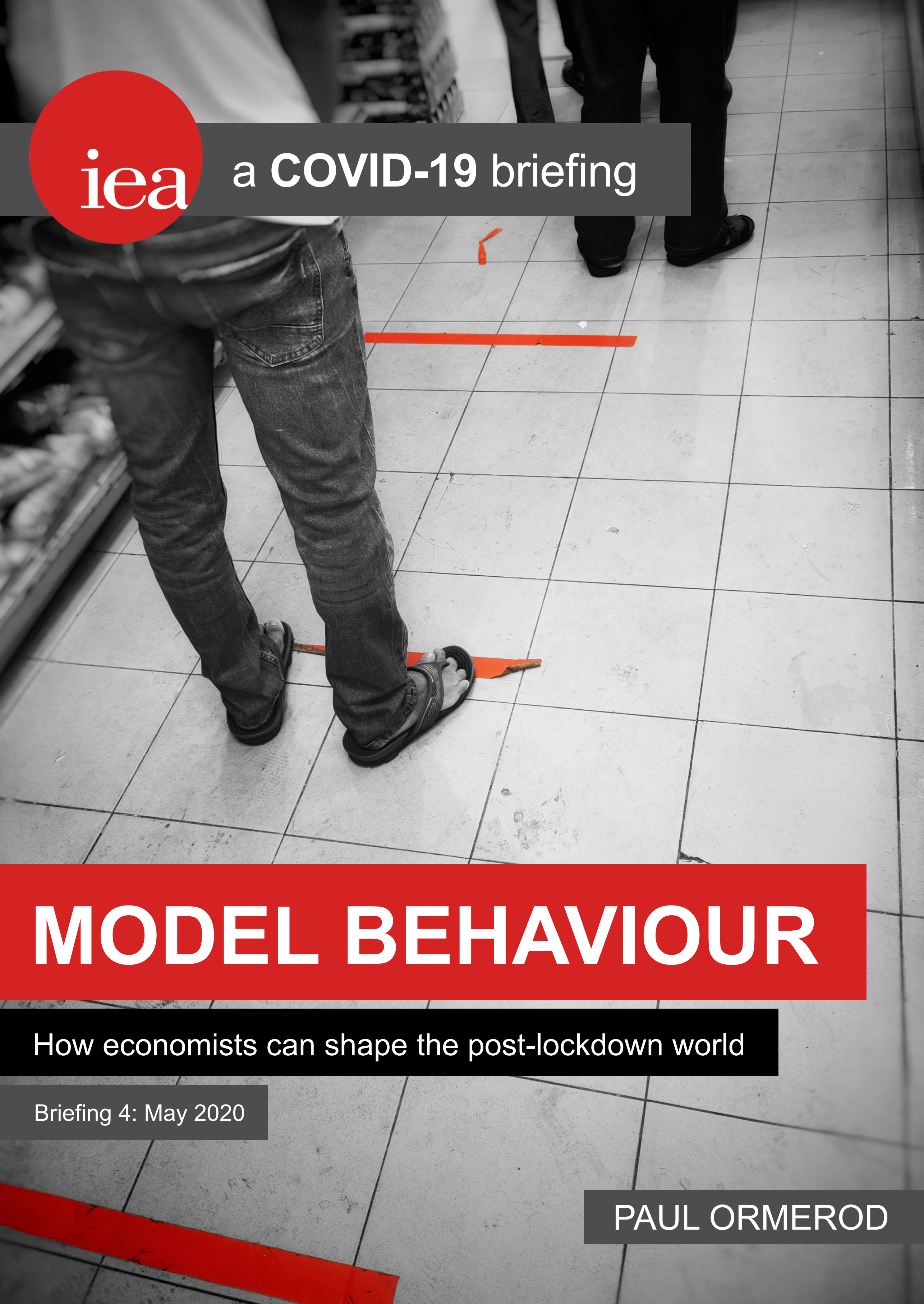

a **COVID-19** briefing

MODEL BEHAVIOUR

How economists can shape the post-lockdown world

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About the author

Paul Ormerod is an economist, author and entrepreneur, and is currently also a Visiting Professor of Computer Science at University College London. He has written four best-selling books on economics, including *Why Most Things Fail*, which developed extensive parallels between economics and evolutionary theory. Paul published an IEA monograph in 2005, *Crime: Economic Incentives and Social Networks*, in which he combined the core model of epidemiology with key insights from economic theory to understand how crime rates change. He has collaborated with people from a wide range of disciplines such as physics, computer science, anthropology, sociology and history and has published in an equally wide range of academic journals. Paul originally read economics at Cambridge and did the MPhil in economics at Oxford, where he specialised in econometrics.

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Summary

- The seminal work on epidemiological models was carried out in the late 1920s and early 1930s. The models have developed substantially since then, but their key drivers are still essentially those discovered nearly a century ago.
- Epidemiological models do have real scientific value. But any forecast made with them must rely on assumptions about the way in which people behave. A crucial one is the extent to which people who are susceptible to any given infectious disease mix socially with people who are already infected. The greater the mixing, the more people who will catch the disease.
- Epidemiology is about the process by which a disease spreads, for any given set of behaviours. It is not about understanding how behaviour might be changed so that it is different in the future to the past.
- Economists, along with other social scientists, have expertise in analysing how people change their behaviour when either incentives change or the set of information which they have changes.
- Economists have been conspicuous by their absence from the policy debate over the easing and ultimate ending of lockdown. Yet whether a second wave of Covid-19 occurs, for example, depends crucially on assumptions which are made about how people will behave. Economists should become much more active in this area.

Introduction

The current Covid-19 crisis is the most serious the West has faced since World War II. Economists have had plenty to say about its impact on GDP, and what finance ministers or central banks either have done or ought to do. This fits in with the popular perception of economics. In the media, it is about the big picture stories such as GDP, unemployment, inflation and the stock market. Talking heads from the City proliferate on news bulletins and current affairs programmes.

These factors are grouped within economics under the heading of 'macro'. But in essence economics is about 'micro'. It is about how people, firms, governments and the like behave. The economic theory of behaviour is the main topic in textbooks for students. At the same time, it is the area in which the majority of Nobel prizes have been awarded, for pushing out the frontiers of our knowledge of how people behave.

The focus of the mathematical models of epidemiology is on how any particular disease might spread. They can make assumptions about what happens under different scenarios of how people behave. They do not purport to explain how such scenarios might be brought about or how behavioural change can be induced.

It is behaviour which is the key to easing out of the current lockdown. Economics has a valuable contribution to make to this. But the bulk of the economics profession has been strangely silent.

For example, the European Economic Association (EEA) has set up a register of projects related to the current pandemic.[1] As of 17 April, over

1 https://www.eeassoc.org/index.php?site=JEEA&page=298&trsz=299

80 projects are listed. Only four describe their field of enquiry as being 'behavioural'. From the abstracts, there is a total of around ten whose focus could possibly be thought of as being behavioural. None of these involved British economists.[2]

2 I have written a technical paper for anyone interested (Ormerod et al. 2020). We combine the central insight of economics, that agents respond to changes in incentives, with a standard SIR model of epidemiology. We show that introducing endogenous behaviour by 'susceptibles' (see below) into a standard SIR model influences the solution paths of the models in ways which are highly relevant to current policy debates over the release of lockdown. We look at three scenarios and their impact on a future virus reappearing. For instance, if people adjust their behaviour based on the information contained in infection rates, the proportion of the population which eventually gets the virus is reduced substantially and the peak infection rate is reduced to about one-third of that reached with no behavioural response.

Epidemiological models

It is useful to delve into the mathematical epidemiological models which are being employed to analyse the spread of the virus and to make predictions of the number of new cases.

The mathematical models of epidemiology have long been a quiet byway of scientific research. As it happens, I have a longstanding interest in them, using their analytical framework to develop a model of crime in the mid-2000s for the then Home Secretary (Ormerod et al. 2003) and featuring a range of results based on their approach in an economics book (Ormerod 1998). But outside their immediate sphere, few have shown much interest in the models of epidemiology. Now they occupy centre stage in policy making.

These models have real scientific value. They have already had a major positive impact on policy making. But the results obtained from them do not have the same scientific status as, say, the results from physics. The mere fact that they are set down in mathematical formulations which are incomprehensible to the layperson should not blind us to this fact. The theoretical models of economics are at a similar level of mathematical difficulty and abstraction, arguably even more so.[3] But even the most ardent economist would not claim that their results have the same status as the laws of physics.

The general approach is shared across different models. The principles were first worked out by two Scottish scientists, Kermack and McKendrick, as long ago as 1927 (Kermack and McKendrick 1927; 1932; 1933). This abstract model remains the basis of our modern understanding.

3 As an illustration see Neumann (1945), one of the earliest proofs of existence in general equilibrium theory, the core model of economics.

They proposed that people at any point in time are in one of three conceptual states. The first defines those who are susceptible to any particular virus. The next category is those who are infected. The final one is ‘removed’. This could mean genuinely recovered or dead, but at any rate, no longer susceptible.

Kermack and McKendrick set up three non-linear differential equations to describe how a virus might spread. The equations describe how movements take place from one state to another.

Their apparent simplicity disguises substantial complexity. From the names of the categories, it is known as the SIR model – susceptible, infected, recovered. It does, incidentally, seem to be the consensus that Covid-19 is an SIR-type virus. Once you have had it, you get some form of immunity. If it turns out to be SIS (susceptible, infected, susceptible), we are in a different world entirely.

The key part of the system is essentially how many susceptibles any given infected person passes the disease onto before he or she recovers. In turn this depends on how much the susceptibles and infected intermingle, the probability of catching the virus from a single contact, and the length of time someone is infected.

Modern models are more sophisticated, but they rest on these fundamental principles. Developments in computing power have enabled far more analysis to be carried out much more quickly. They also make them more accessible. Here, for example, is a useful link to an epidemic calculator: http://gabgoh.github.io/COVID/index.html. The visual interface in the calculator is based upon a model of virus spread which is still used at the frontlines of research. By clicking on the chart, the various parameters of the model can be given different values and a wide range of scenarios obtained rapidly.[4]

The whole point here is that assumptions must be made about the key inputs – the parameters – of any model. In everyday physics, the parameters of physical laws are both fixed and are known with certainty. The same is not true of epidemiological models.

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4 This is provided in Pueyo (2020).

Different groups will each have their own model. This accounts in part for the differences in the projections which we see reported. But the differences in assumptions which the groups make is far more important than any differences in the technical details of the models. (Anyone who is interested can see this very easily by playing with the link above).

Those with experience of forecasting with macroeconomic models would feel completely at home in this setting. The key to differences in economic forecasts is not so much the models themselves, but the assumptions which are made.

There is also the familiar context of uncertainty about the data. When making an economic forecast, the first, and in some ways the most important task, is to form a view of where the economy has been in the most recent months. Most economic data only appear with a time lag. A very good discussion of the problems involved with Covid-19 is given by Koerth et al. (2020).

Models, ‘herd immunity’ and lockdown

The mathematical models of epidemiology have already had one major policy success. They provide the intellectual underpinning for the policy of lockdown which has been applied, in different ways, in many countries.

The initial policy response of the UK government in the first half of March was to take the approach of allowing the population to acquire what was described as ‘herd immunity’ - in other words, to allow a sufficient number to experience the virus so that it would die away naturally of its own accord. It would become too hard for the virus to find new people to infect. This was despite the fact that many other countries had either already introduced lockdown or lockdown was imminent.

Given the features of Covid-19, any epidemiological model would have predicted a rather rapid surge of infections. The surge would not only have happened rather quickly; it would have been on a scale which would have overwhelmed the NHS. Patients would have died simply because of a lack of capacity to treat them, as happened in Northern Italy.

The word ‘features’ here refers quite simply to the ‘reproduction number’. This previously obscure phrase now seems to be appearing almost everywhere. The basic idea is simple. If this number is greater than one, it means someone who is infected will infect in turn more than one person. It is easy to see that in such circumstances the virus will spread. Similarly, if it’s less than one, the virus will fade away.

The reproduction number is the clue to whether a virus will spread in the first place. Estimates for Covid-19 vary, but they seem to be in the range 2 to 4.

But it is also the basis of ‘herd immunity’. As more and more people get the disease and then recover, those who remain infected are less and less likely to encounter people who are still susceptible. The *effective* reproduction number falls below one as a result, and the virus fades away. In any event, the initial reproduction number for Covid-19 meant that a surge in new cases would have been inevitable without lockdown.

Behavioural economics did not exactly cover itself in glory in this short interval of time. The Behavioural Insights Team (BIT), set up by David Cameron, appears to have given advice that lockdown would only be effective for a month or two at most. The population would react against it. The only policy open to the government was therefore one of letting herd immunity develop.

Of course, we do not know exactly what went on behind the scenes at the top level of government. However, we can usefully note that, after a brief period in the limelight, the head of BIT, David Halpern, seems to have disappeared from public view. If we were living in, say, North Korea or even China, we might conclude that he had ‘taken one for the Party’. But no doubt he is safe and sound working away in comfortable isolation.

Exiting the lockdown

Recall again the three key factors where assumptions are needed in an epidemiological model:

- How much the susceptibles and infected intermingle.
- The probability of catching the virus from a single contact.
- The length of time someone is infected.

Immediately, there is nothing we can do about the third of these, the length of time someone is infected. If we assume that the other two revert to their pre-lockdown values, then as a matter of pure logic we will see another surge of the virus. Indeed, it is essential to recognise that, until an effective vaccine is developed, the virus will remain in circulation. People will continue to catch it.

The success rate of new vaccines is depressingly low. In normal times, any new drug must go through several stages of testing. The vast majority that get to the testing stage – and many are abandoned even before then at earlier stages of their development – fail at some point during the full procedure. Up to half can fail at the very final hurdle, even when they are in the minority which have passed the initial phases.

Hopefully a vaccine will emerge. But it would not be at all prudent to rely on this. HIV, after all, has been around since the 1980s and no general successful vaccine exists.

The point here is that the scale of new cases must not be such that the capacity of the health service is overwhelmed. The latter has certainly been boosted. We still, however, need to rely on behavioural change to eliminate the risk of unnecessary deaths.

Changing behaviour: incentives and regulation

Economists are used to the idea that people alter their behaviour as the set of incentives which faces them changes. If the price of a product goes up, we usually buy less of it. But price is by no means the only incentive. The population of the UK is currently living through the most serious health threat the country has experienced for a century. Individuals will certainly alter their behaviour as a result.

It is naive to imagine that post-lockdown the previous levels of intermingling will reassert themselves. This will only happen over a considerable period. Some, especially younger people, may pay little regard, but for many, the lockdown will alter behaviour.

Yet economists are not challenging the frequent and prominent pronouncements issued by epidemiologists about the risk of a second (or even more) wave. They are not thinking about how to continue to reinforce behavioural change for many months after lockdown has ended.

Suitable changes in behaviour can be brought about by a combination of agents responding voluntarily to incentives, and to new regulation. Any such changes will impact on either the extent to which susceptibles and the infected mix or on the probability of catching the disease from a single encounter with an infected person.

An important aspect of post-lockdown life will be testing. Matt Hancock, the Health Secretary, announced in March that he planned to have the capacity to carry out 100,000 tests a day by the end of April. It sounds a lot. But the population of the UK is 66 million. Simple arithmetic tells us that at this rate it would take the best part of two years to test everyone.

The 2018 Nobel Laureate Paul Romer made a simple suggestion using incentives. Offer a prize of £1 billion pounds to any laboratory that can process ten million coronavirus tests a day. Regrettably, the idea has not been taken up. Instead, we have the tick-box bureaucrats at Public Health England who seem quite incapable of rising to challenges.

Romer’s idea is an incentive. An example of a regulation would be making face covering compulsory when travelling on public transport. I use the phrase ‘face covering’ rather than ‘mask’. The word ‘mask’ has specific medical connotations. Health professionals need technical masks to protect themselves, given that they are in frequent and prolonged contact with virus carriers.

But the virus is mainly spread through droplets in coughs and sneezes (see Wölfel et al. 2020). Some sort of face cover catches many of these droplets. Even an old T shirt tied around the face and mouth could be useful. Covering should be worn not so much to protect the wearer than to protect other people from the wearer if he or she is infected.

Of course, once we begin the transition from lockdown an entirely different problem might arise. Early experience from countries such as Austria suggests that it might be very real. Although many shops are now legally entitled to open, shoppers are reluctant to go out. How might behavioural change be induced to persuade them to get the economy going again?

The economics profession as a whole - whether mainstream or behavioural - needs to get involved right now in these key policy issues. The seeming certainties proffered by some prominent epidemiologists need to be exposed. Economists understand model uncertainty. Behaviour needs to be carefully influenced. Economists understand how people respond. It’s time for economists to step up to the plate.

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