.2,digits=4,signif=TRUE)

Call: mediate(y = residential ~ govt_exp_health + median_age + dem_index + literacy_rate + Corruption + avrg_hh_size + population_density + gdp_1000 + (stringency_index), data = Final_Data, n.iter = 5000)

Table 4: Direct effect estimates (traditional regression) (c')

	residential	se	t	df	prob
Intercept	11.014	2.9135	3.7803	178	2.14E-04
govt_exp_health	0	0.0002	0.1388	178	8.90E-01
median_age	-0.4282	0.0513	-8.3437	178	1.93E-14
dem_index	0.4615	0.1445	3.193	178	1.67E-03
literacy_rate	0.1331	0.0178	7.495	178	3.00E-12
Corruption	-0.0339	0.0192	-1.769	178	7.86E-02
avrg_hh_size	-1.0075	0.2973	-3.389	178	8.64E-04
population_density	0.0003	0.0002	1.9584	178	5.17E-02
gdp_1000	0.0706	0.0162	4.351	178	2.28E-05
stringency_index	0.1712	0.0189	9.0499	178	2.46E-16

R = 0.7943 R2 = 0.6309 F = 33.8125 on 9 and 178 DF p-value: 3.7684e-34

Table 5: Total effect estimates (c)

	residential	se	t	df	Prob
Intercept	23.9434	3.0596	7.8256	179	4.24E-13
govt_exp_health	-0.0001	0.0002	-0.4198	179	6.75E-01
median_age	-0.4831	0.0614	-7.8668	179	3.32E-13
dem_index	0.3246	0.1732	1.8739	179	6.26E-02
literacy_rate	0.1801	0.0205	8.8042	179	1.11E-15
Corruption	-0.0592	0.0229	-2.5902	179	1.04E-02
avrg_hh_size	-1.2141	0.3571	-3.3994	179	8.33E-04
population_density	0.0004	0.0002	1.9533	179	5.23E-02
gdp_1000	0.0648	0.0195	3.3168	179	1.10E-03

Table 6: 'a' effect estimates

	stringency_index	se	t	df	prob
Intercept	75.5331	10.0338	7.5278	179	2.44E-12
govt_exp_health	-0.0007	0.0008	-0.9536	179	3.42E-01
median_age	-0.3206	0.2014	-1.5919	179	1.13E-01
dem_index	-0.8	0.568	-1.4084	179	1.61E-01
literacy_rate	0.2747	0.0671	4.0959	179	6.36E-05

Corruption	-0.1478	0.075	-1.9707	179	5.03E-02
avrg_hh_size	-1.2072	1.1712	-1.0307	179	3.04E-01
population_density	0.0003	0.0006	0.5815	179	5.62E-01
gdp_1000	-0.0339	0.0641	-0.5289	179	5.98E-01

Table 7: 'b' effect estimates

	residential	se	t	df	prob
stringency_index	0.1712	0.0189	9.0753	179	2.03E-16

Table 8: 'ab' effect estimates (through mediators)

	residential	boot	sd	lower	upper
govt_exp_health	-0.0001	-0.0001	0.0002	-0.0005	0.0003
median_age	-0.0549	-0.0579	0.052	-0.1647	0.0348
dem_index	-0.1369	-0.1433	0.1463	-0.4436	0.133
literacy_rate	0.047	0.0481	0.0159	0.0214	0.0828
Corruption	-0.0253	-0.0248	0.0194	-0.0656	0.0115
avrg_hh_size	-0.2066	-0.2408	0.3531	-0.9402	0.3472
population_density	0.0001	0.0001	0.0002	-0.0002	0.0005
gdp_1000	-0.0058	-0.0065	0.0108	-0.03	0.013