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ARTICLE

# INTRODUCTION: ECONOMIC CONTRIBUTIONS TO INFECTION CONTROL

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The COVID-19 crisis has upended the lives of many, causing almost 200M global infections to date, over 4M deaths and untold damage to the livelihoods of millions. Although the recent vaccine rollout in some parts of the world offers some room for optimism, the epidemic is still far from defeated and many in the developing world are still at significant risk of infection.

The nature of the crisis, ostensibly one related to public health, has proved to be multi-pronged, with economic and social behaviour, public health policy and economic policy closely intertwined and both reacting to and conditioning the future path of the epidemic. The policy challenged posed by the epidemic were well articulated by Chadha (2021).

The severity and characteristics of COVID-19 have meant that people have spontaneously and voluntarily changed how they work, shop and socialise. In turn, these decisions have had severe social and economic consequences, with many businesses struggling to stay afloat in an environment where customers have feared and avoided crowded spaces such as retail, hospitality and public transport. As expected, most governments have sought to actively intervene and cushion people and businesses against the worst fallout from the epidemic. Yet, many governments have struggled to understand who to ask for advice and even to formulate the kind of expertise needed to navigate the crisis.

As a point in case, the government of the UK has been advised primarily by three different sets of experts, namely the Scientific Pandemic Influenza Group on Modelling (SPI-M), the Scientific Pandemic Insights Group on Behaviours (SPI-B) and HM Treasury, respectively. SPI-M, a subgroup of Scientific Advisory Group for Emergencies (SAGE) consisting of technical epidemiologists and modelling experts, have provided forecasting and decision support to the government by considering and simulating different possible scenarios, based on complicated mathematical models of the epidemic. Notably, the models considered by SPI-M are largely mechanistic, non-behavioural models that do not take individual behaviour into account. In addition, the remit of SPI-M explicitly disregarded the effects of different public health measures, such as social distancing and lockdowns on the overall economy. In fact, it appears that economic considerations were specifically disregarded in advice formulated by SPI-M.

SPI-B, another subgroup of SAGE, was tasked with considering the behavioural aspects of the crisis. Consisting primarily of behavioural scientists and psychologists, this group considered how different policy measures would likely be received by the public and how different policy interventions should be presented. Although grounded in empirical and theoretical work in behavioural sciences, the advice given by SPI-B appears not to have been directly integrated into the epidemic modelling carried out by SPI-M but rather was considered by decision makers alongside the modelling advice. In addition, SPI-B was not tasked with determining the aggregate consequences of behaviour on either the path of the epidemic nor on the likely impact of behaviour change on the macroeconomy.

Last, economists working at HM Treasury were tasked with looking after the economy. Reportedly, the Treasury has scarce direct import from either SPI-M or SPI-B and thus treated the epidemic as

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something 'exogenous' to the economy, that is, as something that influences the economy but that is otherwise separate from the economy. This seems to have led the Treasury to design economic policies without an eye on the likely spillover effects of such policies on the overall effort to control the epidemic through public health measures. The apparent tension between different parts of government, exemplified by public statements from the then Minister of Health Matt Hancock and the Chancellor of the Exchequer, Rishi Sunak, have further strengthened the impression of a decision-making process in which 'all bases' seemed to be covered in terms of scientific expertise, yet the structure of the process has created silos of knowledge that have made a proper holistic approach to managing the crisis difficult to achieve.

What then, would such a holistic and interdisciplinary approach to the crisis have contributed to the formulation of policy? There are several key insights, all central to the interdisciplinary field of economic epidemiology that would have contributed to better decision-making.

(a) In important respects, infectious disease epidemiology and public health are closer to the social sciences than to cognate fields such as biology and medical sciences. This is because disease spread in human populations depends on people's decisions in addition to the biomedical properties of the disease. This means that in order to understand and predict the spread of the disease, modellers need to understand both how individuals make decisions (and their incentives to act in the way they do) and how such individual decisions interact with those of others. In addition to yield better predictions of how the disease spreads, understanding behaviour and incentives is fundamental for formulating policy. For if policy makers do not understand how different interventions are likely to change behaviour, on what basis can policy be formulated in the first place? Forecasting, impact studies and best practice cannot be replaced by good intentions and wishful thinking.

(b) As explained above, the characteristics of COVID-19 and the initial lack of pharmaceutical products such as vaccines and antivirals meant that governments have largely depended on non-pharmaceutical interventions that modify or directly control behaviour and contact patters in the population. Together with spontaneous changes in behaviour, this has meant that the COVID-19 crisis has not been confined to merely one of health but has indeed had profound repercussions on social and economic life. For that reason, economic and public health policies must be considered in tandem with a view to achieving desirable outcomes overall. In other words, public health measures must be recognised to have economic impact and economic policies, such as furlough schemes, statutory sick pay and support for self-isolation must be thought of as measures that directly support public health measures designed to control the spread of the disease. In practice, both sets of policies seem to have been formulated in isolation and only been considered together once they reached the PM's desk.

(c) Next, not all public health measures are equally desirable and the composition of desirable measures may change across the stages of the epidemic. For example, it is possible (and even likely) that an effective test-trace-isolate infrastructure at low levels of disease prevalence in the population can obviate more intrusive and damaging lockdown measures that will be necessary at higher levels of disease prevalence. In order to better understand the trade-offs involved in economic–epidemic policy making and to aid in the systematic search for good policies, an integrated analytical framework for decision-making and policy formulation is needed. Fortuitously, many of the ideas necessary for building such a framework already exist in the form of economic epidemiology, as will be outlined below.

(d) Last, in order to formulate policy and to communicate this to the public, decisions should ideally be formulated with the aid of a fully dynamic, economic–epidemic cost-benefit analysis. Government policy making is routinely submitted to the discipline of cost-benefit analysis, with robust and theoretically underpinned principles outlined in the so-called Green Book (ref). The Green Book contains a number of principles that are key to ascertaining different policy interventions, such as how to deal with illness, mortality, long time horizons, uncertainty, and

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> so forth. The lack of a credible cost-benefit analysis has not only hampered effective government decision-making and policy formulation. It has also created unhelpful and unnecessary social tension between different stakeholders such as groups at risk of serious illness from infection on the one hand and business owners and the self-employed on the other. With a clear and transparent cost-benefit analysis, the rationale for different interventions could have been more easily expressed and communicated. Supplemented with a properly thought-out set of economic support schemes designed to provide correct incentives to reinforce public health measures, such an analysis may have gone some way to create a sense of common purpose during difficult times.

Common for all these insights is that they rely on complicated two-way interactions between disease dynamics and economic dynamics. In addition, they rely on how people's incentives change behaviour and on how policy interventions change trade-offs and therefore can be expected to lead to different outcomes, epidemiological as well as economic. Economists working in the field of economic epidemiology (or the economics of infectious diseases) specialise in exactly this type of interactions. As is commonplace in economic modelling, economic epidemiologists explicitly consider individual behaviour and decision-making in formal models of disease propagation akin to the mechanistic models studied by researchers at SPI-M. But rather than looking at non-modelled behaviour and relying on behavioural insights in parallel to the modelling as is done by researchers at SPI-B, economists make the behaviour an integral part of the formal modelling. They do so by using a combination of techniques, including decision theory, game theory and different techniques from dynamic optimisation (such as dynamic programming and optimal control theory). In addition, economists use techniques borrowed from other domains of economics to inform public health policies themselves, such as the optimal design and use of test-trace-isolate, lockdowns, mass testing, and so forth. Notably, by doing so economists directly inform public health policies and not merely the economic consequences of such policies. And by doing so, they also are ideally placed to think about how different economic policies help or hinder the implementation of said public health measures.

In addition to using economic ideas to inform public health policies, economists have also been very actively involved in the empirical study of the epidemic, including in the assessment of the effects of different policies to control the spread of the disease and in determining the role of voluntary behaviour changes and mandated restrictions to activity in causing economic damage. Because economists have developed empirical techniques tailor made to understand data that concern itself with behaviour and policy interventions, they have found fruitful application in understanding policy and behaviour during the epidemic.

This special issue contains a number of papers that showcase the aforementioned approach, which were presented at the workshop *What Can Economics and Epidemiology Learn From Each Other?*, held on 12 February 2021 and hosted by the National Institute for Economic and Social Research. The papers, from leading experts in the field, contain a range of methodological approaches to topical questions in economic epidemiology and are good examples of the type of insights that the field can contribute to the policy debate.

The papers contain analyses of all the main policy issues surrounding the epidemic, including voluntary behaviour change, lockdown policies, testing and vaccination. In addition, the volume contains both theoretical work as well as empirical investigations.

Since the beginning of the COVID-19 pandemic, a continuous challenge has been how to make sense of the huge volumes of data on infections, hospitalisations and deaths, as well as policy measures employed to combat the virus, which has become available on a daily basis for most countries of the world. It is only by doing so that we can evaluate the policies which have been designed to combat the virus. The dominant statistical approach adopted by most countries has been to use the existing statistical models of epidemiology. The paper by Dolton in this issue reviews alternative statistical modelling approaches and compares them providing examples of the alternative contribution from applied econometrics. The review begins by answering the question of why we need to model this worldwide

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pandemic and its separate epidemics in each country. It poses basic questions about the nature of the data we have and how it is measured and why this throws up additional modelling challenges for the applied statistician. A basic taxonomy on the structure of the different models which have been used in conjunction with this data is suggested and the complex modelling dynamics involved is discussed. The economist's distinctive focus on the thorny problem of the endogeneity of the impact measures designed to combat the pandemic and the behaviour is individuals in the population is discussed. The data on the various non-pharmaceutical interventions which have been used across different countries is explained in this context. The simple taxonomy of different modelling approaches and their characteristics permit a review of their relative strengths and limitations. The paper also provides a framework for assessing the possible policy implications of different modelling strategies for data collection and impact evaluation.

In a paper published last year in the Harvard Data Science Review, Andrew Harvey and Paul Kattuman developed a new class of classical time series models that could be used to track the progress of an epidemic by making nowcasts of the growth rate of new cases and the corresponding value of the instantaneous reproduction number, R. The model is also able to make short-term forecasts of key variables. Since the beginning of 2021, they have, together with Craig Thamotheram of NIESR, published a regular tracker of new cases of COVID-19 and deaths from COVID-19 on the NIESR website. Andrew Harvey's paper in this volume extends the univariate model to handle the relationship between two or more series. He shows how daily figures on COVID-19 in Italy in spring 2020 are an excellent leading indicator for the UK and how new cases in the Florida second wave of summer 2020 provide good predictions of deaths several weeks ahead. He then goes on to explain how the multivariate time series framework can be used as the basis for policy evaluation by making use of control groups. This approach is used to investigate the consequences of Sweden's soft lockdown policy in the spring of 2020.

The global vaccine rollout was one of the largest and most far-reaching pharmaceutical public health interventions in history. Auld and Toxvaerd carefully characterise the early stages of the vaccine rollout for a group of 120 countries, relating the speed of vaccination with income and measures of epidemic severity. They find that vaccination did occur faster in countries with more severe epidemics, but also that this correlation disappears once income is held constant, and income strongly predicts the speed of vaccination even conditional on epidemic severity. They then show that as vaccines were rolled out, social distancing and policy restrictions both decreased in response.

The paper by Adriani and Ladley considers contagion and containment within the context of a network formation game. While agents are endowed with an exogenous social structure (their network of friends, family, colleagues and acquaintances), only part of this structure will typically be relevant during an outbreak, depending on the agents' social distancing choices. In their framework, agents choose to socially distance by making some of their links inactive. The focus of the analysis is to study how containment policies (e.g. test and trace) interact with social distancing and contributes to shaping the social structure through which the disease may spread. A central message of the paper is that containment may crowd out private efforts at social distancing, potentially leading to increased infection rates. The extent to which this may happen, however, depends on a number of factors, such as agents' risk perceptions or the speed of the intervention.

In his paper, Galanis examines how the intervention of group testing can alter behaviour and induce social distancing. A group is tested by mixing the samples of all members, so that a positive test means that at least one member is positive, whereas a negative test implies that everyone is negative. Crucially, the identity of the positive cases cannot be revealed. Galanis argues that for groups that are in close social proximity, the uncertainty about who has the virus after a positive group is announced will induce members to rationally choose not to meet. A group is defined to be in close social proximity if their total welfare decreases by meeting, when at least one member is infectious. This can happen either because members care about the welfare of their fellow members, or because meeting in the presence of an infectious member raises the likelihood that they will get infected.

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