Science and Public Policy, 46(2), 2019, 244–253
doi: 10.1093/scipol/scy054
Advance Access Publication Date: 24 September 2018
Article

OXFORD

Perfecting the 'Elevator Pitch'? Expert advice as locally-situated boundary work

James Palmer [1,*], Susan Owens[2] and Robert Doubleday[3]

[1]School of Geographical Sciences, University of Bristol, University Road, Bristol, BS8 1SS, UK, [2]Department of Geography, University of Cambridge, Downing Place, Cambridge, CB2 3EN, UK and [3]Centre for Science and Policy, University of Cambridge, 10 Trumpington Street, Cambridge, CB2 1QA, UK

*Corresponding author. E-mail: james.palmer@bristol.ac.uk

Abstract

Conventional accounts of expert authority frequently over-simplify relations between science and politics, and presume the existence of a singular 'interface' between these domains. In contrast, this article draws on semi-structured interviews to document how the authority of UK Chief Scientific Advisers emerges from their engagement in the construction and bridging of several distinct but interrelated boundaries. Building on co-productionist accounts of science–policy interactions, the paper moreover contends that these various boundaries are themselves constituted within place-specific contexts. The locally-situated, material conditions of advice-giving, in short, fundamentally shape the hybridisation and mutual alignment of science and politics around specific governance objectives. Further analytical work on expert advisory processes and expert authority should, we contend, be more closely attuned to the roles played by discursive, social, and material factors in facilitating boundary bridging and co-production in practice.

Key words: boundary work; co-production; expertise; materiality; science–policy 'interface'.

1. Introduction[1]

While we have become accustomed to calls for policy- and decision-making to be grounded in the best available scientific evidence, a growing body of scholarship on science–policy interactions, as mediated by expertise, has highlighted the complexity of such relationships in practice. Within this broad context, scholars across a wide range of disciplines have provided rich insights on expertise and advisory processes (for an overview, see Owens 2015, ch. 1), drawing on diverse perspectives and developing important conceptual frameworks such as those of 'boundary work' (Gieryn 1983, 1995) and 'co-production' (Jasanoff 1990, 2004). Questions remain, however, about the mechanisms through which expert advice intersects with and comes to influence policy-making and politics (Sutherland et al., 2012)—and a widely perceived loss of trust in expertise renders the search for answers all the more pressing (Jasanoff and Simmet 2017; Kennedy 2016; Nichols 2017). Recently, many scholars have also called for greater scrutiny of the day-to-day practices through which experts engage in boundary work in advisory settings, and of the locally situated and material circumstances of the co-production of science and politics (Le Heron 2009; Mahony 2013; Montana 2017; Palmer 2014).

Taking up this latter challenge, our focus in this article is on the specific case of expert advisory work undertaken by departmental Chief Scientific Advisers (CSAs) within UK government. The higher-level position of UK Government Chief Scientific Adviser (GCSA) has existed since 1964, when the zoologist Sir Solly (later Lord) Zuckerman was appointed to advise Harold Wilson's government.[2] Later, during Professor Sir John Beddington's tenure as GCSA (2008–13), CSAs were recruited across Whitehall, and by 2011 a CSA existed in every major government department.[3] This proliferation forms part of a broader shift towards 'evidence-based policy-making' in the UK, accelerated after the Labour Party's general election victory in 1997 (Sanderson 2009). It also undoubtedly owes much to specifically British ideas about expertise, which—as Doubleday and Wilsdon (2012, 301) note—have long centred on 'the credibility and character of the individual'. Even so, the CSA concept has been taken up in other contexts, including Australia and New Zealand, and the devolved administrations of Wales and Scotland.[4] It was also in favour at the European Union level for a period from 2011.[5]

While CSAs represent just one of many institutional forms 'through which experts influence decisions or policy carried out by others' (Turner 2014: 2), for several reasons they offer an ideal case for examining the day-to-day practices of scientific experts as they engage with the policy process. First, since this model of expert advice spans diverse sectors of UK policy, an enhanced understanding of its functioning should yield wide-ranging benefits. Secondly, since CSAs work inside government departments, they circulate within physical spaces of decision-making, and therefore permit a study of

both discursive and material components of boundary work in practice. Thirdly, focusing on CSAs allows us to examine the activities and experiences of *individual* expert advisers. Thus, we seek to add to those existing studies whose focus has been on collectives of experts—committees, commissions, and other bodies with advisory functions—often institutionally situated outside, or at arm's length from, government (Bijker et al. 2009; Hilgartner 2000; Jasanoff 1990; Owens 2015).

The analysis that follows draws on semi-structured interviews with former and incumbent CSAs to address two inter-related questions: how do CSAs gain access to Ministers and other key decision makers within Whitehall; and how do these advisers, and other actors within government, understand and represent the processes by which advice comes to have effect? While we consider how our interviewees explain the cultivation of 'influence', the actual nature and extent of CSAs' impacts are outside this article's remit.[6] It is worth noting, nevertheless, that CSAs in government have sometimes had significant effects on the course of events; see, for example, Dunlop (2010) on the role of CSAs in the evolution of biofuels policy, and Cassidy (2015) and Dunlop (2017) on the interventions of GCSAs in the long-running controversy over badgers and bovine tuberculosis.

The next section begins by reviewing previous accounts of relationships between expertise and policy processes, suggesting that insights can be gained from more explicit consideration of material factors involved in boundary work and co-production. Section 3 outlines the research design and methods for this study, before section 4 presents key findings. The final section draws out wider implications for theories of policy advice.[7]

2. Science and policy: from 'interface' to co-production

2.1 The fallacy of a singular science–policy 'interface'

While the elicitation of scientific advice from specially recruited individuals is not novel in UK policy making—during World War II, for example, Winston Churchill routinely sought scientific advice from physicist Frederick Alexander Lindemann—formal government guidelines on the use of scientific advice date back only to 1997. According to those guidelines, CSAs—usually recruited directly from the academic community—are charged with ensuring that 'robust, joined-up evidence is at the core of decisions within departments and across government' (GOScience 2010: 12). This objective is to be pursued 'both through offering advice directly to Ministers and official colleagues, and by oversight of processes for ensuring that departments take account of, and commission where appropriate, relevant scientific, and engineering evidence' (GOScience 2015: 6).

Official descriptions of the CSA's role evoke models of science–policy interactions in which experts facilitate one-way, linear flows of knowledge from researchers to decision makers. Under this reading, 'experts who inform the policy process enjoy a kind of "numinous legitimacy", conferred by their scientific authority; values and judgements remain firmly the prerogative of the decision makers whom they advise' (Owens 2005: 288).[8] Such 'technical–rational' (Owens 2005) or 'linear–autonomy' (Jasanoff 2011a) models view science and politics as mutually exclusive, and in science–policy discourse this idea is often extended to imply that scientific evidence in itself will be able to resolve policy controversies (see Pielke 2007 for an interesting discussion). Moreover, in stipulating a benchmark of 'robust, joined-up evidence', the guidelines tacitly reinforce the assumption that expert advice is 'most useful to policy when it is presented as a single, "definitive" interpretation' (Stirling 2010: 1029), rather than in a manner that emphasises areas of potential disagreement or uncertainty (see Sarewitz 2011 for a discussion).

Although the 'technical–rational' representation has proved tenacious, in practice '[l]ittle about this model is *not* misleading …' (Turner 2014: 4). Research in the policy and political sciences, for example, has long served to undermine the view that science simply 'provides the "facts" for policy makers to use' (Forsyth 2003: 233; see also Collingridge and Reeve 1986; Price 1965). Not only can knowledge and advice be deployed (or interpreted) strategically—even Churchill's wartime adviser, Lindemann, was renowned for tailoring advice to 'provide rationales for whichever course the prime minister… wished to follow' (Mukerjee 2010: 42)—but the technical and scientific tools used in knowledge production may themselves embody normative presuppositions about the nature of the issue(s) being addressed (Flyvbjerg 1997; Nelkin 1975; Owens and Cowell 2011; Palmer 2016). Interpretive policy analysts, meanwhile, have identified the cognitive schema used by various actors to make sense of complex policy problems—whether in the form of frames, discourses, storylines, or otherwise—emphasising the hybridisation of 'facts' with 'values' (Hajer 1995; Palmer 2010; Schön and Rein 1994). Collectively, such work has challenged conceptions of a sharp science–policy 'interface' across which knowledge is straightforwardly transmitted, highlighting a messier reality in which the boundary between the two spheres is neither fixed nor pre-determined.

2.2 Navigating hybridity: constructing and bridging boundaries

Faced with these complexities, expert advisers have been shown to cultivate and preserve authority for scientific knowledge claims by engaging in 'boundary work' (Gieryn 1983; Guston 2001; Jasanoff 1987). Defined as attributing 'selected characteristics to the institution of science… for purposes of constructing a social boundary that distinguishes some intellectual activities as "non-science"' (Gieryn 1983: 782), the concept of boundary work suggests that CSAs' ability to deliver influential expert advice depends in part on controlling the processes through which certain knowledge claims come to be perceived as rigorous and objective, whilst others do not.

At the same time, however, and especially in relation to complex controversies, the legitimacy of scientific knowledge claims comes to depend less on their being perceived as rigorous and objective, and increasingly on their sensitivity and responsiveness to social and political contexts (Callon et al. 2009; Nowotny et al. 2001). Conventional risk assessment has long been criticised for being hubristic and yet poorly equipped to embrace 'deep' uncertainties (Stirling 2003), and science and technology studies scholars have built upon the concept of boundary work to argue that in such contexts experts and decision makers engage in a *range* of boundary-type activities, including the production of judgements. Thus, for Jasanoff (2005a, 211), the question 'is no longer which scientific assessments are right, or even more technically defensible, but whose recommendations the public should accept as credible and authoritative'.

While the necessity of good judgement in the face of complex policy problems has been widely acknowledged (see, for example, RCEP 1984, 1998; Weinberg 1972), there is less agreement about

its relationship with 'the facts'. Collins et al. (2010: 186), for example, advocate separation of a 'technical' from a 'political' phase of what they term 'technological decision-making in the public domain' (seeing such separation as feasible and desirable). But others contest the presumption that facts and values can readily be disentangled in this way in complex science–policy issues (Ezrahi 1980; Fischer 2011; Owens 2011b). From the latter perspective, technical advice can rarely, perhaps never, be produced in the absence of normative judgements about the wider public meanings of an issue. Indeed, technical assessments—ostensibly neutral and objective—may in practice prescribe wider public meaning, by presuming both the relevance to the assessment of particular risks and uncertainties and the appropriateness of certain metrics, standards and techniques for their measurement (Shrader-Frechette 1995; Wynne 1992). Where CSAs are concerned, this implies that policy influence might derive not from the ability to impose a hard distinction between science and non-science (as in Gieryn's 1983 account of boundary work), but rather from an ability to *bridge* boundaries by making judgements about competing knowledge claims whose relative value is at least partly obscured by prevailing risks and uncertainties.

Recent studies of expert advisory bodies have added weight to these arguments, drawing attention to the purposeful production of advice combining scientific knowledge with judgements about the social context within which that knowledge is produced and applied. In her long-term analysis of the UK Royal Commission on Environmental Pollution, Owens (2015: 166) finds that the Commission's deliberations were less akin 'to any technically oriented appraisal of "the facts"' than to what Weale (2010: 266) terms 'practical public reasoning'. Similarly, Bijker et al.'s (2009: 142) analysis of the *Gezondheidsraad* (the Health Council of the Netherlands) highlights the presence in this body's reports of what the authors term 'wisdom', defined as a 'well argued reflection on the state of knowledge in relation to the state of the world'.

To retain their authority, however, such institutions must also reinforce widely perceived boundaries between science and non-science, even as they offer advice transcending the perceived dichotomy between facts and values. This they achieve through rhetorical, social, and material techniques, with the latter including the design of committee procedures, the choice of members, or simply the norms and conditions of committee work. The claim that knowledge production is underpinned by social and material techniques is not new, of course; Shapin and Schaffer (1985: 25) drew attention to the interconnected role of material, literary, and social technologies 'employed in fact-making' in their historical analysis of Robert Boyle's air pump experiments, for example. But such factors play a quite different role in the expert advisory processes of the 21st century than they did in authorising the findings of 17th century natural philosophy experiments. Specifically, by reinforcing the perception of science and politics as mutually exclusive spheres, such techniques preserve an expert advisory body's licence to give advice, even as the substance of that advice *bridges* boundaries, contributing to the co-production of knowledge and policy (Bijker et al. 2009; Jasanoff 2004; Owens 2011a, 2015; Turnpenny et al. 2013).

2.3. Venues, sites, rooms, and spaces

By highlighting the social and material dimensions of the boundary bridging activities in which advisory bodies engage, recent studies raise additional questions for scholars of co-production, notably concerning the ways in which such activities are shaped by their situatedness in particular venues, sites, rooms, and spaces. Research in geographies of science has long contended that knowledge does not simply unfurl across space; rather, in encountering new places and cultures, scientific ideas can be reinterpreted or remoulded to suit local contexts. Thus, Livingstone (2015), for example, documents how various Presbyterian communities in Britain and North America engaged with Darwin's theory of evolution, arguing that in each case a unique 'speech space' was created, permitting the articulation of certain arguments but not others.

In the field of interpretive policy analysis, Hajer's (2005) dramaturgical approach to policy deliberations contends that persuasiveness and influence are not exclusively cognitive entities, because 'sustainable persuasion is often enacted' (Hajer and Versteeg 2005: 344). From this perspective, and in a manner that applies to all policy actors, including expert advisers, 'what is said, how it can be said, what it is possible to say, and what can be said with effect are all influenced by setting' (Campbell et al. 2014: 6). More recently, Pallett and Chilvers' (2015: 150) offer a view of organisations at the science–policy 'interface' (including expert advisory bodies) as 'practised, performative and of the (banal) everyday'.

Reflecting a broader trend for social scientists to (re)turn to questions of materiality (Whatmore 2006), such conceptual approaches have informed studies of boundary work and co-production in numerous settings, including, for example, debates about sustainable growth in New Zealand (Le Heron 2009), international climate change negotiations (Mahony 2013), EU biofuels policy (Palmer 2014), and deliberations of the Intergovernmental Platform on Biodiversity and Ecosystem Services (Montana 2017). In all these studies, attention to ostensibly banal variables such as room layouts, seating arrangements, and the regulation of access to meeting rooms, has shown how 'local acts of constant co-production and mutual realignment' of science and policy are materially grounded in what might be termed 'boundary spaces' (Mahony 2013: 37).

While the research outlined above has begun to illuminate the role of context-specific, material factors in shaping processes of co-production, much of the work on advisory institutions to date has focused on the discursive and argumentative strategies used by experts when communicating their advice [as in Pielke's (2007) framework, for example], and often, as noted above, on the practices of expert advisory bodies positioned *outside* of government (Bijker et al. 2009; Hilgartner 2000; Jasanoff 1990; Owens 2015)[9]. This paper, building on the insights of previous work, adds a further dimension by focusing on individual advisers working inside government. We examine how the role and influence of departmental CSAs has been understood by CSAs themselves and by those with whom they interact, and how CSAs, in seeking to ensure that their advice has effect, engage in processes of boundary construction and boundary bridging. We also consider the extent to which such boundary activities are constituted by materially grounded practices within specific spaces of decision making in Whitehall. Before presenting our analysis, however, it is necessary to outline the data sources and methodology.

3. Research materials

Interviewees for this study were identified using purposive sampling, drawing on the established (formal and informal) networks of the University of Cambridge's Centre for Science and Policy.[10] Criteria for selection centred on individuals' ability to provide direct accounts of serving as, or working alongside, a CSA, with the aim of including individuals whose combined experience spanned multiple

Table 1. Interviewee identifiers, posts, and periods of commencement.

Identifiers	Post	Period of commencement
I1	Former GCSA	1985–94
I2, I3	Former departmental CSA	
I4	Former governmental advisory committee member	
I5	Former GCSA	1995–2004
I6, I7, I8, I9	Former departmental CSAs	
I10	Former senior civil servant	
I11	Former departmental CSA	2005–12
I12, I13, I14	Incumbent departmental CSAs (at time of interview)	
I15, I16	Incumbent senior civil servants (at time of interview)	

government departments at various times during the period 1985–2012. These criteria generated an initial sample comprising twenty former CSAs, four GCSAs, two former members of governmental advisory committees, and four former senior civil servants (including a cabinet secretary and a deputy CSA). Of these thirty individuals, sixteen, including ten former and incumbent departmental CSAs, and two former GCSAs, accepted the request for an interview. Four interviewees had taken up their posts in the period 1985–94; six in the period 1995–2004; and six in the period 2005–12. In the interviews themselves, which lasted between 40 and 90 minutes, respondents were encouraged to reflect on the day-to-day realities of working at the interstices of science and politics, and to reflect on the factors—whether interpersonal, political, practical, or otherwise—that they felt had made a significant contribution to the success (or failure) of their efforts to deliver influential advice. A semi-structured format was adopted so that the same themes could be explored in each interview, while allowing scope for interviewees to introduce novel ideas based on their personal perspectives or experiences. Due to the sensitive nature of the advisory and political processes discussed, steps have been taken to protect anonymity, with quotes being attributed to identifiers according to interviewees' roles and the period within which they first took up their post (Table 1).

Interviews were complemented by analysis of documents, selected on the grounds that they had been identified by the majority of our interviewees as playing a key role in the evolution of the CSA concept in the UK. Specifically, these documents included government guidelines on the use of scientific advice in policy making[11]; a cross-cutting review of science and research in government, undertaken jointly by four Whitehall institutions (Her Majesty's Treasury [HMT], Department for Education and Skills [DES], Office of Science and Technology [OST], Department of Trade and Industry [DTI] 2002); and a report on the role and functions of departmental CSAs by the House of Lords Science and Technology Committee (HoLSTC 2012), including oral and written evidence. These sources provided valuable additional material against which to compare interviewees' contentions, while affording insights into conceptions of CSAs within the wider policy community.

4. Working with the grain? Gaining access, giving 'good advice'

4.1 Scientific standing, rapport, and materiality

In government documentation and other published reports, CSAs' standing and experience as practising scientists frequently emerge as important signifiers of their epistemic authority, and therefore their credibility in Whitehall.[12] The 2002 multi-departmental review of the use of science and research in government, for instance, contends that CSAs 'need active experience at the cutting edge of science, in order to ensure that they have appropriate credibility both within and outside [their] department' (HMT et al. 2002: 89). The House of Lords Science and Technology Committee similarly argues that CSAs must have standing and authority within the scientific community, nationally and internationally' (HoLSTC 2012: 22). Several interviewees added weight to this perspective, for example:

> 'The strength of the CSAs, in my view, is having somebody who comes from outside and has a fresh view, who's got one foot in universities or research institutes, is doing research, is very active in [national] academies. . .' (I13, Interview, 21 June 2012).

In these accounts, CSAs' standing as recognised practising scientists is taken as an indicator of their ability to offer objective, dispassionate advice and, by extension, of their independence from government. The presumption of a link between independence and credibility is consistent with wider institutional frameworks for utilising scientific advice in UK policy making—successive guidelines have reiterated the importance of independence, whether advice is 'provided by eminent individuals, learned societies, advisory committees, or consultants' (OST 1997: 4).[13] But characteristics like disinterestedness, independence, credibility, and trustworthiness, while frequently invoked, are far from unambiguous or straightforward to define (Owens 2015; Withers 2017); we return to this point in Section 5.

Calls for the wider recruitment of CSAs across multiple government departments, which took on particular urgency following the 2001 'foot and mouth' outbreak, depicted a need not only for independent expert advice, but also a more efficient means of accessing it, especially in 'crisis' situations. Following criticism of the government's handling of 'foot and mouth'—an outbreak that precipitated the slaughter of nearly four million animals (Fergusson et al. 2001)—public trust in policy makers was severely damaged (Poortinga et al. 2010). This episode compounded the impact of the Bovine Spongiform Encephalopathy 'fiasco' (HoLSTC 2000: para 1.1) of the 1990s, in which policy makers had sought, erroneously, to reassure the public that infected beef, if properly cooked, posed no risk to human health. In this context, the recruitment of CSAs was interpreted by many interviewees as an effective means of securing expert advice when rapid, decisive action was required to address an urgent or unforeseen problem. One senior civil servant viewed CSAs as an 'immensely powerful' means of improving 'the way in which people look on particularly controversial decisions' (I15, Interview, 4 May 2012), while a former CSA remarked that 'the big crises point to a need for really high-level independent scientific advice' (I8, Interview, 20 June 2012).

These perspectives, while revealing, are confined to circumstances in which policy makers proactively seek advice from CSAs. They say little, in contrast, about processes through which CSAs might *challenge* policy makers, either by questioning the evidence base underpinning proposed decisions, or by identifying emergent problems requiring political attention. These more unsolicited forms of advice raise the question of how CSAs gain access to key decision makers in Whitehall.[14] Here, accounts varied markedly amongst our interviewees, but in all cases recognised that independence and scientific standing, while necessary, were not sufficient in themselves.

The construction of good working, and indeed social, relationships with civil servants—and not only those in senior positions—was frequently invoked by interviewees as key to facilitating access to high-level decision makers, as in the following observation from a former CSA:

> 'The first relations that were extremely important to deal with… would not be with [senior figures], but with the people who reported *to them*, so it was very important that these people passed the word down the line, "the CSA is OK"'. (I2, Interview, 22 June 2012).

Another was more pragmatic and straightforward:

> 'How in hell do [CSAs] get [their advice] heard?… In Whitehall, having a budget is power. If they don't have a budget, they lack power, and therefore in essence, it entirely relates to their personal relationship with the ministers'. (I7, Interview, 9 May 2012).

Without downplaying the importance of CSAs' perceived independence, or indeed their ability to command and discharge a research budget,[15] these accounts depict the advisory landscape as simultaneously professional and social, thereby recognising the need for CSAs to bridge a boundary between 'insiders' and 'outsiders' in government. Doing so entails day-to-day work, as CSAs not only seek to establish rapport with civil servants and ministers, but also hinges on the extent to which they demonstrate a willingness to commit to their role full-time. In this respect, some interviewees contradicted the House of Lords Science and Technology Committee's view that CSAs should be employed part-time, while remaining active in scientific research. An incumbent CSA, for instance, remarked:

> 'People seem to maintain both an academic and a civil service career and I think that's actually quite difficult and almost disingenuous. I think… you come in and you take it seriously and it's your full-time commitment'. (I14, Interview, 21 June 2012).

In emphasising the need to be regarded by government officials as an 'insider', some CSAs therefore advocated suspending the very scientific research activities upon which their perceived independence was predicated. Even as CSAs' scientific standing and independence from government are routinely pinpointed (both in government guidelines and by CSAs themselves) as important sources of credibility, therefore, the boundary between austere technical analysis and congenial personal relations frequently becomes blurred in practice.

Not all interviewees, however, singled out personal relations as vital to a CSA's ability to gain access to decision makers. One former CSA remarked:

> 'I think it's very appropriate that these sorts of governance issues, to do with evidence and scrutiny and analysis, are *independent of the personalities*'. (I11, Interview, 10 May 2012, emphasis added).

Yet when prompted to reflect on why (in his own assessment) he hadn't achieved certain objectives as a CSA, even this individual conceded that personalities had made a difference:

> 'Part of it may be to do with me, I waited to be invited, others were more forceful about their interventions and as it were, knocked the door down'. (I11, Interview, 10 May 2012).

This last quote also hints at a further set of practices used by CSAs to gain access to decision makers, predicated on actively creating opportunities to engage in advisory interactions, beyond those offered by formal departmental procedures. The reflections of another former CSA epitomise this approach:

> 'The [Minister's] outer office is very, very good at keeping people away… But I had a trick… called the elevator pitch[16]… I used to lurk at the elevator, at the bottom, and wait for a minister to come and jump in… and as we're going up say "oh minister do you know such-and-such"?' (I9, Interview, 29 May 2012).

Similarly, a former GCSA recounted how he:

> '… used to quite frankly have to go in the back door to Number 10 [Downing Street] because the Cabinet Secretary says "Oh, the Prime Minister's far too busy to be interested in science"'. (I1, Interview, 22 June 2012).

In these examples, the ostensibly banal characteristics of the spaces within which decision makers and CSAs circulate—including for instance the positioning of lifts, doorways, and Ministers' 'outer offices'—are imbued with creative potential, serving as material artefacts that might be used to bring about unscheduled, face-to-face advisory interactions. But the characteristics of these spaces could also act, in the opposite vein, to constrain a CSA's access to decision makers, as in the following example:

> 'For the first half of the time I was largely ignored; I was given an office and a PA. The Chief Economist would walk past regularly, he had a much grander office than me, and would just carry on doing things as though I wasn't there'. (I9, Interview, 29 May 2012).

Here, the material character of the CSA's office—not as 'grand' as that of another prominent adviser, and situated such that it could easily be bypassed—emerge as partly constitutive of this individual's perceived lack of influence within the department. Collectively, these accounts suggest that the spaces within which CSAs and policy makers circulate cannot be relegated to the role of a 'passive' backdrop for social and discursive interactions (Pallett and Chilvers 2015: 153). Instead, material artefacts within those spaces convey *affordances* (Ingold 1992), making themselves available to certain uses while constraining others, thereby influencing the extent—and the nature—of advisory encounters themselves.

Overall, these accounts suggest that CSAs routinely engage in boundary bridging activities as part of their day-to-day engagement with decision makers, and that these activities are underpinned by both social and material practices. They enable CSAs to progress from an 'outsider' role, as a dispassionate scientist-*cum*-expert, to that of an 'insider', as a familiar, full-time colleague, and also to generate opportunities for face-to-face interactions outside of formal meetings or other routinised settings. At the same time, government guidelines and many CSAs themselves rhetorically reinforce the notion of a sharp boundary between science and politics, specifically by emphasising the scientific credentials of advisers and the

imperative of disinterested advice. The basis for CSAs' boundary construction and bridging activities therefore differs subtly from that observed in Bijker et al.'s (2009) study of the *Gezondheidsraad*. Here, social and material processes intrinsic to the day-to-day activities of the *Gezondheidsraad* served predominantly to *reinforce* its perceived independence (and thereby its authority), while the rhetorical substance of its published reports hybridised scientific and political considerations into a form of 'wisdom'.

4.2 Stage management, hybridisation, and collaboration

While the previous section suggests that a CSA's influence is 'enormously a matter of the chemistry between that individual and the other senior people' (I2, Interview, 22 June 2012), it does not address the question of what makes advice effective in practice. We now go on to illuminate two further dimensions of a CSA's activities—concerning the processes by which advice is delivered on the one hand, and the substance of that advice on the other—which emerged from the accounts of interviewees as important determinants of effectiveness. These activities, too, can usefully be conceptualised as forms of boundary construction and bridging.

In trying to pinpoint the hallmarks of effective advice, interviewees often spoke of the degree of transparency enacted around its delivery and use in policy making. Guidelines have advocated transparency in advisory practices since their first iteration (OST 1997), with the 2010 version (the most recent at the time of writing) urging policy makers to 'explain publicly the reasons for policy decisions, particularly where the decision appears to be inconsistent with scientific advice' (GOScience 2010, 10). Perhaps understandably therefore, interviewees who commenced their roles during the first period covered in this study (1985–94), prior to the publication of formal guidelines on the use of scientific advice, felt that the CSA's role had shifted from a 'low key', private one, to one centred on 'the openness of scientific advice' (I2, Interview, 22 June 2012). On the surface, this shift did not appear to trouble interviewees, given that most thought it unlikely that deep disagreement or conflict would develop between a CSA and a policy maker in the first place. Indeed, interviewees were very measured when accounting for the significance accorded to their advice within the wider context of the policy process, recognising that 'there is . . . a gap as to what [the scientific position] turns into in policy terms' (I16, Interview, 25 July 2012). At the same time, the increased emphasis on transparency sits uncomfortably with a desire on the part of many interviewees to reserve at least some of their interactions with decision makers for more private settings:

> 'I still believe if you are given a job, you advise on a very private and confidential basis'. (I1, Interview, 22 June 2012).

> 'If the guidelines are about saying it the way it is without fear or favour, that's fine; if the guidelines say you have to do that publicly, that isn't going to work'. (I14, Interview, 21 June 2012).

These extracts evoke Hilgartner's (2000: 42) concept of stage management, suggesting that the quality of 'good advice' derives at least in part from a CSA's negotiation of the boundary between what might be thought of as 'backstage', private interactions on the one hand, and 'front stage', public declarations about those interactions on the other. Moreover, they also suggest that the substance of interactions between scientific advice and other considerations in policy making should not be disclosed to wider public audiences even where disagreement is *absent*. In this sense, our interviewees effectively contend that the quality of advisory processes will be compromised if any party involved—either the CSA or the decision maker(s) in question—cannot be certain of the privacy of their exchanges.

This in turn hints at a second dimension of 'good advice' identified by our interviewees, relating not to the question of transparency, but to the substance of advisory interactions themselves. Specifically, for many interviewees, giving 'good advice' was associated with the adoption of a constructive, open approach in which provisional ideas about the relationships between scientific evidence and other policy-relevant considerations would, of necessity, have to be developed collaboratively and iteratively. For example, for one CSA:

> 'The job consists of. . . actually explaining the scientific position, understanding it, but *working with the grain*'. (I14, Interview, 21 June 2012, emphasis added).

The same interviewee went on to reject the view that effective advice should ever have to be underpinned by an adversarial challenge to the will of policy makers:

> 'A lot of the challenge is to say, 'I don't think that's quite the way we should be going and I'd suggest that we do it in such and such a way'. . . Seeing that as an adversarial challenge is nonsense. . . I've done it by explaining things, by gaining their trust and so on'. (I14, Interview, 21 June 2012).

The CSA in these examples depicts the task of giving 'good advice' not simply as transmitting scientific knowledge, but as elucidating how that knowledge sits within a broader context of competing value judgements and worldviews. Within Pielke's (2007: 17) typology of idealised roles for scientific advisers, the CSA serves here as an 'honest broker of policy alternatives', seeking to 'place scientific understandings in the context of a smorgasbord of policy options'. Reflecting on the implications of uncertainty in complex policy debates, a former CSA similarly described 'good advice' as argumentative and contextual:

> 'It was more to do with how you construct arguments in the face of uncertainty, which has now become very important for CSAs in general because uncertainty about data, uncertainty about the analysis and yet politicians wanting to make definitive policy statements, is now an almost every day occurrence'. (I11, Interview, 10 May 2012).

Taken together, these insights suggest that in seeking to give 'good advice', CSAs recognise that it is necessary not only to work collaboratively with policy makers, but also to tailor arguments to what Jasanoff (2011b: 131) calls 'contexts of interpretation'. These contexts of interpretation will, to a considerable extent, be shaped by 'civic epistemologies'—defined as broad, culturally-specific 'understandings of what credible [knowledge] claims should look like and how they ought to be articulated, represented, and defended' (Jasanoff 2005b: 249). But in the context of expert advisory processes, they will also—we contend—be influenced by more transient and situated factors, including the prevailing political climate within which advisory interactions take place, the specific characteristics of the policy problem(s) discussed, and the balance of interests amongst relevant stakeholders and wider publics. Consequently, especially under conditions of uncertainty and what Funtowicz and Ravetz (1993: 739) term high 'decision stakes', for advisers to invoke the intrinsic substance of supposedly objective facts—whether to support or oppose particular policy proposals—is unhelpful.

Instead, there is a necessity to work with policy makers to formulate arguments which have been tailored to 'the performative and persuasive demands of reasoning' (Jasanoff 2011b: 131) within a situated 'context of interpretation'.

In describing how they formulated such arguments in practice, moreover, CSAs recognised the importance of both social *and* material conditions in facilitating the cultivation of sufficiently collaborative and iterative interactions. The following extract from an interview with an ex-departmental CSA, recounting his interactions with a minister over a particularly complex policy issue, is insightful in this regard:

> 'I sat with [the minister] for about four hours and tried to work through a sensible situation in the face of uncertainty… Our data sources were… wet finger in the air at best and yet we got ourselves into a policy trajectory where we needed to be able to say *something*. I can remember we crafted [the] speech for the House of Commons and when version 18 was produced we were comfortable that [the minister] was going to say something that was… built on good analytic evidence and projected the right level of uncertainty…' (I11, Interview, 10 May 2012, emphasis added).

In acknowledging that the argumentative basis for a specific policy trajectory was effectively co-constructed in this case, this CSA clearly aligns with calls for 'stronger processes of mediation and translation [to be] woven into the processes of knowledge making itself' (Jasanoff 2011b: 141). However, in emphasising the length, intensity, and painstaking nature of the interactions required to 'craft' this minister's speech, the quote also implies that such processes are best facilitated by sustained, face-to-face deliberation. Put differently, being in the same room—and taking the time to *sit down* together—significantly enhances the ability of the CSA and the relevant minister to work through the issues in question. A series of briefer, more rushed interactions, especially if not conducted face-to-face, would not permit the same level of constructive hybridisation between scientific knowledge and its 'contexts of interpretation' (*ibid*., 131).

Overall, this section suggests that CSAs foster mediation and translation in knowledge-making not only rhetorically (for example by producing independent reports) but also through a combination of particular social and material practices. They frequently adopt a collaborative, iterative approach to the process of formulating advice, and engage closely with decision makers on a sustained, face-to-face basis—in both cases building processes of mediation and translation into the substance of their advisory work. As in Bijker et al.'s (2009) study of the *Gezondheidsraad*, 'good advice' can therefore be said to constitute the purposeful hybridisation of science and politics. In this case, however, the techniques employed in boundary bridging, like those used to facilitate access to decision makers in the first place, are at least as much social and material as they are rhetorical or discursive in nature.

5. Discussion

This article has examined how CSAs gain access to, and build trust with, policy makers, as well as the characteristics that advisers and others working at the boundaries between science and policy ascribe to 'good advice'. At a general level, there was broad support among our interviewees for the CSA model of institutionalising expert advice. All agreed that CSAs could have positive impacts upon public policy, if given sufficient fiscal and administrative support in Whitehall. Altogether more nuanced accounts emerged, however, when interviewees were asked to delineate the precise responsibilities of a CSA, and to reflect on the day-to-day nature of their work in practice.

Formal accounts of the responsibilities of CSAs largely reinforce a technical–rational view of a singular science–policy 'interface', wherein facts and values can, and should, be kept separate. From this perspective, the *independence* and *disinterestedness* of expert advice is crucial; a CSA's standing within the scientific community then transmits into credibility, trust and influence within the (separate) political sphere. Our analysis shows, however, that for individual advisers (as for external advisory bodies), the reality is more complex, with characteristics like 'independence' and 'disinterestedness' frequently being inferred as much from the ways in which advice is delivered as from the credentials, experience or institutional background of the adviser. In this sense, our study of CSAs reinforces Withers' (2017: 13) claim that trust and credibility 'are negotiated outcomes borne of particular individual relationships, institutional settings and social connections', rather than fixed dispositions.

These conclusions, based on a relatively small number of interviews with actors operating exclusively in the UK context, can be neither definitive nor exhaustive. But if we accept the proposition that each CSA adopts a unique approach to their job, we can go further to suggest that expertise itself—in the advisory context at least—is always a contingent, relational construct. This is not to call into question the expertise of CSAs in their particular fields. Rather it is to argue that the perceived legitimacy and effectiveness of CSAs' advice derives not only from its intrinsic properties—that is, the combination of evidence, argument and persuasion that it comprises (Majone 1989)—but also from the approach taken by the CSAs to constructing and managing boundaries of various kinds. These boundaries, moreover, transcend any singular 'interface' between science and politics. Instead, the analysis presented in this paper suggests that at least four boundaries, distinct but interrelated, constitute the terrain within which interactions between science and policy occur.

The first two concern not the substance of advice itself, but the processes by which CSAs establish relationships with, and consequently gain access to, decision makers. First, CSAs must make judgements about how to navigate a social boundary between 'insiders' and 'outsiders' in Whitehall, both in the tenor of their day-to-day interactions with civil servants and ministers, and through the level of commitment they demonstrate towards the role (one presumption being that CSAs must work full-time to count as genuine 'insiders'). Second, CSAs must navigate a closely-related boundary between formal, procedural interactions with decision makers on the one hand, and informal, spontaneous interactions on the other. This latter boundary can sometimes be actively bridged by a CSA's careful manipulation of social *and* material factors, as in the case of the 'elevator pitch', for example. However, the affordances of the material spaces in which advisers engage with decision makers are not limitless; 'outer offices' can deny access at critical moments, much as CSAs' chances of bumping into key figures can be diminished by the physical placement of their offices within the department. In this sense, the means of keeping experts 'on tap, but not on top' are not confined to formal rules set out in official guidelines; they also include apparently banal, material aspects of the corridors of Whitehall themselves.

The third and fourth boundaries identified in this study concern the practices by which CSAs deliver advice. Here, to borrow Hilgartner's (2000) terminology, one boundary separates 'front

stage', public pronouncements about the outputs of interactions between CSAs and decision makers from the substance of their 'backstage', private deliberations. CSAs' management of this boundary enables outcomes of advisory interactions to be reported independently of the processes by which those outcomes emerge. Closely related is then a fourth and final boundary, between the straightforward delivery of evidence and 'facts' on the one hand, and the iterative, collaborative co-construction of arguments and judgements on the other. A bridging of this boundary is clearly at play, for instance, when CSAs speak of 'working with the grain' (I14, Interview, 21 June 2012) in their interactions with decision makers. Both social and material factors are again imbricated in CSAs' efforts to bridge this final boundary, since the effective co-construction of arguments and judgements requires not only a distinct communicative approach—one that is collaborative and enables the iterative development of ideas—but also the physical proximity and time required to sit down and work through issues slowly and carefully, rather than through a series of briefer (or indeed remote) exchanges.

While CSAs' management of these four boundaries has much in common with the 'coordination work' observed in Bijker et al.'s (2009: 143) analysis of the *Gezondheidsraad*, there are important differences to be identified. Whereas the *Gezondheidsraad* bridges boundaries between science and politics principally through the rhetorical substance of its reports, which seek to provide 'well argued reflection on the state of knowledge in relation to the state of the world' (Bijker et al. 2009: 142), the individual CSAs in this study frequently bridged boundaries using a careful combination of social and material techniques. Moreover, the *Gezondheidsraad* uses its own institutional routines and practices—which themselves have important social and material components—to reinforce the concept of a sharp boundary between science and politics. By contrast, in our analysis, the perception of such a boundary is most obviously reinforced at a rhetorical level, through repeated reference to CSAs' 'independence', 'disinterestedness', and 'scientific standing' as determinants of their effectiveness.

At one level then, this examination of CSAs supports existing, co-productionist accounts of relationships between science and politics in modern democracies (Jasanoff 2004). Indeed, it suggests that co-production should be embraced not just as a critical analytical tool, but also as a positive normative principle. This means going beyond Pielke's (2007) call for experts to operate as honest brokers of policy alternatives, however. More fundamentally, we contend that expert advisers can and should reflect with policy makers not just on multiple ways of governing, but on multiple ways of knowing too. In other words, the efficacy of policy-making processes is at least partly dependent upon acknowledging that expert advisors 'make judgements on behalf of the common good rather than [act] as spokespersons for the impersonal and unquestionable authority of science' (Jasanoff 2005a: 222).

We further build upon existing analyses by highlighting differences in the circumstances and mechanisms through which co-production might be realised in practice. Specifically, we identify multiple *kinds* of boundary work involved in co-production, which are distinct but interrelated, and might easily be conflated in discussions of advisory practices. At one level, therefore, the article suggests that greater analytical attention can usefully be paid to the interplay between these boundaries in different contexts. Going further, it proposes that scholars exploring boundary construction and bridging should pay greater attention to both the social *and* the material components of those practices, and to their interplay with rhetorical and discursive techniques, in different institutional settings. Such work promises not only to advance academic understandings of co-production. Equally importantly, it has the potential to enrich public discourse about the nature of (scientific) expertise and its role(s) within democratic governance processes, particularly as expertise is called into question in many spheres, and as policy makers continue to grapple with a wide range of complex, contentious issues.

Notes

1. The views expressed in this article are the authors' own, and should not be taken to represent the views of any organisations with which they are associated.
2. The remit for the GCSA is to ensure the quality and use of scientific evidence and advice *across* government, provide advice to the Prime Minister, and chair the Chief Scientific Adviser's Committee on which all CSAs sit.
3. At the time of writing (April 2018), three CSA posts are vacant, and one department has no CSA. Details of incumbent CSAs can be found at: http://www.bis.gov.uk/go-science/science-in-government/chief-scientific-advisers [accessed 26 April 2018].
4. Prior to the collapse of its devolved government in January 2017, there were also plans to recruit a Chief Scientific Adviser for Northern Ireland.
5. The European Commission abolished the post of Chief Scientific Adviser in 2014. While a discussion of the circumstances surrounding this decision is beyond the scope of this article, it nonetheless underlines that there is 'no universal solution to science advice' (Doubleday and Wilsdon 2012, 301).
6. The nature of expert influence in policy processes is not always self-evident. In her long-term study of the UK Royal Commission on Environmental Pollution, for example, Owens (2015) identifies a spectrum, or continuum, of many different kinds of effects that expert advice can have, including those which are rapid and visible, gradual and diffuse, or negligible, depending on context.
7. Whilst social scientific expertise, currently under-represented in the UK's scientific advisory system (with the exception of economics), is worthy of further study, its role is beyond the scope of this article. See Kattirtzi (2016) for an interesting analysis of the role of social scientists in two UK government departments.
8. The concept of 'numinous legitimacy' can be traced to Weber (1922); see also Clark and Majone (1985).
9. Studies of advisory processes operating 'within' government do exist, but have tended to focus on collective bodies rather than individuals. Scholars have for instance examined the influence of UK Parliamentary select committees (Turnpenny et al. 2013; Williams 1993), and the White House Office of Science and Technology Policy (Hart 2014).
10. CSaP was founded in 2009, aiming to build relationships between policy professionals and academics. Since 2011, its Policy Fellowship scheme has brought over 200 policy makers to Cambridge for meetings with over 1,000 academics and other experts. See: www.csap.cam.ac.uk/policy-fellowships.
11. Four versions of these guidelines exist. The first (OST 1997) was issued by Lord May during his term as GCSA. Updated versions were twice issued during the tenure of Sir David King (OST 2000, 2005), and then again under Sir John Beddington (GOScience 2010).

12. For Quack (2016: 363), it is through claims to epistemic authority that 'individuals or groups attempt to convert their specific knowledge into expertise as a type of knowledge that stands out from other, more commonly shared forms of the latter', and which may then be seen as 'particularly rare or valuable'.
13. One manifestation of this concern is the insistence on documenting individuals' 'interests', though the emphasis in such declarations tends to be on financial or institutional arrangements that might give rise to a real or perceived conflict of interest.
14. The House of Lords Science and Technology Committee recommends that CSAs 'should have a right of direct access to ministers to ensure that they can challenge effectively at the highest level' (HoLSTC 2012: 36).
15. It was not possible, in our interviews, to obtain reliable information on the fiscal or budgetary dimensions of CSAs' responsibilities. Nonetheless, this study's focus on more situated, day-to-day practices used by CSAs to gain credibility and deliver advice within Whitehall, should not be read as a dismissal of the importance of what might be regarded as a CSA's 'fiscal' authority.
16. An 'elevator pitch' comprises a compelling synopsis of a proposal or idea, delivered in a very constrained period of time. While accounts differ about the origins of the concept, it is often associated with venture capitalism and the film industry.

Acknowledgements

The authors would like to thank Miles Parker and Tim Forsyth for their perceptive comments on earlier versions of this paper, as well as two anonymous referees for their constructive suggestions. Most importantly, the authors extend their thanks to all interviewees who generously gave their time to contribute to this study. Any remaining errors are entirely the authors' own.

Funding

This work was supported by the University of Cambridge Humanities Research Grants Scheme and the Isaac Newton Trust and was undertaken while JP was a research assistant at the Cambridge Centre for Science and Policy.

References

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

Callon, M., Lascoumes, P., and Barthe, Y. (2009) *Acting in an Uncertain World: An Essay on Technical Democracy*. Cambridge: The MIT Press.

Campbell, L. M., Corson, C., Gray, N. J., MacDonald, K. I. et al. (2014) 'Studying Global Environmental Meetings to Understand Global Environmental Governance: Collaborative Event Ethnography at the Tenth Conference of the Parties to the Convention on Biological Diversity', *Global Environmental Politics*, 14/3: 1–20.

Cassidy, A. (2015) 'Big Science' in the Field: Experimenting with Badgers and Bovine TB, 1995–2015', *History and Philosophy of the Life Sciences*, 37/3: 305–25.

Clark, W. C. and Majone, G. (1985) 'The Critical Appraisal of Scientific Inquiries with Policy Implications', *Science, Technology and Human Values*, 10: 6–19.

Collingridge, D. and Reeve, C. (1986) *Science Speaks to Power: The Role of Experts in Policymaking*. London: Francis Pinter.

Collins, H., Weinel, M., and Evans, R. (2010) 'The Politics and Policy of the Third Wave: New Technologies and Society', *Critical Policy Studies*, 4/2: 185–201.

Doubleday, R. and Wilsdon, J. (2012) 'Science Policy: Beyond the Great and Good', *Nature*, 485/301: 302.

Dunlop, C. A. (2010) 'The Temporal Dimension of Knowledge and the Limits of Policy Appraisal: Biofuels Policy in the UK', *Policy Sciences*, 43/4: 343–63.

——— (2017) 'Pathologies of Policy Learning: What are they and How do they Contribute to Policy Failure?', *Policy and Politics*, 45/1: 19–37.

Ezrahi, Y. (1980) 'Utopian and Pragmatic Rationalism: The Political Context of Scientific Advice', *Minerva*, 18: 111–31.

Fergusson, N. M., Donnelly, C. A., and Anderson, R. M. (2001) 'Transmission Intensity and Impact of Control Policies on the Foot and Mouth Epidemic in Great Britain', *Nature*, 413: 542–8.

Fischer, F. (2011) 'The 'Policy Turn' in the Third Wave: Return to the Fact–Value Dichotomy?', *Critical Policy Studies*, 5/3: 311–6.

Flyvbjerg, B. (1997) *Rationality and Power: Democracy in Practice*. London: University of Chicago Press.

Forsyth, T. (2003) *Critical Political Ecology: The Politics of Environmental Science*. London: Routledge.

Funtowicz, S. O. and Ravetz, J. R. (1993) 'Science for the Post-Normal Age', *Futures*, 25/7: 739–55.

Gieryn, T. F. (1983) 'Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists', *American Sociological Review*, 48: 781–95.

——— (1995) 'Boundaries of Science'. In: S. Jasanoff, G. E. Markle, and T. Pinch (ed.) *Handbook of Science and Technology Studies*, pp. 393–443. Thousand Oaks: Sage.

GOScience (Government Office for Science). (2010) *The Government Chief Scientific Adviser's Guidelines on the Use of Scientific and Engineering Advice in Policy Making*. London: Department for Business, Innovation and Skills.

—— (2015) *Chief Scientific Advisers and their Officials: An Introduction*. London: Department for Business, Innovation and Skills.

Guston, D. (2001) 'Boundary Organizations in Environmental Policy and Science: An Introduction', *Science, Technology, & Human Values*, 26/4: 399–408.

Hajer, M. A. (1995) *The Politics of Environmental Discourse*. Oxford: Oxford University Press.

——— (2005) 'Setting the Stage: A Dramaturgy of Policy Deliberation', *Administration and Society*, 36/6: 624–47.

Hajer, M. and Versteeg, W. (2005) 'A Decade of Discourse Analysis in Environmental Politics: Achievements, Challenges, Perspectives', *Journal of Environmental Policy and Planning*, 7/3: 175–84.

Hart, D. M. (2014) 'An Agent, Not a Mole: Assessing the White House Office of Science and Technology Policy', *Science and Public Policy*, 41/4: 411–8.

Hilgartner, S. (2000) *Science on Stage: Expert Advice as Public Drama*. Redwood City: Stanford University Press.

HMT, DES, OST, and DTI. (2002) *Cross-Cutting Review of Science and Research: Final Report*. March 2002. London: Her Majesty's Treasury.

HoLSTC. (2000) *Science and Society*. House of Lords Select Committee on Science and Technology Committee, 3rd Report of the Session 1999-2000, HL Paper 38. London: Her Majesty's Stationery Office.

—— (2012) *The Role and Functions of Departmental Chief Scientific Advisers - Report*. House of Lords Select Committee on Science and Technology, 4th report of the session 2010-2012, HL Paper 264. London: The Stationery Office.

Ingold, T. (1992) 'Culture and the Perception of the Environment'. In: E. Croll and D. Parkin (eds) *Bush Base: Forest Farm: Culture, Environment and Development*, pp. 39–56. London: Routledge.

Jasanoff, S. (1987) 'Contested Boundaries in Policy-Relevant Science', *Social Studies of Science*, 17: 195–230.

——— (1990) *The Fifth Branch: Science Advisers as Policymakers*. Cambridge: Harvard University Press.

——— (2004) *States of Knowledge: The Co-Production of Science and Social Order*. London: Routledge.

——— (2005a) 'Judgement Under Siege: The Three-Body Problem of Expert Legitimacy'. In: M. Sabine and W. Peter (eds.) *Democratization of Expertise? Exploring Novel Forms of Scientific Advice in Political Decision-Making*, pp. 209–24. Dordrecht: Springer.

——— (2005b) *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton, NJ: Princeton University Press.

——— (2011a) 'Quality Control and Peer Review in Advisory Science'. In: L. Justus and W. Peter (eds) *The Politics of Scientific Advice: Institutional Design for Quality Assurance*, pp. 19–35. Cambridge: Cambridge University Press.

——— (2011b) 'Cosmopolitan Knowledge: Climate Science and Global Civic Epistemology'. In: J. S. Dryzek, R. B. Norgaard, and D. Schlosberg (eds) *The Oxford Handbook of Climate Change and Society*, pp. 129–43. Oxford: Oxford University Press.

——— and Simmet, H. R. (2017) 'Funeral Bells: Public Reason in a Post-Truth Age', *Social Studies of Science*, 47/5: 751–70. No

Kattirtzi, M. (2016) '"Challenge and Be Challenged": A History of Social Research Capacity and Influence in DEFRA and DECC 2001–2015', Unpublished PhD thesis, University of Edinburgh, Edinburgh, UK.

Kennedy, D. (2016) *A World of Struggle: How Power, Law, and Expertise Shape Global Political Economy*. Princeton: Princeton University Press.

Le Heron, R. (2009) 'Rooms and Moments' in Neoliberalising Policy Trajectories of Metropolitan Auckland, New Zealand: Towards Constituting Progressive Spaces through Post-Structural Political Economy', *Asia Pacific Viewpoint*, 50/2: 135–53.

Livingstone, D. (2015) *Dealing with Darwin: Place, Politics and Rhetoric in Religious Engagements with Evolution*. Baltimore: John Hopkins University Press.

Majone, G. (1989) *Evidence, Argument and Persuasion in the Policy Process*. New Haven, CT: Yale University Press.

Mahony, M. (2013) 'Boundary Spaces: Science, Politics and the Epistemic Geographies of Climate Change in Copenhagen, 2009', *Geoforum*, 49: 29–29.

Montana, J. (2017) 'The Constitution of Expert Authority: the Organisation of Knowledge Practices for Biodiversity in IPBES', Unpublished PhD thesis, University of Cambridge, Cambridge, UK.

Mukerjee, M. (2010) *Churchill's Secret War: The British Empire and the Ravaging of India During World War II*. New Delhi: Tranquebar Press.

Nelkin, D. (1975) 'The Political Impact of Technical Expertise', *Social Studies of Science*, 5/1: 35–54.

Nichols, T. (2017) *The Death of Expertise: The Campaign Against Established Knowledge and Why it Matters*. Oxford: Oxford University Press.

Nowotny, H., Scott, P., and Gibbons, M. (2001) *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press.

OST (Office of Science and Technology). (1997) *The Use of Scientific Advice in Policy Making*. London: Department for Trade and Industry.

—— (2000) *Guidelines 2000: Scientific Advice and Policy Making*. London: Department for Trade and Industry.

—— (2005) *Guidelines on Scientific Analysis in Policy Making*. London: Department for Trade and Industry.

Owens, S. (2005) 'Making a Difference? Some Perspectives on Environmental Research and Policy', *Transactions of the Institute of British Geographers*, 30: 287–92.

——— (2011a) 'Knowledge, Advice and Influence: The Role of the UK Royal Commission on Environmental Pollution, 1970-2009'. In: L. Justus and W. Peter (eds.) *The Politics of Scientific Advice: Institutional Design for Quality Assurance*, pp. 73–101. Cambridge: Cambridge University Press.

——— (2011b) 'Three thoughts on the Third Wave', *Critical Policy Studies*, 5/3: 329–33.

——— (2015) *Knowledge, Policy, and Expertise: The UK Royal Commission on Environmental Pollution 1970–2011*. Oxford: Oxford University Press.

——— and Cowell, R. (2011) *Land and Limits: Interpreting Sustainability in the Planning Process*. Abingdon: Routledge.

Pallett, H. and Chilvers, J. (2015) 'Organizations in the Making: Learning and Intervening at the Science–Policy Interface', *Progress in Human Geography,* 39/2: 146–66.

Palmer, J. (2010) 'Stopping the Unstoppable? A Discursive-Institutionalist Analysis of Renewable Transport Fuel Policy', *Environment and Planning C: Government and Policy*, 28: 992–1010.

——— (2014) 'Biofuels and the Politics of Land-Use Change: Tracing the Interactions of Discourse and Place in European Policy Making', *Environment and Planning A*, 46: 337–52.

——— (2016) 'Interpretive Analysis and Regulatory Impact Assessment'. In: C. A. Dunlop and C. M. Radaelli (eds) *Handbook of Regulatory Impact Assessment*, pp. 52–65. Cheltenham: Edward Elgar.

Pielke, R. A. (2007) *The Honest Broker: Making Sense of Science in Policy and Politics*. Cambridge: Cambridge University Press.

Poortinga, W., Bickerstaff, K., Langford, I., Niewöhner, J. et al. (2010) 'The British 2001 Foot and Mouth Crisis: A Comparative Study of Public Risk Perceptions, Trust and Beliefs about Government Policy in Two Communities', *Journal of Risk Research*, 7: 73–90.

Price. (1965) *The Scientific Estate*. Cambridge, MA: Harvard University Press.

Quack, S. (2016) 'Expertise and Authority in Transnational Governance'. In: R. Cotterrell and M. Del Mar (eds) *Authority in Transnational Legal Theory*, pp. 361–86. Cheltenham, UK: Edward Elgar.

RCEP. (1984) *Tackling Pollution—Experience and Prospects. Royal Commission on Environmental Pollution Tenth report, Cm 9149*. London: Her Majesty's Stationery Office.

—— (1998) *Setting Environmental Standards. Royal Commission on Environmental Pollution Twenty-first report, Cm 4053*. London: The Stationery Office.

Sanderson, I. (2009) 'Intelligent Policy Making for a Complex World: Pragmatism, Evidence and Learning', *Political Studies*, 57: 699–719.

Sarewitz, D. (2011) 'The Voice of Science: Let's Agree to Disagree', *Nature,* 478: 7.

Schön, D. and Rein, M. (1994) *Frame Reflection: Towards the Resolution of Intractable Policy Controversies*. New York: Basic Books.

Shapin, S. and Schaffer, S. (1985) *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.

Shrader-Frechette, K. (1995) 'Evaluating the Expertise of Experts', *Risk: Environment, Health, and Safety*, 6/2: 115–26.

Stirling, A. (2003) 'Risk, Uncertainty and Precaution: Some Instrumental Implications from the Social Sciences'. In: F. Berkhout, M. Leach, and I. Scoones (eds) *Negotiating Environmental Change: New Perspectives from Social Science*, pp. 33–77. London: Edward Elgar.

——— (2010) 'Keep it complex', *Nature*, 468: 1029–31.

Sutherland, W., Bellingan, L., Bellingham, J. R. et al. (2012) 'A Collaboratively-Derived Science–Policy Research Agenda', *PLoS ONE*, 7/3: 1–5.

Turner, S. P. 2014. *The Politics of Expertise*. London and New York: Routledge.

Turnpenny, J., Russel, D., and Rayner, T. (2013) 'The Complexity of Evidence for Sustainable Development Policy: Analysing the Boundary Work of the UK Parliamentary Environmental Audit Committee', *Transactions of the Institute of British Geographers*, 38/4: 586–98.

Weale, A. (2010) 'Political Theory and Practical Public Reasoning', *Political Studies*, 58: 266–81.

Weber, M. (1922) *The Theory of Social and Economic Organization*. New York: Free Press.

Weinberg, A. M. (1972) 'Science and Trans-Science', *Minerva*, 10: 209–22.

Whatmore, S. (2006) 'Materialist Returns: Practising Cultural Geography in and for a More-than-Human World', *Cultural Geographies*, 13/4: 600–9.

Williams. (1993) 'The House of Lords Select Committee on Science and Technology within British Science Policy and the Nature of Science Policy Advice'. In: Peters G. B. and Barker, A. (eds) *Advising West European Governments: Inquiries, Expertise and Public Policy*, pp. 137–50. Edinburgh: Edinburgh University Press.

Withers, C. W. J. (2017) 'Trust – in Geography'. *Progress in Human Geography* Online First, pp. 1–20.

Wynne, B. (1992) 'Uncertainty and Environmental Learning: Reconceiving Science and Policy in the Preventive Paradigm', *Global Environmental Change*, 2/2: 111–27.