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Institutional boundaries and the challenges of aligning science advice and policy dynamics: the UK and Canada in the time of COVID-19

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Abstract
This comparison of institutions of science advice during COVID-19 between the Westminster systems of England/UK and Ontario/Canada focuses on the role of science in informing public policy in two central components of the response to the pandemic: the adoption of non-pharmaceutical interventions (NPIs) and the procuring of vaccines. It compares and contrasts established and purpose-built bodies with varying degrees of independence from the political executive, and shows how each attempted to manage the tensions between scientific and governmental logics of accountability as they negotiated the boundary between science and policy. It uses the comparison to suggest potential lessons about the relative merits and drawbacks of different institutional arrangements for science advice to governments in an emergency.

Keywords: COVID-19; institutions of science; comparative institutional analysis

1. Introduction

This paper compares the institutions of science advice during COVID-19 in England/UK and Ontario/Canada in the development of two different sets of responses by governments to COVID-19. The first is the adoption of non-pharmaceutical interventions (NPIs), such as testing for cases and tracing contacts, and lockdowns. In both the UK and Canada, responsibility for NPIs and the health care systems that had to cope with the disease burden largely rests at the subnational level (country in the UK's devolved system, province in Canada's federal system). Hence, for NPIs, we compare England (accounting for 75% of the UK's population) with Ontario (accounting for almost 40% of Canada's population). The second is the procuring of vaccines, for which responsibility was at the national level. Hence, for policies on vaccines, we compare the UK and Canadian Federal governments. Ideally, we would wish to consider structures of advice on vaccine strategy in addition to vaccine procurement, as well as economic modelling occurring elsewhere within and outside government. Within the space limitations of a journal article, we have narrowed our focus to two pairs of advisory bodies: one for public health advice on NPIs, and one for vaccine procurement. These cases allow us to focus on two basic dimensions

of significance for the negotiation of the science–policy boundary: the degree to which the structures were pre-established or were purpose-built, and their institutional base within or outside government.

UK/England and Canada/Ontario are Westminster systems, which concentrate both authority and accountability in the political executive, and increasingly in the office of the first minister. Governmental accountability runs along hierarchical lines, from civil servants and advisers to ministers, who in turn form a cabinet that is collectively responsible for all decisions. The governments in England/UK and Ontario/Canada relied on a mix of established and newly purpose-built bodies to structure science advice. Their different institutional bases varied in their degrees of independence from formal Cabinet machinery. They therefore offer a rich mix for studying the conditions under which the logics of scientific and governmental accountability can be reconciled or must be traded off. We explore how these arrangements affected expectations about the role of science in the policy process among policy-makers and scientific experts themselves. The concentration of authority exposes the political executive, providing little opportunity to deflect blame when things go wrong, and therefore creating strong incentives for politicians to insist upon strong control of a process for which they must assume responsibility. Hence a vital issue is how the different institutional arrangements enable there to be an independent authoritative body that can 'speak truth to power' in making decisions on the timing and severity of lockdowns.

The next section of this paper provides a framework for understanding the tensions that structures of the science advice must accommodate. It outlines the nature of clashes between the logics of scientific accountability to peers, and governmental accountability to the electorate. That leads into the two main sections of this paper on the ways that the institutions of science advice developed and informed policy in England and Ontario on NPIs and on the procuring of vaccines in the UK and Canada. The final section discusses what we can infer from these comparisons of the institutions of science advice to explore differences in outcomes and draws lessons for the future.

2. The logics of accountability in science and government

When COVID-19 first arrived, decision-makers in both countries were confronted with the spectre of levels of hospitalisation and deaths in the earliest and hardest hit regions of Northern Italy that threatened to overwhelm – potentially fatally – health systems. What followed jumpstarted a new era in science advising for policymakers across advanced democracies. Although pandemics, and the related virology and epidemiology are hardly unknown, the novelty of the COVID-19 virus and the magnitude and speed of its spread initially swamped the normal channels of response. These factors also created intense pressure from the mainstream and social media on key government actors (many of whom suffered from the disease). In the face of the uncertainty that continued through much of the pandemic, governments looked for advice to a wide range of experts (e.g. epidemiologists, economists, behavioural scientists). Government decision-makers were in a state of 'unknown unknowns' and looked for advice from scientists on what precautions should be taken. But little was known about the pathophysiology, transmission and clinical management of the disease (Wiersinga *et al.*, 2020; Bradley and Roussos, 2021). Scientists therefore had to grapple with modelling in a context of 'radical uncertainty' (Kay and King, 2020): i.e. without the data needed to know if their models were valid. In this context, what was needed were what Jasanoff (2015) has insightfully and influentially termed 'serviceable truths': that is, 'a state of knowledge that satisfies tests of scientific acceptability and supports reasoned decision making, but also assures those exposed to risk that their interests have not been sacrificed on the altar of an impossible scientific certainty'.

In this process, governments and their scientific advisers had to manage the tension between two fundamentally different logics of accountability. The logic of scientific accountability is a set of common expectations, enforced by peers, that scientists must be free to pursue inquiry where it leads them subject only to peer standards, and their work must be open to scrutiny and

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independent of extraneous influences. The logic of accountability of liberal democratic governments flows from the need to balance a number of collective objectives in accordance with legitimately registered public preferences. Governments are expected to make decisions in accordance with democratic norms, and to be judged through lines of accountability that run from decision-makers to elected officials who will ultimately be rewarded or sanctioned through the ballot box and the courts.

The balancing of these two logics, and the management of tensions between them, constitutes the essential 'boundary work' that is inherent in the science advising process (Gieryn, 1983; Bijker *et al.*, 2009). This work involves both the delimitation of the boundary between science and policy, and the bridging of that boundary through cooperative mechanisms, and the relative attention to delimiting or bridging the boundary is likely to vary over time in a dynamic relationship. A degree of separation or 'independence' of science advisors from those they advise is necessary if advisers are to be able to 'speak truth to power'. But that degree of independence is a matter to be continually negotiated and managed. As Gieryn has put it: 'For scientists, the mapping task is to get science close to politics, but not too close' (Gieryn, 1995: 435). Boundary work therefore both shapes, and is shaped by, the institutional channels of science advice, within the broader institutional context in which that advice is rendered. During the COVID-19 pandemic, all of this had to take place under circumstances in which the science advising process was thrust into public prominence to an unprecedented extent. Using the analogy of Bijker *et al.*, this meant that the tensions needed to be managed on both the 'frontstage' and the 'backstage' (Bijker *et al.*, 2009: 138–149).

The extraordinary life-threatening and socially pervasive threat of the COVID-19 pandemic exacerbated these tensions. All policy-making involves value trade-offs, but in this case those trade-offs literally involved life and death, liberty and solidarity, and technocracy and democracy. As Birch (2021) persuasively argues, under such 'in extremis' circumstances it may be legitimate for science advisors to be drawn into making value judgements, offering what Birch calls 'normatively heavy' advice. It may also mean that governments must short-circuit established institutional procedures. These pressures further strain the contesting logics of accountability, and boundary work becomes even more challenging than the norm. In the initial stages of responding to COVID-19, these tensions were further exacerbated by problems of feedback and delay, and trade-offs involving high stakes. Senge (2006) shows how communication lags between multiple players with feedback results in chaos because there is no learning by doing. There were multiple such lags along a chain of developments from new infections to symptomatic cases, to hospitalisations to deaths and a lack of timely data on the disease pathway. Senge (2006) argues that models are the only way we can understand how to respond in systems of multiple lags. Estimates of the average number of people infected by one infected individual, the rightly famous *R* number, were crucial in monitoring the disease over time. The number of cases decreases if *R* is less than one; and increases exponentially if *R* is greater than one: the larger the number, the more explosive the rate of increase. Delamater *et al.* (2019) explain that *R* is often estimated as a function of three primary parameters: the duration of contagiousness after a person becomes infected, the likelihood of infection per contact between a susceptible person and an infectious person, and the contact rate. Data on daily case incidence are vital in estimating *R*. But, as we explain, in England and Ontario in early 2020, there was inadequate capacity for testing and tracing infected individuals and their contacts. That meant scientific advisers lacked the reliable data they needed and had to develop models based on large numbers of assumptions. The policy choice over the intensity and timing of lockdowns was problematic when delay risked the pandemic spreading beyond control.

Governments faced a different set of challenges over procuring vaccines, and a different type of uncertainty: the 'known unknowns' of which firms if any might develop effective vaccines, and what side effects even an effective vaccine might entail. But, if a government were to delay making decisions on procurement until after companies have developed vaccines that had been proven

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effective, it would be at the back of the queue. This also placed intense pressure on regulators to assess quickly when there was sufficient evidence to approve a vaccine as effective and decide for which population groups it was safe.

In making these judgements, governments were playing for high stakes and would be judged with hindsight bias: that is the tendency to view events in retrospect as having been predictable, even though they were unpredictable at the time (Kahneman, 2011).

3. Science advice, policy and outcomes of NPIs

3.1 England

In the UK, the Civil Contingencies Committee, which is a Cabinet body, is convened to coordinate different departments and agencies in response to emergencies such as a pandemic. It is known as COBRA (from meeting in Cabinet Office Briefing Room A) and originated in response to the 1972 miners' strike (Haddon, 2020). To support COBRA, the Government Chief Science Officer (GCSA) convenes a subcommittee of scientific experts, the Scientific Advisory Group for Emergencies (SAGE). The position of the GCSA dates from 1964 and is currently funded by the Department for Business, Energy and Industrial Strategy. The GCSA reports jointly to the Cabinet Secretary and the Prime Minister. The current GCSA, Sir Patrick Vallance, had worked at a senior level in public, corporate and academic institutions. He played a leading role in both imperatives of the government's response to COVID-19. Both SAGE and COBRA are supported by the Civil Contingencies Secretariat (CCS) in the Cabinet Office.

SAGE is populated by experts from both within and outside government. Internal members include scientists who are civil servants within the relevant departments. External members are drawn largely from academia, primarily through existing networks, and serve on a volunteer basis. (Although the structure of SAGE and the governmental expectations around its functioning are well-developed, most of its membership will be newly assembled on the occasions on which it is needed. During COVID the home universities of some especially engaged SAGE members received some compensation.) The SAGE structure resolved the tension between scientific and public lines of accountability essentially by subordinating the former to the latter. Advice from SAGE was communicated to the public through governmental lines and at governmental discretion in content and timing. In the early months, SAGE was shrouded in secrecy: the government neither disclosed its membership nor published its minutes. Later its membership was made public and minutes published with a lag or a month or more (Sasse *et al.*, 2021: 40–47). The terms of reference of SAGE leave publication to the discretion of government:

> The SAGE secretariat [within the Cabinet Office] should also act as the information manager for all SAGE products, storing and circulating them and publishing them as and when appropriate. It is likely that the policy development, national security and/or personal information FOI exemptions may apply and this may mean that some information needs to be redacted or omitted before publication. The timing of publication will also need to be considered, with the most appropriate timing, often being after the emergency is over (Cabinet Office, 2012: 23).

There were three advantages of having an established structure for SAGE and its integration into the Cabinet apparatus. First, COBRA and SAGE began meeting in January 2020, even before the virus was first detected in the UK. Even though SAGE was purpose-built for each emergency, its members were drawn from standing lists maintained by the Cabinet Office. Second, expectations about the role of SAGE were relatively well-established on the government side. Third, SAGE had a secretariat to support its work and report to the most senior members of the government. But these arrangements also rendered SAGE vulnerable to 'path dependence' on established

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expectations and relationships. While an established path reduces transaction costs when time is of the essence, it also raises the costs of departing from established understandings. This had at least two corollary effects. Lessons from previous pandemics may have been 'overlearned': early deliberations were heavily conditioned by assumptions drawn from previous emergencies involving infectious viruses such as SARS, MERS and H1N1, when in fact COVID-19 was different in degree of transmissibility from the first two and different in kind from the third (Sasse *et al.*, 2021: 14). While this was a problem common to governmental responses to COVID-19 in many other jurisdictions, it was exacerbated in the UK by the close relationships that characterised SAGE processes.

This in turn highlights another aspect of path dependence: a tendency to 'groupthink' within established circles. A key function of mechanisms of science advice to government, as noted at the beginning of this paper, is to forge a consensus sufficient to provide a platform for action. In order to do that effectively, however, a range of contending scientific positions on the evidence need to be considered, debated and weighed. The SAGE process has been criticised as drawing on too close a network (Sasse et al., 2021: 34, 38). (Indeed dissatisfaction with the process led to the mobilisation of a counter-organisation outside government, dubbed 'Independent SAGE', under the leadership of a former Chief Science Adviser, David King.) Within this closed process, a common narrative developed among both scientific advisers and government officials that guided decision-making in the early stages of the pandemic. This was that the virus was an inexorable pathogen that would sweep through the population until a level of 'herd immunity' sufficient to slow its spread was developed. In the face of this inevitability, the best that policy-makers could do was to defend the health system so that the height of the peaks of infection were in the summer and not in the usual 'winter crisis' of the NHS. That policy also meant shielding those most vulnerable to severe disease and seeking to expedite the development of vaccines. Together with a desire among SAGE advisers for greater certainty before offering advice, this narrative contributed to 'the delay in the critical decision to instigate a nationwide lockdown' (Sasse et al., 2021: 64). This shared narrative proved very difficult to challenge, as Dominic Cummings (then Chief Adviser to the Prime Minister) would later testify before the Select Committees of the House of Commons (Health and Social Care Committee and Science and Technology Committee, 2021a, Q1007). An account in the *Financial Times* reports that, according to some members of SAGE, Cummings made a decisive intervention in the 'crucial week starting 16 March' pointing to the need for lockdown because 'Britain had given up testing in the community and the disease was spreading exponentially'. The Imperial team of Neil Ferguson (a key member of SAGE) had produced a compelling report warning that the NHS would soon be overwhelmed by demand for intensive care beds. Still the scientists on Sage, fearing the possibility of a second peak many months down the line, 'were holding back from drawing the obvious conclusion' (Parker *et al.*, 2020). It was not for another week that, alarmed by Ferguson's results, SAGE finally recommended, and the government implemented, a nation-wide lockdown on 23 March – a delay that the two Select Committees would later deem 'astonishing' in light of international experience and the 'raw mathematics' of the virus (Health and Social Care Committee and Science and Technology Committee, 2021b: 39).

The media characterised government as being careless of the resulting suffering from a 'policy of herd immunity' (thus triggering the government to deny any such policy) (Cairney, 2021: 95–6; Evans 2022). Many scientists outside the SAGE structure were critical of 'herd immunity' whether as an inevitability or as a policy. The reluctance of the government to publish SAGE minutes fuelled further perception that SAGE scientists were being muzzled by a stubborn government. The government relented to pressure to do so and did publish at the end of May 2020. The delay in lockdowns was crucial. Neil Ferguson pointed out that in March 2020: 'The epidemic was doubling every three to four days before lockdown interventions were introduced. So, had we introduced lockdown measures a week earlier, we would have reduced the final death toll by at least a half' (Parker *et al.*, 2020).

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The early work of SAGE was hampered by a lack of reliable data due to failures adequately to test and trace the spread of COVID-19. Responsibility for that surveillance rested with Public Health England (PHE), which had been created in 2013 by the reorganisation of the NHS. That had moved the public health function from the hierarchical NHS into local authorities. Their directors of public health are accountable to their elected councillors. Responsibility for policy on control of infectious diseases remained with the Chief Medical Officer in the Department of Health and Social Care. The Health and Social Care Committee and the Science and Technology Committee (2021: 62 and 63) highlighted calamitous consequences from the shortage of testing capacity in England in early 2020. Community testing and contact tracing had to be abandoned in March 2020; there was inadequate testing of those arriving in Britain from abroad; there was a lack of testing of patients discharged from hospitals to care homes and the staff who worked there, which resulted in the high number of premature deaths in care homes in the first wave. At the end of May 2020, Boris Johnson notoriously promised that 'NHS' Test and Trace ('NHS' T&T) would 'become a truly world-beating test and trace operation in the course of the next days' (BBC News, 2020). 'NHS' T&T was outsourced. Its ambition was to develop a national system from scratch without involving the public health departments in local authorities (National Audit Office, 2020: 7–8). However, the assessment of the joint Report by the two Select Committees was: "Were it not for the success of the Vaccine Taskforce and the NHS vaccination programme, it is likely that further lockdown restrictions would have been needed in Summer 2021" (Health and Social Care Committee and Science and Technology Committee, 2021b: 81). In March 2021, another reorganisation absorbed PHE's functions into a new UK Health Security Agency.

The two key players in England in formulating policy based on SAGE advice were the Chief Medical Officer, Chris Whitty, and the Chief Scientific Officer, Patrick Vallance. But the Prime Minister's Office was central to the formulation of policy and informing the public. SAGE minutes suggest that these players acted in tandem in the decision to institute the first 'lockdown' (Cairney, 2020). It appears that, as advisors and officials negotiated the boundary of science and policy, the common narrative of herd immunity provided a mechanism of coordination for a time. However, the Prime Minister had regrets in retrospect (Health and Social Care Committee and Science and Technology Committee, 2021a: Q 1091) and subsequently government decision-making vacillated without apparent connection to science advice through the second and third waves. SAGE's location within the Cabinet office machinery meant that it lacked a platform from which to assert its independence and criticise government policy.

3.2 Ontario

As noted above, responsibility for the development and implementation of NPIs in Canada (with the exception of those related to international borders) rests largely at the provincial level in Canada. Hence, we focus on the provincial level in dealing with NPIs, and specifically Ontario.

The federal Public Health Agency of Canada (established following the SARS epidemic of 2003) plays a convening and supporting exchange among provincial public health agencies, and was active in this role throughout the pandemic. Nevertheless, there was substantial variation across provinces in the stringency of NPIs (Dekker and Macdonald, 2022).

In Ontario, the failure to respond quickly in an effective manner to the SARS outbreak (especially in Toronto) in 2003 resulted in the establishment, in 2008, of the Ontario Agency for Health Protection and Promotion (now known as Public Health Ontario (PHO)) as an arms-length agency within the portfolio of the provincial health minister. Both the federal (2017) and provincial (2013) governments had created pandemic preparedness plans. These emphasised the importance of early action through the precautionary principle, and attention to a wide range of factors including societal disruption and equity. But, as in the UK, PHO was subsequently weakened in its capabilities to cope with a global pandemic. It had suffered losses of scientific staff with expertise in disease modelling and in vaccines as some left for the

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University of Toronto, its affiliated teaching hospitals or other organisations. In the first months of the pandemic, PHO further lost three vital staff: its CEO, a public health physician and researcher; a senior public health physician and senior scientist. The position of Chief Science Adviser had been maintained at the federal level but been abolished in Ontario (having only recently been created). There was no counterpart to SAGE.

We can divide the institutional response to COVID-19 in Ontario into two phases – before and after June 2020, when the first COVID-19 wave had largely passed. The first phase was characterised by institutional incoherence, with a proliferation of new structures; the second phase brought more coherence with the establishment of the Ontario Science Advisory Table, albeit with an ambiguous institutional status.

In the early days of the pandemic, the government of Ontario lacked urgency in its approaches to pandemic control. Although COVID-19 became a notifiable – and tracked – disease at the end of January 2020, testing was limited to travel cases or those who had been in close contact with a case until the middle of March. The Premier of Ontario had stated that Ontarians should go on the school March break and that there was little to worry about. The Prime Minister of Canada urged Canadians who were on that break to come back. With hindsight, we now know that COVID-19 was then circulating in Ontario where multiple major events and conferences provided good conditions for super-spreader events.

In mid-March the sense of urgency grew. The federal government tightened border controls: in addition to the screening that had been expanding since January, a ban on the entry of foreign nationals was instituted on 18 March, and the Prime Minister urged Canadians abroad to come back to Canada. (In addition to these federal controls at international borders, some provinces including Ontario adopted their own border policies. From mid-April to mid-June 2020, Ontario attempted to restrict interprovincial travel to those travelling for essential reasons such as health care or compassionate grounds.) On 14 March, the Premier announced that the school break would be extended into April, and on 17 March he announced a provincial state of emergency under which a series of orders closing or restricting 'non-essential' businesses and facilities were issued. All of these decisions were taken while the advisory apparatus was both immature and struggling for coherence (Auditor General for Ontario 2020: 22–37).

The Ontario Ministry of Health led the early response. In February 2020, it established a Health Command Table, reporting to the Minister of Health 'to serve as a single point of oversight, executive leadership and strategic direction to guide Ontario's health response to Covid-19' (Government of Ontario, 2021: 3). At the beginning of March, the Ministry announced a 'Scientific Table', to be set up by Public Health Ontario, and a plethora of Sub-Tables (Minister of Health 2020). The Ministry of Health considered the Chief Medical Officer and the CEO of Ontario Health to be 'functional co-chairs' of the Health Command Table as of 6 March 2020. Its terms of reference never reflected these changes. The Auditor General 'saw no discernible difference in the role and responsibilities of the Chief Medical Officer of Health in relation to the Health Command Table after the change was identified'; nor were members of the Table aware of the change. The Chief Medical Officer continued to play a modest role (Auditor General for Ontario 2020: 26). After the government commissioned a consulting firm to advise on a 'whole of government' structure, a 'Central Coordinating Table' was established on 11 April 2020. It was composed of the deputy ministers of nine ministries including the Ministry of Health, and co-chaired by the Secretary of Cabinet and the Chief of Staff to the Premier. The Health Command Table became the 'Health Coordinating Table', reporting to the central Table alongside three other coordinating Tables on supply chains, critical personnel and public safety. Sub-Tables of each of these coordinating bodies continued to evolve: as of 31 August 2020, the Auditor General for Ontario identified 25 Sub-Tables with over 500 participants (Auditor General for Ontario, 2020: 22). A number of Sub-Tables existed on paper only or had evolved although organisational charts, terms of reference and other documentation did not always update to reflect these changes.

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The absence of a strong and consistent channel for providing and synthesizing scientific advice resulted in action by key academic actors, with the dean of public health at the University of Toronto (and former assistant deputy minister of health) acting as lead. Their first initiative was to draw the various modelling groups from four universities (some of them former PHO scientists who had left). They together with senior public service decision-makers worked to reconcile differences among the multiple models being produced in a common 'Consensus Modelling Table' (CMT). Established on 26 March 2020, the CMT was 'sponsored' by the Ministry of Health and its agencies Ontario Health and PHO, but effectively operated under the aegis of the Dalla Lana School of Public Health at the University of Toronto. Chaired by two senior academics, its members were primarily academic mathematicians, epidemiologists, health services researchers and statisticians, with additional analysts and executives from the sponsoring groups.

The Modelling Consensus Table worked under simple principles, which reflected close attention to delimiting the science–policy boundary. All of the members were volunteers, independent and subject to an overarching ethics review framework from the University of Toronto. They were free to publish and share their work under the Chatham House Rule. Unlike SAGE, all work endorsed by the Table had to be released to the public and individual members were encouraged to use different options such as pre-publication to share their work. In developing ensemble models, they did not seek to forge a definitive consensus, but rather sought a synthesis of differing results that could provide a platform for action – a serviceable truth. In other, smaller provinces, one or two teams of modellers also produced models. At first, their efforts were hampered by the lack of data, due to limited testing capacity and to some incoherence in testing policies. Although this problem lessened over time, when the omicron variant later emerged in Ontario it overwhelmed testing capacity and Ontario abandoned a structured consistent approach to PCR testing. Data collection itself suffered from some incoherence. Data were collected from multiple sources (PCR testing in labs and hospitals, hospital administrative systems, administrative data submissions from other parts of the healthcare system like long-term care homes and other sources including purpose-built data collection systems), collated by different agencies including the Ministry of Health, Ontario Health (responsible for the operation of the health care system) and PHO and organised into various databases for analysis, within and outside government. The Ministry of Health created an extraordinary portal for data for the CMT researchers to facilitate access to most of the available data (Hillmer *et al.*, 2021).

At the beginning of April, the first models of the CMT projected up to 30,000 deaths from the disease and a much higher case rate. Subsequent work informed multiple public briefings that were broadcast from the provincial parliament, often in collaboration with the provincial Chief Medical Officer of Health. Much later in the year, the federal government released substantial funding to re-enforce modelling groups across the country.

Over the next few months, the Modelling Consensus Table was joined by an Evidence Synthesis Network and finally, in recognition of the need for a broader swathe of expertise, by an overarching Ontario Science Advisory Table (OSAT) in June 2020. OSAT reviewed work from the modelling and synthesis tables and provided public guidance on a wide range of topics including vaccine safety, sick pay, school re-opening and testing and vaccination strategies among other topics. All three bodies operated on a similar model, and worked closely together. Essentially, they combined the government resources of access to data (CMT), some existing research funding lines (the Evidence Synthesis Network) and connection to authoritative decision-makers with academic resources of expertise (all tables). Their governing principles were transparency and independence – like the CMT, OSAT was effectively run outside government through the Dalla Lana School. OSAT's terms of reference required that synopses of evidence be published rapidly after their submission to the Health Coordinating Table. The academic co-chair of OSAT held press conferences on their publication. Public reporting also exposed the work of OSAT to scientific scrutiny. In contrast to SAGE, the balance between

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scientific and political logics of accountability was tilted strongly toward the former. Coordination mechanisms were also in place, however: OSAT was co-chaired by an academic and a senior PHO official, and press conferences were led by the academic co-chair of OSAT and at least one senior health official, usually the Chief Medical Officer of Health. Political accountability was respected, moreover, by the very independence of OSAT, which left legitimate 'decision space' for political leaders to exercise discretion in policy-making.

As a result, there were on occasion clear public differences between what scientists advised and the decisions governments made. The independence of OSAT and its capability 'to speak truth to power' was dramatically illustrated on two occasions. First, in February 2021, when the OSAT Chair concurred with a reporter's characterisation of OSAT's evidence as 'actually predicting a disaster'. Second, in April 2021, when OSAT issued a carefully worded critique of government policy, by reiterating its core principles of transparency and independence and outlining 'what will work' and 'what won't work'. Shortly thereafter, the government reversed several aspects of that policy. In Ontario, schools were closed in 2020–2021 (with online learning) longer than any other Canadian jurisdiction and most European countries (Ontario Covid-19 Science Advisory Table, 2022). After schools had been closed for a first full year, the Premier publicly requested advice from the Science Table, paediatric hospitals, professional and patient associations and unions. All of these groups, with the exception of the unions, responded in one letter urging schools to be reopened but schools stayed closed.

4. Outcomes: stringency of NPIs, reported cases and excess deaths

Figure 1 shows a measure of the policies on NPIs adopted in the two nations, using the 'stringency index' developed by Our World in Data (undated). Its nine metrics include 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. Both countries relied largely on public information campaigns prior to the middle of March 2020, but then sharply ramped up measures on a timeline within days of each other (at a time when days nonetheless mattered greatly). Canada began its escalation on 12 March, and sharply escalated in the following days, by 20 March reaching a level of restriction that was largely sustained until being boosted somewhat higher at the end of December 2020. The UK escalated somewhat more slowly until 23 March, at that point achieving a level of restraint slightly higher than in Canada, which then fluctuated more for the rest of the year. In Canada, the severity and timing of restrictions varied by province, and were somewhat more sustained over time in Ontario and Quebec than most other provinces (Dekker and Macdonald, 2022).

Figure 2 gives daily new confirmed COVID-19 cases and deaths per million people for the UK and Canada. This shows, for the former, the high case fatality rate in the first wave (Spring 2020), and the high rates of cases in second and third waves.

Data on cases with, or deaths from, COVID-19 depend on this being diagnosed, which can vary over time and location. Rates of excess mortality which are easily accessible provide another basis for making comparisons that are not subject to variations in diagnoses. Figure 3 gives comparisons of four estimates for excess deaths (per 100,000) to populations (HM Treasury, 2020; World Bank, 2023): for 2020, for Canada and the UK by the World Health Organisation (WHO, 2022) and the Economist (2020); for 2020, for Canada and England and Wales by Parildar *et al.* (2021); and from mid-February 2020 to mid-February 2021, for Canada and England and Wales by Kontis *et al.* (2022). These give ranges for Canada from 40 (Economist) to 53 (Kontis *et al.*, 2022), and for UK (or England and Wales) from 100 (Parildar *et al.*, 2021) to 171 (Kontis *et al.*, 2022). The ratios of estimated rates of excess deaths for the UK (or England and Wales) to those of Canada for each set of estimates range from 2.4 to 3.3.

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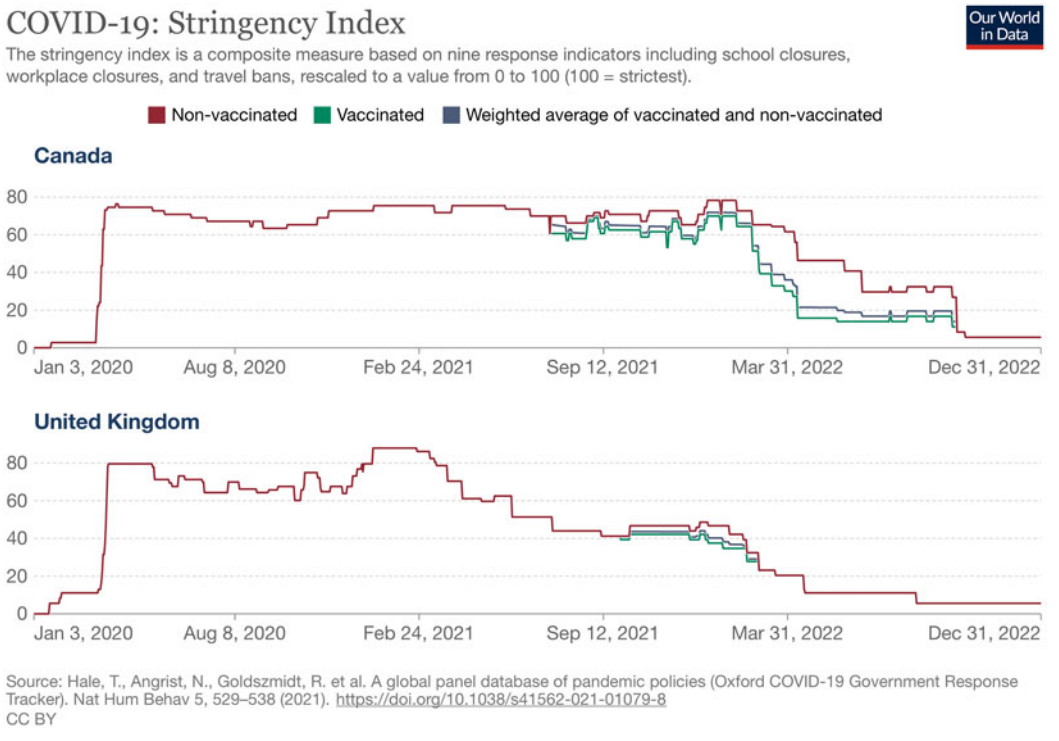

Figure 1. COVID stringency index.

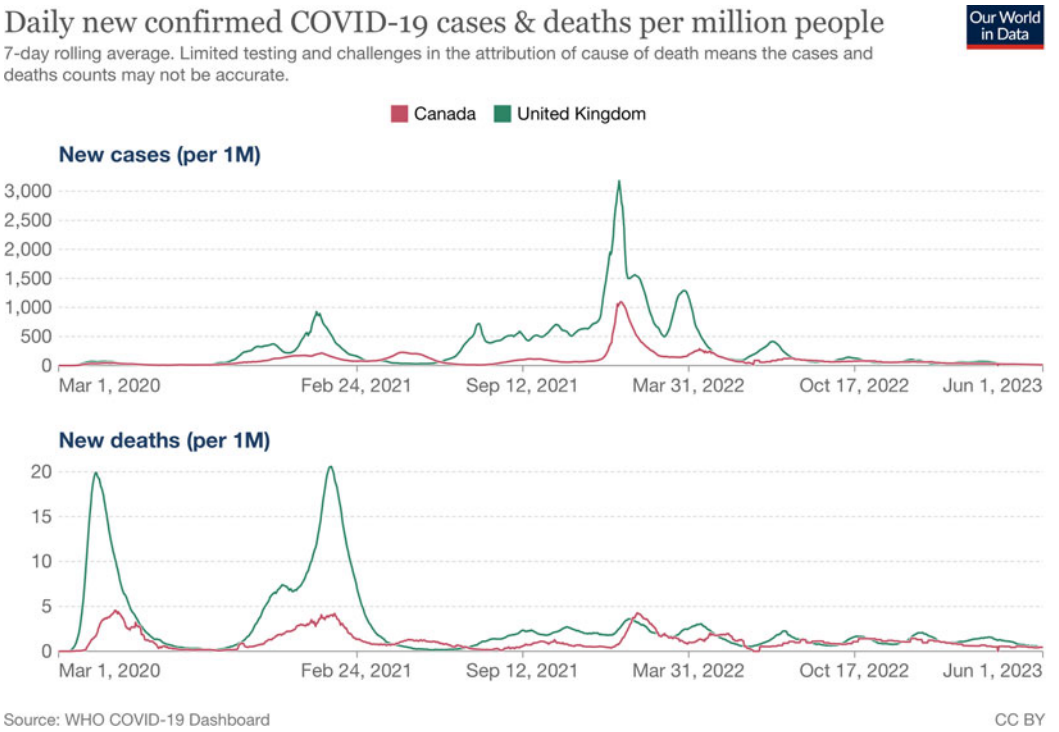

Figure 2. Daily new confirmed COVID-19 cases and deaths per million people.

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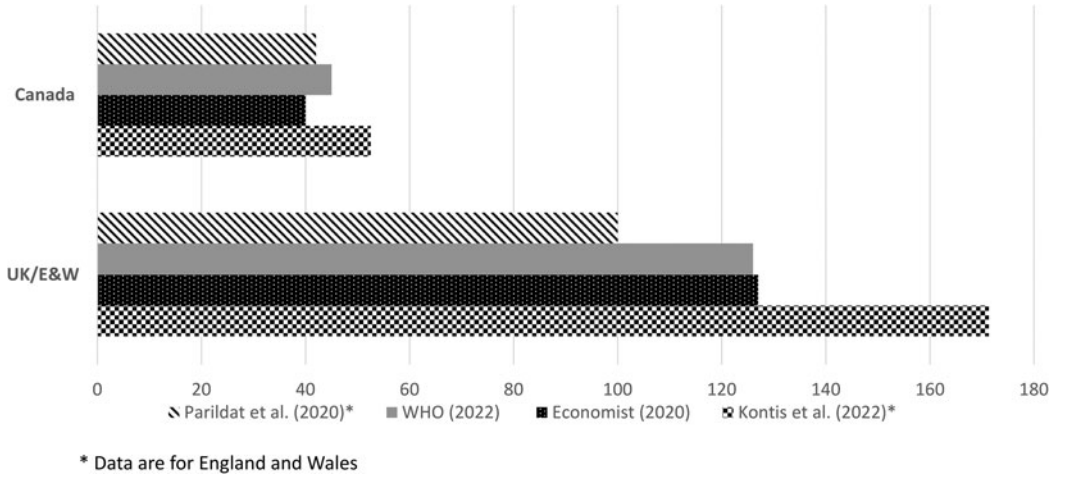

Figure 3. Excess deaths/100,000 for 2020 for UK/England and Wales, and Canada.

5. Science advice, policy and vaccine procurement

In each nation, the relevant regulatory authorities of vaccines were long established: the federal department of health (Health Canada) in Canada; and the Medicines and Healthcare products Regulatory Agency in the UK. (Following Brexit, the MHRA became independent of the European Medicines Agency, which moved from London to Amsterdam.) The bodies charged with the development of vaccination strategies (priority population groups, dosing intervals, etc.) were also long established: the British Joint Committee on Vaccination and Immunisation (JCVI) and the Canadian National Advisory Committee on Immunisation (NACI).

For the procurement of vaccines, both the UK and Canada relied on purpose-built task forces. The process of identifying and contracting with vaccine suppliers would involve a range of government departments – health, industry, justice, finance and social security, for example, in addition to the department with formal responsibility for government procurement. In neither nation was there a body that could 'join up' the various pieces, and in different ways dedicated task forces were established to play that role. Science advisers were drawn from both academic and industrial bases, and recommendations were informed not only by the underlying science but by a pragmatism born of experience with the operation of the relevant markets. At the outset, both task forces were operating in an environment of 'unknown unknowns': there were no vaccines to procure, and no one knew which vaccine platforms, if any, might ultimately provide a successful vehicle or which companies might make these breakthroughs. In this context, both task forces adopted 'hedging' strategies, deciding to contract with a diverse set of suppliers using different platforms, and with different supply chains, and risking that one or more of these bets would pay off.

In effect, in the process of generating 'serviceable truths' for the purpose of vaccine procurements, the tension between scientific and governmental logics of accountability met with another tension between scientific rigour and industrial pragmatism. The similarities and differences between the British and Canadian task forces in how these tensions were managed make for a fruitful comparison, and within our space constraints here we focus on these two bodies.

5.1 UK

In the UK, the GCSA, Sir Patrick Vallance, was a key figure in developing the institutional arrangements that enabled England's successes in procurement of vaccines and their rapid approval by the MHRA. He determined that a new mechanism was needed to 'join up' the relevant agencies and to

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augment them with private-sector expertise in procuring vaccines (Bingham and Hames, 2022: 14–16). He drew together a Vaccine Taskforce (VTF) initially co-chaired by himself and the Deputy Chief Medical Officer for England. Jonathan Van-Tam, pending its fuller development with the advice of an External Advisory Board comprising luminary experts from all three sectors (Bingham and Hames, 2022: 16–18), a VTF. Vallance and Van-Tam proceeded to recruit Dame Kate Bingham, a biotechnology venture capitalist with deep professional connections in biotechnology across sectors and strong personal connections to the incumbent government, to chair the VTF beginning in May 2020. Bingham rapidly set about working with a new deputy chair, government procurement expert Nick Elliot, who had independently been tapped by the Cabinet Secretary and drafted to a Director-General position in BEIS, to assemble the remaining VTF membership. Four of the 11 members held positions in BEIS, four (including Bingham) from the biotech industry, two from the Department of Health and Social Care and a lawyer from UK Government Investments. This was a body whose composition and institutional aegis was strongly oriented to industry: scientific experts on vaccines were consulted as necessary.

There was some artful ambiguity in the lines of accountability of the VTF. The initial press conference announcing its establishment in April 2020 was conducted by the Secretary of State for Business, Energy and Industrial Strategy (BEIS, where Vallance's budget line sat), but was vague as to its institutional position and leadership (Bingham and Hames, 2022: 21). Similar to OSAT, the VTF existed in some tension with established institutions of government, especially its parent institution BEIS. From the governmental perspective, standard operating procedures were set in abeyance and new arrangements for authorisation, including a committee of relevant ministers that could be called together to provide rapid approval as needed. But from Bingham's perspective, established procedures were still unduly constraining. She later reported that while she could make a strong case for procuring vaccines in two short sentences, the VTF was required to use 'the Whitehall Business Case template', which required making the strategic economic, commercial, financial and management cases – but, not an explicit scientific case. In June 2020, that required estimates of the monetary impact of vaccines on British economy, which among other things required assigning a value to each life saved when there was no common estimate of the value of life across Whitehall departments. Fitting the case for vaccines into this 'Procrustean bed' was in Bingham's view a waste of time (Bingham and Hames, 2022: 98).

Bingham's communications with the public were controlled by Number 10, which sought to control the tone and limit Bingham's media exposure relative to cabinet ministers (Bingham and Hames, 2022: 263–272). The prominence of its members, as well as the cross-sectoral connections of Vallance and Bingham, nonetheless gave the VTF the influence it needed to mount a stunningly successful vaccine acquisition programme: by March 2021, the UK secured early access to 457 million doses of eight of the world's most promising vaccines (Department of Health and Social Care and Department for Business, Energy & Industrial Strategy, 2021). The logistics of delivery could draw upon the primary care infrastructure of the NHS. In England, the national roll out of England's vaccination programme by NHS and general practitioners was a triumph and directed at those at high risk. The first persons in the world received the Pfiser/BioNTech on 8 December and the AZ vaccine on 4 January. The UK hit its target of offering a vaccine to everyone in the top 4 priority groups by mid-February 2021 with more than 20 million people having had their first jab (Department of Health and Social Care and Department for Business, Energy & Industrial Strategy, 2021). As will be shown below in Figure 4, the UK was faster to administer vaccine doses than Canada (and was indeed faster than most of its peers) in the first months of 2021.[1]

[1]It must be acknowledged that this measure of 'success' is from the perspective of the national populations of high-income countries, not the global environment.

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5.2 Canada

The Canadian Vaccine Task Force was established by the federal government in June 2020, meeting for the first time on 16 June and provided its first letter of advice on 29 June (Auditor General of Canada, 2022: 5). It was formally announced 2 months later as a joint unit between the industry department (the Department of Innovation, Science and Economic Development, or ISED) and Health Canada (and more specifically the public health agency PHAC). The structure evolved somewhat over time, but it continued to function with support from both ISED and PHAC, and to consult regularly with senior government officials across the relevant departments. Like its British counterpart, it was populated by a mix of academic and industrial members. It was co-chaired by an academic and a veteran of the pharmaceutical industry, but more integrated into the structure of government through its *ex officio* membership: deputy ministers of the health and innovation ministries, the president of PHAC and the Chief Science Officer. It regularly consulted with deputy ministers of other ministries including procurement, justice, finance and social development, in addition to representatives of the Cabinet Office. Its boundary work, in other words, tilted towards coordination vs delimitation, and towards a governmental logic of accountability.

On balance, this process worked effectively, as later confirmed by the Auditor General for Canada. On the advice of the VTF and with the approval of PHAC, the Department of Public Services and Procurement (PSPC) began negotiating with vaccine producers in June 2020. Between July 2020 and January 2021, PSPC established advance purchase agreements with seven companies that were deemed to have the potential to develop viable vaccines (Auditor General for Canada, 2022: 5), representing a mix of vaccine platforms, established vs start-up firms and national bases. PSPC departed from its normal procurement policies and procedures, in this case adopting a non-competitive approach under emergency contracting authority but still met the Auditor General's tests of due diligence. Indeed, the contracts did not and could not specify deliverables, but rather undertook to purchase the results of ongoing R&D. As Roman Szumski, who was seconded from ISED's National Research Council to PHAC as Senior VP COVID-19 Vaccine Acquisition would later put it, 'we were buying the science'[2].

Moreover, because of the uncertainty about which vaccines would be approved for use in Canada, and when the approvals would occur, PSPC chose to negotiate only broad delivery timeframes rather than specific dates, resulting in some delays as other nations held to tighter timelines. This was a tactical judgement by PSPC based on their knowledge of the procedures of the regulatory bodies and cannot be attributable to the design of advisory structures. What is more attributable to the structure, and specifically to the weight of the public health agency within the joint arrangement, was the relatively low priority initially given to the prospects for domestic production, on the argument that to do so risked privileging a single platform and could not be expected to meet the immediate demand. Some members of the VTF were especially frustrated by this orientation, and continued to mobilise their networks accordingly, and as urgency lessened a longer-term focus on domestic production began to strengthen.

In part to pursue this longer-term agenda, the VTF continued to function after the emergency had passed. It continued as a cross-ministerial body, now primarily reliant on the administrative base within the ISED portfolio. In mid-2022, it was announced that the task force would be 'in place for a period of at least 12 months, subject to extension at the discretion of the Government of Canada'[3], with a mandate more oriented to building domestic capacity for R&D and production in Canada. As of the time of writing, the task force continues to meet, with an indefinite lifespan.

Vaccine taskforces were also established in several provinces, but they were primarily concerned with the logistics of delivery and tended to rely on science advice generated by other

[2]Roland Szumski, personal communication 14 December 2022.

[3]https://ised-isde.canada.ca/site/biomanufacturing/en/covid-19-vaccine-task-force. Accessed 21 December 2022.

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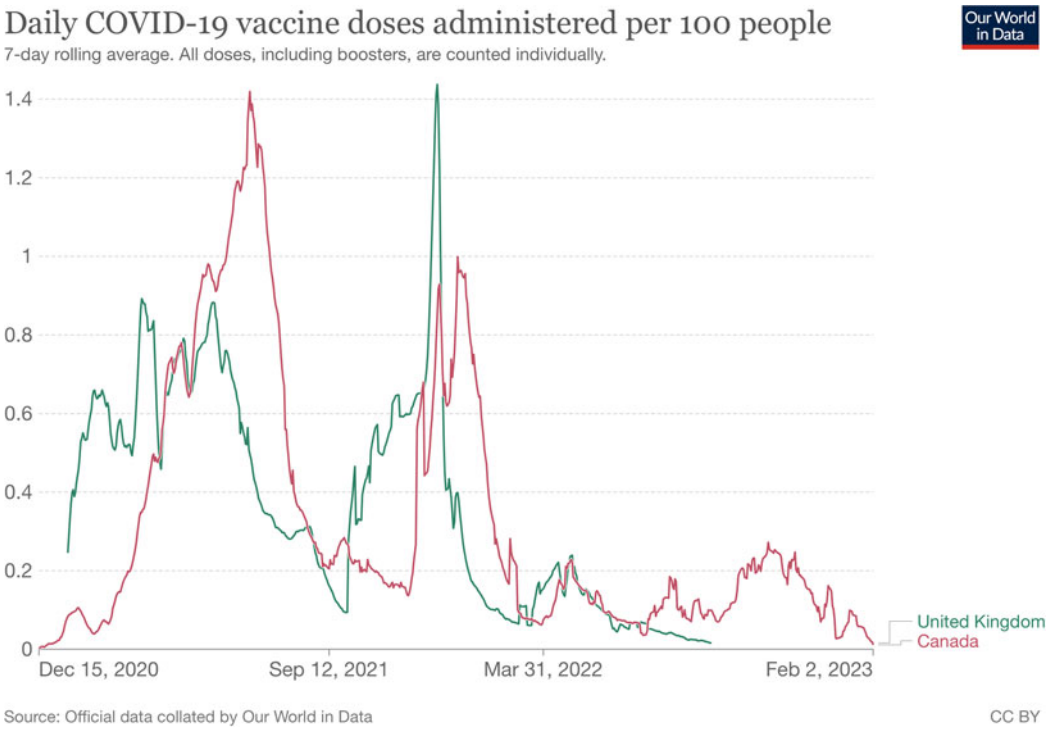

Figure 4. Total daily COVID-19 vaccine doses administered per 100 people.

bodies such as those addressed here on matters like priority target groups. These provincial taskforces, though worthy of study, fall outside the scope of this paper.

6. Rates of vaccination in Canada and the UK

Figure 4 shows the exceptional start in mass vaccination in the UK, which was directed at those at high risk from December 2020. Canada lagged, but soon achieved higher levels of vaccination, indeed among the highest among advanced nations.

7. Discussion

Taking the examples in this UK–Canada comparison together can yield several potential lessons about the relative merits and drawbacks of different institutional arrangements for science advice to governments in an emergency. Consider the trade-offs between having an established body such as SAGE, ready to be mobilised upon the appearance of a threat requiring a scientific understanding, vs building made-to-order structures such as OSAT or the two vaccine taskforces. Establishing permanent advisory bodies requires explicit lines of accountability, which in Westminster systems are likely to be defined according to governmental logics. The greater ambiguity of lines of accountability for purpose-built sector-spanning bodies may be a short-term advantage, but presents later challenges of institutionalisation. The experiences of SAGE and OSAT illustrate these trade-offs quite sharply.

The most obvious advantage of an established body is its readiness: SAGE began meeting in January 2020; OSAT and the vaccine taskforces were not up and running until June of that year. In the UK, much of the boundary work had already been done: established agencies could rely on

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networks of relationships and expectations about roles and procedures, and a cadre of experts familiar with the demands of the advisory process, that were already in place and did not have to be negotiated and assembled *de novo*. These were material advantages when days mattered in the taking of government action. But they have to be set against the consequences of building an advisory body into the structure of government. In England, the tight SAGE structure together with a lack of data produced a set of shared assumptions that allowed, as the first wave hit, for 'herd immunity' to become government policy by default. Hence, the government could claim their policy was 'following the science'. Only in March 2020, as data became available, did scientific modelling call those assumptions and the resulting policy into question. The experience of SAGE shows the consequences of operating under the governmental logics of accountability, in which advice is privileged and the extent of the delay of its public release is at governmental discretion (Cabinet Office, 2012: 23). This logic contravenes scientific norms of open debate, independence and publicity, and weakens the ability of scientific advisers to ensure that their advice is fully taken into account.

The advantages of purpose-built bodies are most obvious when the expertise and authority needed in a crisis resides in multiple portfolios and social sectors, and cannot be generated within the hierarchical lines of government institutions, and/or when the relevant capacity within government has been eroded over time. In a Westminster model, the logical place to maintain a body with a cross-portfolio reach is at the level of Cabinet. That location, however, is likely to reinforce the governmental logic of accountability as just discussed. Here the experience of OSAT, as well as the vaccine taskforces in both nations, is illustrative. Purpose-built bodies can be specifically designed to engage with a particular mix of portfolios and to draw on particular sector-spanning networks. At the outset, this portfolio- and sector-spanning structure can allow for an ambiguity in accountability that effectively gives science advisers considerable independence and enables open debate, while still being close enough to decision-makers to be able to offer serviceable truths. There is, in other words, more latitude for boundary work that suits the specifics of the situation. But that very ambiguity threatens the sustainability of these bodies. Either by design or as a result of reaction from established bodies, none of the purpose-built bodies reviewed here acquired a permanent mandate.

Whether established or purpose-built, institutions of science advice are venues of ongoing 'boundary work', both drawing and bridging the line between science and policy. We make five final points in this regard.

First, the institutional mooring of advisory bodies matters. The closeness of SAGE to Cabinet was both a strength (being part of the official machine) and a weakness (subjection to Cabinet norms of confidentiality, relying on officials to summarise scientific advice), a fostering of 'groupthink' within a closed process and an inability to offer an independent critique of government policy. The base of OSAT in a university offered it a degree of independence and flexibility enjoyed by none of the other bodies reviewed here, but also left it without leverage when it came time to put it on a sustainable basis. The initial location of the Canadian VTF in the public health agency placed its emphasis on acquisition as opposed to domestic production, a balance that shifted after it was transferred to the industry department. Conversely, the tethering of the British VTF to the industry department meant that domestic production received heavier emphasis.

Second, governmental capacity to generate data relevant to the management of a crisis is one of the most vital resources governments bring to the science–policy relationship. A significant incentive for science advisers to volunteer their time and expertise is access to the sorts of data that government can command. Science advisers and decision-makers can be effective only with reliable data from surveillance of the disease. In the COVID crisis, the failures of testing and tracing to generate reliable data on cases hampered the ability of advisers to model the spread of disease in both Canada and England and required them to rely on the lagging indicators of hospitalisation, ICU use and deaths.

Third, beyond institutional location and capacity, the 'collectively enforced expectations' (Streeck and Thelen 2005) that define institutions of science advice will determine their effectiveness. Most important is the expectation that, especially in the context of an emergency, science advisors should strive not for certainty but for 'serviceable truths'. The quest for certainty hobbled SAGE in recommending action in the first wave, while the looser more free-wheeling processes of CMT and OSAT, once established, allowed for the mobilisation of a continually evolving consensus around the advice to be offered.

Fourth, the ability to span sectors is an important leadership attribute in a crisis. Individuals with cross-sectoral linkages played pivotal roles as 'institutional entrepreneurs' (Tuohy, 2018: Ch. 10) in the mobilisation of SAGE, OSAT and the two vaccine taskforces.

Finally, there is no clear line of causality between the different structural arrangements in the UK and Canada and the metrics of performance. Canada and the UK presented almost polar opposites at the outset of the pandemic: 'groupthink' within the tight and closed SAGE process in the UK vs disarray and cacophony in the Ontario context in the absence of a coherent structure for clear and authoritative scientific advice. Arguably, British groupthink sustained a quest for certainty that paralysed policy until a particular model jolted the Prime Minister into action, and later provided no authoritative platform for calling government to scientific account. Ironically, the very absence of definitive advice in Ontario in the early days of the pandemic triggered an alarmed government into taking *ad hoc* action somewhat sooner. Later, a more coherent structure in Ontario allowed for a forging of a working consensus around serviceable truths and independent critiques of government policy, and may have contributed to Ontario's more sustained public health measures vs the fluctuating UK pattern. Two caveats are important. First, we can note at best an association between these structures and outcomes; the dynamics are much too complex and resistant to measurement to allow for any inferences of causality. Second, science advice and governmental responses under any structure are matters of judgement. 'Hindsight bias' might lead us to question some of those judgements on their merits. A more legitimate question for further research, however, is the degree to which structures and processes of science advising allow for the vigorous exchange of perspectives that put those judgements to the test and forge consensus around serviceable truths.

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References

Auditor General for Canada (2022) *Covid-19 Vaccines*. Report No. 9. Covid-19 pandemic. Ottawa: Office of the Auditor General for Canada.

Auditor General of Ontario (2020) COVID-19 Preparedness and Management: Special Report on Outbreak Planning and Decision-Making. Toronto: Office of the Auditor General of Ontario. November.

BBC News (2020) Coronavirus: track and trace system in place from June – PM. 20 May. Available at https://www.bbc.com/news/uk-52741331

Bijker E, Bal R and Hendriks R (2009) *The Paradox of Scientific Authority: The Role of Science Advice in Democracies*. Cambridge: The MIT Press.

Bingham K and Hames T (2022) *The Long Shot: The Inside Story of the Race to Vaccinate Britain*. Leicester: W. F. Howes Ltd.

Birch J (2021) Science and policy in extremis: the UK's initial response to COVID-19. *European Journal for Philosophy of Science* **11**, 90.

Bradley R and Roussos J (2021) Following the science: pandemic policy making and reasonable worst-case scenarios. *LSE Public Policy Review* **1**, 6, 1–7.

Cabinet Office (2012) Enhanced SAGE guidance. Available at https://www.gov.uk/government/publications/scientific-advisory-group-for-emergencies-sage

Cairney P (2020) *Covid-19 policy in the UK: Did the UK Government 'follow the science'? Reflections on SAGE meetings*, July 8. Available at https://paulcairney.wordpress.com/2020/07/08/covid-19-policy-in-the-uk-did-the-uk-government-follow-the-science-reflections-on-sage-meetings/comment-page-1/

https://doi.org/10.1017/S1744133123000221 Published online by Cambridge University Press

Cairney P (2021) The UK government's Covid-19 policy: assessing evidence-informed policy analysis in real time. *British Politics* **16**, 90–116.

Dekker J and Macdonald R (2022) Covid-19 restrictions index update, *Statistics Canada*. August 24. Available at https://www150.statcan.gc.ca/n1/pub/36-28-0001/2022008/article/00002-eng.htm

Delamater PL, Street EJ, Leslie TF, Yang YT and Jacobsen KH (2019) Complexity of the basic reproduction number (R_0). *Emerging Infectious Diseases* **25**, 1–4.

Department of Health and Social Care and Department for Business, Energy & Industrial Strategy (2021) *Update on the Vaccine Taskforce: 1 March 2021*. Available at https://www.gov.uk/government/news/update-on-the-vaccine-taskforce-1-march-2021

Evans R (2022) SAGE advice and political decision-making: 'Following the science' in times of epistemic uncertainty. *Social Studies of Science* **52**, 53–78.

Gieryn TF (1983) Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists. *American Sociological Review* **48**, 781–795.

Gieryn TF (1995) Boundaries of Science. In S Jasanoff (ed.), *Handbook of Science and Technology Studies*. Thousand Oaks, CA: Sage.

Government of Ontario (2021) *Evolution of Ontario's COVID-19 response structure*. Central Coordination Table Secretariat. Cabinet Office. February.

Haddon C (2020) *Explainer: COBR(A)*. London: Institute for Government. https://www.instituteforgovernment.org.uk/explainer/cobr-cobra.

Health and Social Care Committee and Science and Technology Committees (2021*a*) *Oral evidence: coronavirus: lessons learnt* HC 95, Wednesday 26 May 2021. London: The Stationary Office. Available at https://committees.parliament.uk/event/4435/formal-meeting-oral-evidence-session/

Health and Social Care, and Science and Technology Committees (2021*b*) *Coronavirus: lessons learned to date*. (Joint Report by two Select Committees). HC 92, p 81 London: The Stationary Office. Available at https://committees.parliament.uk/work/657/coronavirus-lessons-learnt/

Hillmer MP, Feng P, McLaughlin JR, Murty VK, Sander B, Greenberg A and Brown AD (2021) Ontario's Covid-19 Modelling Consensus Table: mobilizing scientific expertise to support pandemic response. *Canadian Journal of Public Health* **112**, 799–806. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8404759/

HM Treasury (2020) *National statistics. Country and regional analysis: November 2020*. Available at https://www.gov.uk/government/statistics/country-and-regional-analysis-2020/country-and-regional-analysis-november-2020

Jasanoff S (2015) Serviceable truths: science for action in law and policy. *Texas Law Review* **93**, 1723–1749.

Kahneman D (2011) *Thinking, Fast and Slow*. New York: Farrar, Strauss and Giroux.

Kay J and King M (2020) *Radical Uncertainty. Decision-Making Beyond the Numbers*. London: Bridge Street Press.

Kontis V, Bennett JE, Parks RM, Rashid T, Pearson-Stuttard J, Zhou B, Guillot M, Mathers CD, Khang YH, McKee M and Ezzati M (2022) Lessons learned and lessons missed: impact of the coronavirus disease 2019 (Covid-19) pandemic on all-cause mortality in 40 industrialised countries and US states prior to mass vaccination. *Wellcome Open Research*; **6**, 279.PMCID: PMC8861471.

Minister of Health (2020) *Ontario Implementing Enhanced Measures to Safeguard Public Against COVID-19*. Toronto: Office of the Minister of Health. March 2.

National Audit Office (2020) *The government's approach to test and trace in England – interim report*. London: National Audit Office. Available at https://www.nao.org.uk/report/the-governments-approach-to-test-and-trace-in-england-interim-report/

Ontario Covid-19 Science Advisory Table (2022) *Ontario returns to school: an overview of the science*. 12 January. Available at https://covid19-science`.ca/wp-content/uploads/2022/01/Ontario-Returns-to-School-An-Overview-of-the-Science_20220112-1.pdf

Our World in Data (undated) Coronavirus (COVID-19) deaths. Available at https://ourworldindata.org/covid-deaths

Parildar U, Perara R and J Oke (2021) Excess mortality across countries in 2020. Available at https://www.cebm.net/covid-19/excess-mortality-across-countries-in-2020/

Parker G, Cookson C, Neville S, Payne S, Hodgson C, Gross A and Hughes L (2020) Inside Westminster's coronavirus blame game. *Financial Times*. 16 July.

Sasse T, Haddon C and Nice A (2021) *Science Advice in a Crisis*. London: Institute for Government.

Senge PM (2006) *The Fifth Discipline: The Art and Practice of the Learning Organisation*. London: Currency.

Streeck W and Thelen K (2005) Introduction: Institutional Change in Advanced Political Economies. In Streeck W and Thelen K (eds), *Beyond Continuity: Institutional Change in Advanced Political Economies*. New York: Oxford University Press, pp. 1–39.

The Economist (2020) Tracking covid-19 excess deaths across countries. Available at https://www.economist.com/graphic-detail/coronavirus-excess-deaths-estimates

Tuohy CH (2018) *Remaking Policy: Scale, Pace and Political Strategy in Healthcare Reform*. Toronto: University of Toronto Press, Ch. 10.

https://doi.org/10.1017/S1744133123000221 Published online by Cambridge University Press

Wiersinga WJ, Rhodes A, Allen C. Cheng, Peacock SJ and Prescott HC (2020) Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review. *JAMA* **324**, 782–793.

World Bank (2023) World Development Indicators database. Available at https://databank.worldbank.org/data/download/POP.pdf

World Health Organisation (2022) Global excess deaths associated with Covid-19 (modelled estimates). Available at https://www.who.int/data/sets/global-excess-deaths-associated-with-covid-19-modelled-estimate

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