15. SPI-M-O was in large part an evidence-generating group. SAGE, as I understand its function, was an evidence evaluation and synthesis group. Those are different roles. Yet the only epidemiological modelling expertise on SAGE came from SPI-M-O, a situation I have described as SPI-M-O marking its own homework. I do not consider that this arrangement was best practice as evaluation of evidence should be done independently.
16. I am not able to comment on the relationship between SAGE and senior politicians. The SAGE subgroups I was on did not engage with politicians. I can say, however, that the Scottish C19AG did regularly brief ministers, including the First Minister, and I believe this was a fast and effective way of communicating advice.
17. I am not able to comment on whether SAGE took sufficient account of international perspectives in the early months of the pandemic. I can say, however, that the Scottish C19AG did regularly consider actions taken in other countries and their possible relevance for Scotland. In my view (expressed at the time), this activity was done poorly: the work was not systematic; it gave the appearance of cherry-picking examples to support arguments for or against one policy or another; it relied on overly hasty evaluations of which countries were doing well or badly; and it consistently failed to take into account that different countries had very different pandemics, so that it was naïve to claim that what worked in one setting would work equally well in Scotland.
18. The membership of SPI-M-O was exceptionally well qualified in epidemiology, epidemiological modelling and public health. The group was fit for purpose with regard to quantifying the direct health harms caused by Covid-19. However, SPI-M-O did not have the appropriate expertise to assess (using models or any other form of analysis) the harms being done to the economy, nor the harms to education, mental health or societal well-being.
19. The issue of lack of attention to wider harms was repeatedly raised by myself and others in general discussion during SPI-M-O meetings. We understood that this was not our role but neither DHSC officials nor Cabinet Office observers were able to advise on whose role it was. I am aware of two studies that attempted to fill this perceived gap, one from the University of Warwick and one from Imperial College.
20. The Warwick study was conducted in the first quarter of 2021 and first published in April that year. The report of the study was titled 'Optimal health and economic impact of non-pharmaceutical intervention measures' and is included here as Exhibit **MWO/001** {INQ000220375}. The study described a model-based analysis considering public health harms and economic harms in a single framework. I am not aware that it was submitted to SAGE and so the study is unlikely to have had any impact on policy.
21. The Imperial College study was published as their Report 35 and titled 'How can we keep schools and universities open?' and is included here as Exhibit **MWO/002**

and had too much confidence in the outputs of epidemiological models. I am concerned that policy makers did not fully understand just how uncertain those outputs were. I note that best practice for epidemiological modelling has long stated that models should be one of the inputs in decision making but never the only one.

33. I have described the relationship between science, scientific advice and policy as "sub-optimal". In my view, there were problems in both directions. A common complaint from advisors – aired at SPI-M-O meetings and in Select Committee – was that government did not set out a clear strategy for its pandemic response. For example, though the government was concerned with saving lives it was also concerned about damage to the economy, but SPI-M-O was never directed to consider this. Nor was SPI-M-O asked to explore ways of responding to the pandemic that both saved lives and negated the need for lockdown.
34. In the other direction, the advice from SPI-M-O tended to focus on the need for social distancing measures not because this was the only viable option for responding to the pandemic but because it was the type of intervention the models were designed to consider (though they would later be extended to cover vaccination). The net effect was that not all available policy options for tackling the pandemic received equal attention.
35. The two advisory groups that I was a member of – SPI-M-O and Scottish C19AG – both provided advice on the basis of consensus. One advantage of this is that it gives policy makers and officials greater clarity. One disadvantage is that consensus can be slow to form (which matters, for example, when policy decisions have to made quickly) and, once formed, can be even slower to shift. It is possible that this led to delays in communicating advice to ministers but I have no first-hand knowledge of examples.
36. Another weakness is that on many issues there was not complete consensus at the time and reporting what was effectively the majority view might have given an impression of groupthink. In my experience, minority views were not always communicated to officials and ministers.
37. I do not know the basis for the claim that resources for SAGE and its sub-groups were significantly overstretched. From my perspective, it is certainly true that my team was stretched to the limit, particularly in the first few months of the pandemic. I dealt with issues of funding, equipment and personnel as best I could through the University of Edinburgh, so I consider this an internal matter. I had no expectation that government would be able to help in this regard, reflecting my experience of earlier crises.

Infectious Disease Modelling: An Overview

concern that information was slow to emerge from China. Key (interrelated) information gaps at that stage were the fraction of cases that were asymptomatic, the case-fatality rate, and the way that both were related to age.

242. Though these numbers were integral to the analyses my team and others were doing at time, I do not think that this had immediate policy implications since numerous scientists – including myself – had recognised and communicated the threat. We were able to provide preliminary but useful indications of the expected course of the UK epidemic as early as mid-January.

243. An important question in those early stages was whether a Covid-19 epidemic would be more influenza-like or more SARS-like. The UK response initially assumed on an influenza-like event. This was not unreasonable but, in my view, it took too long to recognise that Covid-19 had many similarities to SARS: we knew from early January that Covid-19 was closely related to SARS. Compared with influenza, Covid-19 had a higher R number and had little impact on children while being highly dangerous to the elderly, frail and infirm.

244. If we had accepted these SARS-like features sooner it might have led to better policy advice: for example, that care homes would be far more important than schools. On the other hand, Covid-19 turned out to less severe than SARS and exhibited a higher proportion of asymptomatic cases; these features also had policy implications. So, though better information faster would certainly have helped, it was also important that the information we did have was correctly interpreted and acted upon.

245. The only real-time analyses that my team carried out during the pandemic was calculation of the weekly ratios of cases, hospitalisations and deaths in Scotland. Those data were obtained from Scottish Government twice a week in the early stages with a lag of a few days. This was adequate for our primary purpose of communicating the trajectory of the epidemic in Scotland after the first lockdown, informing decisions that were taken on the basis of trends over weeks rather than days. We did not use data from PHE, CO-CIN or NHS England.

246. I was also involved in the EAVE II data analysis study led by Aziz Sheikh at the University of Edinburgh. This study linked demographic and near real-time clinical data from almost the entire population of Scotland. Because of its scale, EAVE was able to make estimates of key quantities with unprecedented speed. Two high-profile examples from 2021 were rapid estimates of vaccine efficacy and the severity of omicron infections.

247. EAVE was conceived early in 2020 and activated in mid-March. However, it was unable to carry out large-scale analysis of linked databases until the requisite permissions had been obtained and implemented, which took until June. In my opinion,