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Legislative science advice in Europe: the case for international comparative research

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ABSTRACT This article provides an introduction to science advisory structures in elected legislatures; an arena of public decision-making which, although critical to the healthy functioning of democratic societies, has been largely neglected in recent discussions of science advice. The article begins by contrasting the functions and operating environments of legislatures with those of executive branches of governments, examining how these differences shape the requirements of their respective science advisory structures. A study of three national legislative science advice units within Europe is then presented, revealing a range of advisory structures and practices. These variations in approach suggest different underpinning conceptions about both why science advice is being provided, and how science advice can most effectively influence a legislature's activities. Given these differences, and our currently limited comparative understanding of the influence of scientific knowledge across different spheres of public decision-making, we argue that more attention needs to be focused on the difficult challenge of mapping and understanding legislative science advisory structures via a comparative international study. We close by arguing that an international comparative exercise of this type could significantly improve our understanding of the different influences science advisory practices and structures can have on the function of our democratic societies' deliberative bodies. This article is published as part of a collection on scientific advice to governments.

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Introduction

The importance of science advice—broadly defined here as practices for mobilizing scientific knowledge in support of public decision-making—is now widely accepted (OECD, 2015). Over the last decade, governance organizations at all scales, local through international, have increased their commitment to informing policy decisions with the best available scientific knowledge. This has in turn generated a steady expansion in the number and types of established science advisory structures.

Throughout this period, our understanding of science advice has also steadily improved, particularly in the context of the executive branches of governments (see for example Doubleday and Wilsdon, 2013; Spruijt *et al.*, 2014; Wilsdon *et al.*, 2014). However, while much is known about the use and influence of scientific evidence in some well-studied institutional and topical contexts (see for example Hofer *et al.*, 2015), there remain some important gaps. One arena of public decision-making critical to the functioning of healthy democracies that has been largely overlooked in the recent expansion and study of science advice is that of legislatures (Tyler, 2013; Spruijt *et al.*, 2014).

As social institutions charged with representing the collective will of their society, legislatures—and the elected members comprising them—carry unique responsibilities. Most importantly, legislatures exist to reconcile the diverse, often conflicting, interests and expectations of a society's constituent groups and communities through the democratic means of peaceful dialogue and compromise. While the detailed practices vary, legislatures fulfil these responsibilities through the performance of three general functions: public deliberation over any and all matters of societal concern [debate]; the creation of legal and budgetary frameworks that guide how those matters should be addressed [legislation]; and oversight of programmes enacted by the executive branches of government to address those matters [scrutiny]. Elected members also respond to informational requests from constituents and provide frequent public statements and comments, which serve the additional function of shaping public understanding of the diverse range of issues with which they engage [public engagement]. To effectively perform these functions and fulfil their responsibilities in the modern era, elected members would ideally be supported by effective science advisory systems (Lake, 1995; Guston, 2004).

The importance of understanding the influence of science advice on legislatures is increasingly recognized, both in the literature (for example, Padilla and Gibson, 2000; Nath, 2011; Tyler, 2013) and by policy institutions funding networks and capacity building projects on legislative science advice (for example, the international project on Building Capacity in the Use of Research Evidence funded by the UK Department for International Development). Those engaged in providing science advice to legislatures would benefit from knowing whether, and to what extent, they are influencing their respective audiences; and those establishing new or modifying existing science advisory institutions, whether legislative or otherwise, could learn from approaches tried and tested elsewhere (Glynn *et al.*, 2003; Doubleday and Wilsdon, 2013; Wilsdon *et al.*, 2014). At present, however, we have insufficient knowledge about how existing legislative science advisory structures currently conceive of and work to enact their influence upon their legislature's functions and responsibilities.

This article presents the argument that legislative science advice deserves more comprehensive and internationally comparative attention. This argument is developed first by articulating the different contexts of science advice in legislative versus executive environments (Section “science advice in legislatures versus executives”). The current landscape of legislative science advice institutions in Europe is then outlined (Section “science

advisory units in European legislatures”), followed by the results of an initial comparative study examining three existing science advisory units within national legislative environments in the EU (Section “case study of three European science advisory units”; the methods for this study are described in section). The main purpose of this study was to explore differences between these units, both in terms of structures and practices, and in terms of their intended impact on their legislatures and/or their broader societies. Our findings reveal a richer landscape of practices and conceptions of impact for legislative science advice than generally discussed in the literature, suggesting that more comprehensive studies are needed to map the many influences science advice can have on legislatures' activities. These components are integrated in the final Discussion and Conclusions (Section “Discussion and Conclusions”), wherein we discuss the opportunities of and challenges facing a comprehensive, internationally comparative research agenda, which we argue could significantly advance our understanding and practice of science advice.

Science advice in legislatures versus executives

Before discussing the analysis of specific legislative science advisory units, the substantially different context of science advice in legislative versus executive branches must be appreciated (Tyler, 2013; OECD, 2015). Legislators have different needs for science advice than decision-makers in the executive, and the structures of these systems mean that the ways in which science advice is organized institutionally, as well as the type of advice provided, differs to that in the executive. Using the example of the UK executive and legislature (Parliament), the following describes the major differences between these structures and the institutional sources of science advice that support them.

The UK executive and its institutional sources of science

advice. The UK executive is made up of (at the time of writing) 120 ministers (of whom, 27 are from the House of Lords, the rest are from the House of Commons) plus 29 whips (across both Houses). These politicians are all aligned to a single political vision: they are, usually, from the same political party, signed up to the same manifesto, and report, ultimately, to the Prime Minister. A large civil service, made up of a little over 400,000 staff, supports them. An organization of such size requires a clear hierarchy with well-defined lines of communication, and the UK civil service has both.

Institutional scientific advice in this context has certain characteristics. First, it must fit into the extensive structure of the civil service, slotting into the hierarchy where it can make a difference. Several hundred-science advisers across the executive provide information and analysis to (mostly) other civil servants and (sometimes) ministers. They operate in policy teams within departments, on cross-departmental advisory groups, in executive agencies, and in independent advisory committees, in all cases reporting to specific posts within the executive structure. Second, it is provided within an environment shaped by the political agendas of the ministers running the executive. In that sense, even when not explicitly framed as evaluating specific policy proposals, advice is provided in a context shaped by understood political agendas, and is frequently interpreted as either supporting or challenging given policy alternatives. Although science advice in executives has sometimes been idealized using a simplistic caricature of Pielke's (2003) “honest broker” model—that is, assuming that “independent advice” also means complete disinterest towards the various policy options—this kind of romanticized, value-free conception of science advice seldom turns out to reflect reality (Douglas, 2009). Rather, science advice

in executives is frequently, and necessarily, directive in nature (House of Lords Science and Technology Committee, 2012; Simon, 2014).

The UK legislature and its institutional sources of science advice. Legislatures differ starkly from this characterization of science advice. The UK Parliament is made up of 650 Members of the House of Commons (MPs) and more than 800 Members of the House of Lords (Peers). The former is elected, with each Member representing a constituency and a political party. The latter is appointed, with over 80% of Members representing a political party, and the rest being independent “cross benchers” who are selected from a wide range of professions, including academia, medicine and engineering. Across both Houses, there are well over a thousand active politicians with an extremely wide range of interests, expertise and politics. They represent constituencies from the north of Scotland to the south of England, every conceivable interest group and a spectrum of politics that ranges from “right wing” (conservative) to “left wing” (socialist).

A relatively small staff of impartial officials, numbering only a few thousand, supports the whole system. Compared with the executive, Parliament has an order of magnitude more politicians and two orders of magnitude fewer staff. Full time science advisers in the UK Parliament sit in the House of Commons and House of Lords Libraries¹ (both provide research services), several of the select committees of both Houses, and in the Parliamentary Office of Science and Technology (POST), which is an office of both Houses. Most select committees also appoint external specialist advisers, usually academics, either to individual inquiries or sometimes for longer, part-time, ad hoc contracts.

In contrast to the UK executive, Parliament has a relatively loose and changeable hierarchy, and focuses less on making policy, and more on debate and scrutiny. This means that science advice has a wide range of possible targets, which affects the way that advice is presented, and is used both as a supporting tool for making arguments (in debate) and for asking forensic questions (in scrutiny), which affects the type of advice required. Thus, in Parliament, science advice is usually presented in a fashion that enables its use by multiple parties, from MPs’ staffers preparing their bosses for debate, to committees of MPs asking searching questions of government ministers. Critically, the same scientific advice in a legislative environment will frequently be used by two or more members (or their staff) seeking to advance profoundly different political agendas, based on widely varying underlying values. In this context, the advice given has to be sensitive to these different views, while representing the evidence impartially. In contrast to much of executive science advice, UK parliamentary science advice is discursive in nature. Such advice is not a broker of a narrow range of policy options, but of evidential value to a wide range of policy options.

The differences between science advice in executive and legislative environments are essential to understand that, from a practical perspective, structures and modes developed for one environment do not necessarily translate easily to the other. However, developing a better understanding of how science advice plays out across these different environments provides a valuable opportunity for both identifying general principles and practices, and for diversifying our understanding of the various routes and structures through which scientific knowledge can be, and currently is being, mobilized in support of public decision-making.

Science advisory units in European Legislatures

To date, the most significant body of literature on institutional structures for science advice to legislatures comes from the

United States and is focused on the former Congressional Office of Technology Assessment (OTA), which closed on 29 September 1995 (Gibbons and Gwin, 1985; Bimber, 1996; Jones *et al.*, 1996; Bimber and Guston, 1997; Guston *et al.*, 1997; Morgan and Peha, 2003). The OTA pioneered a particular mode of science advice, referred to as Technology Assessment (TA), which sought to advise legislators on the ethical and legal aspects of new sciences and technologies and possible social, economic and environmental impacts. This informed the development of a number of similar units across Europe in the 1980s and 1990s that set out to emulate the expert analysis provided by the OTA, alongside a focus on the involvement of stakeholders and the wider public in TA processes (Hennen and Nierling, 2015a: 12). The establishment of institutional TA units in Europe is often referred to as a “second wave of TA” in recognition both of the influence of the OTA (Rip, 2012), and of the different organizational, methodological and mission of European TA units (Vig and Paschen, 2000; Hennen and Ladikas, 2009; Enzing *et al.*, 2012; Hennen and Nierling, 2015a). These units now represent the considerable majority of institutional science advisory structures for European legislatures.

Awareness and understanding of European TA units and the important science advisory functions they serve have increased in large part thanks to international networking and research projects, such as the EU-funded Parliaments and Civil Society in Technology Assessment (PACITA) and the European Parliamentary Technology Assessment (EPTA) network. These have furthered understanding of the different ways that these units are structured across Europe, as well as how different factors shape their varying design and operation (Lentsch and Weingart, 2011; Bütschi, 2012; European Parliamentary Technology Assessment, 2012; Bütschi and Almeida, 2015; Hennen and Nierling, 2015a,b). Moreover, the “intense networking and mutual learning processes” within the EPTA Network has led to a collective learning about methodologies and ideas and “a widening field for mutual exploration and collaboration” (Hennen and Nierling, 2015a: 9).

These networks and literature on European TA units provides an excellent foundation for exploring one of the most institutionalised forms of science advice in legislative environments. However, there remain at least two important gaps surrounding the challenging but critical question of how (and how effectively) these units influence legislative and/or broader societal outcomes.

First, empirical studies of such influence are limited, and typically focus on the broad question of whether such bodies are “fulfilling their mission to explore the possible impact of technology on society in order to support decision-making or not” (Hennen *et al.*, 2004: 57). However, this generic framing assumes that all such science advisory institutions have (or should have) the same concept of what this broad mission means; an assumption that is not borne out by our examination of three TA institutions in Europe, as demonstrated in the next section (Section “Case study of three European science advisory units”).

Second, studies on influence have to date typically examined the impact of these units independently of any consideration of the importance of other sources of science advice. Influence is frequently seen in terms of specific mechanistic outcomes, without consideration to mapping or understanding the diverse routes through which science advice can reach legislators and influence legislative activities. Examples such as the approval of mitochondrial donation in the UK legislature—a case outlined in the Supporting Information for this article—demonstrate the difficulties of identifying the impact of institutional bodies on legislatures. Despite being held up as an example of science advice informing legislative scrutiny in the UK context (Blackwood,

2015; Gallagher, 2015), a closer examination of this case reveals the role of multiple actors and therefore, the competition that institutional sources of science advice face from other evidential sources, both internal and external to the legislature. While the details will vary in different countries, the existence of a range of mechanisms, formal and informal, for diverse societal actors to provide advice and evidence to legislators is foundational to modern democratic legislative environments. While beyond the scope of this study, we would expect detailed examination of cases from other legislatures with formal science advisory units (for example, those within the EPTA community) would reveal similar patterns. We return to the challenges of mapping and understanding the impact of science advice within such a diverse ecosystem in our Discussions and Conclusions (Section “Discussion and Conclusions”).

Case study of three European science advisory units

The analysis presented in this section is based on a small study of three science advisory units for national legislatures in Europe. This involved a nine-month secondment of one author (CLW) to the UK POST, along with exploratory visits by that author to two further legislative science advisory units in Europe—OPECST in France, and TA-Swiss in Switzerland. Semi-structured interviews were undertaken with representatives of the offices in order to assist with interpreting and navigating public domain materials, and a comparative analysis of these three bodies was undertaken using these materials. (All authors contributed insights to the comparative analysis.) The objective was to identify similarities and differences in the structure and function of these units, and the potential implications for the units’ influence on legislative functions.

Table 1 compares critical points in the output generation process for the three examined science advisory units. The first row presents a summary of the “impact” statements provided in a 2012 report produced by EPTA to provide, in one location and in the same format, basic institutional and procedural information about all its member institutions (EPTA, 2012). This table then looks at four parameters to highlight similarities and differences between the approaches taken to: physical and administrative location of the office; method for generating TA questions; the nature of the unit’s outputs; and the means by which these outputs are produced. These parameters illustrate, even within this limited sample, distinct combinations of approaches to the production of science advice. It is argued below that these approaches both contribute to, and are derived from, the different units’ perspectives on what type of influence is important, and how each specific conception of influence is most effectively mobilized. This work forms a set of initial observations and hypotheses that warrant further investigation.

From the information collated in Table 1, it can be seen that the science advisory units examined take a spectrum of approaches across each parameter discussed. The impact statements included highlight the differently stated organizational perspectives with respect to impact. This illustrates the sometimes overlapping and other times differing perspectives on the nature and measurement of impact, from quantification of use by parliamentarians to visibility in the media. Question generation ranges from reactive (based upon an actual or perceived imminently pressing need from stakeholder communities) and fully determined by MPs (OPECST) to proactive and determined by the unit’s staff (overseen by a board or committee) (POST and TA-Swiss). Outputs regularly include a long-form written version of the information collated, but the nature and content of these reports differs from a technical manual (TA-Swiss) to a summary of policy and public debates (OPECST). Summary reports and

public events are also a common output, though vary in their immediate audiences, aims and format. Similarly, generation of outputs can occur at many different levels of TA body involvement in collation, production and editing: from entirely within the unit’s team (POST) to externally tendered bodies of experts organized for the purpose (TA-Swiss).

A brief analysis of the above suggests that in considering the self-reported effectiveness and impact of legislative science advisory units, five key considerations are: target audience; institutional location; scope of the unit’s role in relation to the legislature; methods used by the organization to generate study questions and produce outputs; and the involvement of legislators in the work of the unit. It also invites further reflection on the nature and expectations of the likely target audience(s) in shaping the impact agenda of these bodies.

Target audience. The intended audience for outputs is correlated with both the methods and outputs of the units examined. While all of the outputs of the bodies noted above are a product of the related TA-based processes, their primary readership differs vastly, which is reflected in the considerably different format of their outputs in Table 1. TA-Swiss long reports are likely to be read by students and technical specialists, while their short reports are designed for the general public as well as legislators. All of POST’s outputs are designed primarily for decision makers, as are those of OPECST. Some elements of the outputs conform to the idea that legislative science advice is usually presented in a fashion that enables its use by multiple parties, particularly the content, language and presentation style of short briefing and summary reports.

Institutional location. The location of POST and OPECST within the UK and French legislatures, respectively implies more direct access to, and therefore influence upon, legislators themselves. The evolution of POST from an organization outside of the UK legislature, funded by external sponsorship, to an internal body within it demonstrates the philosophy behind this point. According to Professor Michael Norton, POST’s first director, the experience of starting POST outside of Parliament, then migrating inside, reinforced the value of being close to POST’s targeted legislative customers (Norton, 1997). Being located within the UK legislature enables POST to demonstrate its expertise and advice on scientific and technological matters as a valuable and distinct addition to the support provided by other internal science advisory structures, such as the Science and Environment Section within the House of Commons Library (House of Commons, 1995; Norton, 1997: 229). The assumption that closer proximity between science advisory structures and legislators facilitates the transmission of advice through formal as well as informal channels is echoed in the literature (Cruz-Castro and Sanz-Menéndez, 2004; European Parliamentary Research Service, 2015; van Est *et al.*, 2015). However, it is not accepted universally. Some authors argue that independent science advisory organizations such as TA-Swiss have the most visible effects in terms of “raising knowledge” and “forming attitudes/opinions” (Enzing *et al.*, 2012: 20).

Scope of work. It is important to consider the scope of these units in relation to the legislature and, specifically, whether they function purely as an information service or one that has the capacity, or indeed expectations, to put forward policy options or make recommendations. Hennen (2000) argues that such science advisory units should not be assessed according to their impact on political decision-making as they were not designed to influence such decision-making directly. Rather, they are “designed

Table 1 | Comparison of three TA organizations in Europe*

	UK (POST)	France (OPECST)	Switzerland (TA-Swiss)
Impact	<p>“Impact is difficult to assess due to the logistical and administrative obstacles... POST is one of many organizations delivering commentary on scientific issues”. Qualitative and quantitative data indicates that POST is a valued organization. “POSTnotes are particularly valued for their impartiality”. 2009 survey data indicated that “over 80% of parliamentarians (out of a sample of 50) had used POSTnotes more than once in the past year.” “POSTnotes are known to have considerable impact outside Parliament [and] usually account for around a third of all downloads from the Parliamentary website”. POST also has over 7,500 followers on Twitter, and a newsletter which has over 3,500 subscribers.</p>	<p>OPECST has progressively “become an acknowledged instrument of parliamentary action. Several laws make provision either for it to be informed of, or to participate in the appointment of representatives of Parliament to various bodies, or for its representation, by its President or one of its members, on the board of directors of various organisations.” It contributes to the development of international parliamentary relations (particularly via EPTA). OPECST has become a special interlocutor for the scientific community and maintains close links with it. Its events and conferences bring together OPECST and high-level scientific organizations. “In the near future, OPECST would like to continue to strengthen its missions and, in particular, to play a role in furthering the exchange between the political and scientific worlds.”</p>	<p>“Political decision makers rely on assessments which show the consequences and social impact of technologies. The work of TA-SWISS is widely recognized for its quality and the impartiality of its assessments. It is vital for TA-SWISS to continually strive for these qualities in order to maintain support from all political parties”. TA-Swiss—reports are often cited in committee reports and in chamber debates but can also be used in other forums such as the government, local authorities etc. Most of the committee seminars are webcast and broadcast on television.</p>
Institutional Location	<p>Internal. Office based within parliamentary offices and located on the parliamentary estate.</p>	<p>Internal. Office based within parliamentary offices and located on the parliamentary estate.</p>	<p>External. Office is a Centre of Competence of the Swiss Academies of Arts and Science located away from the parliamentary estate.</p>
Generation of questions	<p>Proactive and reactive. Topics are selected through horizon scanning by the POST team and requests from MPs and/or parliamentary staff. Questions are co-produced by POST team and POST Board (comprising 14 parliamentarians from the House of Commons [10] and Lords [4]; external science and technology specialists [4]; ex-officio representatives from the House of Commons and Lords).</p>	<p>Reactive. All topics are determined and proposed by MPs (matters can be referred to OPECST at the request of a chair of a political group, a request of 60 deputies or 40 senators, or a request of a special or permanent commission).</p>	<p>Proactive and reactive. Horizon scanning by TA-Swiss team, with selection overseen by executive committee (around 15 members with different professional competences and institutional backgrounds).</p>
Outputs	<p>Format:</p> <ul style="list-style-type: none"> • Written briefings—mostly four-page summary briefs (POSTnotes) • Events—smaller events held for MPs and Peers (often linked to POSTnote publication topics), occasional larger events and exhibitions • Oral briefings—to MPs and Peers and/or parliamentary staff by request 	<p>Format:</p> <ul style="list-style-type: none"> • Legislative reports—recording MPs views on the technical content of the TA question (supported by scientific input) • Summary reports—four-page summary versions of legislative reports • Public hearings—gathering the views of leading figures and organizations (outputs may be annexed to legislative report) • Symposiums and conferences—larger policy / public meetings 	<p>Format:</p> <ul style="list-style-type: none"> • Technical reports—large books which collate detailed, contemporary technical knowledge on the topic • Summary reports—which summarize the key technical and policy-relevant content of reports • Public presentations—workshops and debates to encourage participation
Generation of outputs	<p>Internal topical expertise from POST team sections (social sciences, energy and environment, physical sciences and ICT, and biological sciences and health), review of existing evidence base and interviews with relevant experts across academia, industry, government, NGO, civil society and so on. Outputs are peer reviewed by external experts before publication.</p>	<p>Guidance from OPECST team in assisting a nominated parliamentary rapporteur to undertake the process of creating a record of conversations between MPs on the topic, based on preliminary technical content. Organization of public hearings may also be part of this process. Report generation is overseen by rapporteurs and a scientific standing committee.</p>	<p>Tendering for expertise to external, topical scientific research groups (self-formed 10–20 persons with appropriate professional competences). All assessments are project managed by a member of the TA-Swiss team, guided by the executive committee (mixed expertise) and a monitoring group (technical expertise) formed for the purpose</p>

*Information in Table 1 is adapted from EPTA 2012. Impact statements are summarized for brevity, with quotation marks illustrating direct quotation from the reference material.

to... prepare knowledge that is relevant for decision making ... [in] an attempt to include the knowledge and perspectives of social groups normally not involved in technology policy decision making in order to expand the scope of perspectives considered in technology policy” (Hennen, 2000: 152). However, examining the different functions and operations of these units in Europe suggests that what is considered within the remit of “preparing knowledge for decision-making” varies between organizations. Outputs (usually in the form of reports) produced by TA-Swiss can include recommendations (Attila *et al.*, 2012: 148; Feresin *et al.*, 2012: 164–165; Nentwich *et al.*, 2012: 32, 42; Paldam Folker *et al.*, 2012: 69). This can be contrasted with POST in the United Kingdom, which does not make policy recommendations, seeing this as a key factor in maintaining its demonstrable impartiality. The variations in the approaches adopted by these units to providing science advice suggest different underpinning models about both why such advice is being provided, and how it can influence legislatures’ activities.

Methods for generating study questions and outputs. The use of methods that increase the legitimacy and visibility of science advisory organizations are valued because they maximize the perceived independence of outputs (Nowotny *et al.*, 2001). The generation of study questions can be overseen by a board or executive committee, as is the case with POST and TA-Swiss, providing oversight and transparency, with OPECST topics selected directly by MPs. The processes for generating outputs range from the external appointment of a specific technical research group (TA-Swiss), to conducting literature reviews and research interviews across a range of stakeholders (POST), and includes the broader participatory methods used by both OPECST and TA-Swiss. Focusing on informing public debate through participatory methods is a mechanism used by some legislative science advisory units to feed into parliamentary decision-taking processes (Schot and Rip, 1997; Genus, 2006: 15–16; Delvenne *et al.*, 2011: 41). Units that engage with the media as part of a broader mission to stimulate public debate have been found to be particularly effective at raising the interest of legislators and communicating their results to the general public (Salo and Kuusi, 2001: 457; Enzing *et al.*, 2012: 20), and many have stated interest and capacity for doing so.

Involvement of legislators. The degree of involvement of legislators in the functioning of different science advisory units suggests particular understandings about impact. Legislators are actively involved on a permanent basis in OPECST in France (Enzing *et al.*, 2012: 12). Involving legislators in the unit’s practices—whether through the selection of topics, or in the OPECST case, in the development, production and communication of outputs—is seen to be an important mechanism for impact (Enzing *et al.*, 2012: 18; van Est *et al.*, 2015). However, this is not always straightforward. While the committed involvement of legislators is “desirable, if not indispensable”, the impartiality and methodological robustness of science advisory institutions may be questioned if such bodies are perceived to be too close to legislators (Salo and Kuusi, 2001: 460). POST and TA-Swiss are largely distanced from legislative involvement in the production of outputs, and to some extent in the generation of research questions.

These three examples of legislative science advisory units within Europe show considerable variation in the potential objectives, operational models and specific practices. The above analysis shows these variations to be closely correlated with different ideas of how science advice can most effectively influence legislative decision-making. Differences include both

the type of influence and audiences that are prioritized, and the mechanisms through which these units seek to achieve and monitor their influence.

A detailed historical analysis of the origins of these three units’ perspectives on impact was beyond the scope of this study. Some aspects will have derived from explicit aims at the inception of the units, while others will have evolved in parallel with the changing practices and structures of the units. Regardless, this initial comparative study clearly demonstrates that contemporary legislative science advisory units have notably different conceptions of desired influence (or mission) on their respective legislative bodies.

This variety in science advisory objectives, and the different routes identified through which a science advice unit can accomplish those different objectives, is also different from, and broader than, those typically discussed in contemporary science advice literature focused on the executive branches of government. On the basis of these initial results, we argue that more comprehensive studies are needed to identify and understand the variety of influences that science advice can have on legislative responsibilities and functions. Ideally, such studies would also aim to evaluate how effective different structures and practices of formal science advisory units are at delivering different conceptions of impact.

Discussion and conclusions

Improving the supply and demand of science advice is now an international concern. In this context, “[pooling] our efforts... and [learning] from each other” by sharing insights and best practices across different advisory systems is essential (Wilsdon *et al.*, 2014). The study presented in this paper aims to contribute to this collective learning process by documenting and analysing the current structures and practices of legislative science advice—a domain of public decision-making currently underrepresented in the current science advice literature.

The first important observation is the notably different requirements for science advice that exist in legislative contexts relative to those within executive environments (Section “Science advice in legislatures versus executives”). Executive science advice must operate within extensive civil service bureaucracies; is provided in an environment shaped by focused, delivery-oriented political agendas stemming from Ministers; and must frequently provide directive analysis of and advice on specific policy alternatives. Conversely, legislative science supports the broader deliberative processes of legislation, debate and scrutiny; needs to be provided in a manner that enables adoption and use by diverse users with divergent political agendas; and must provide an evidence base that is relevant to, but generally not directive about, a wide range of policy alternatives. Understanding these differences is critical for designing effective structures and practices for science advice within diverse public decision-making contexts. This emphasizes the need for expanding research into legislative science advice to parallel currently expanding exploration of executive science advice.

Of course, as is true for executive science advice, legislative science advisory units do not all approach the delivery of their core objective to support public decision-making in the same way. In fact, our initial comparison of only three legislative science advisory units in Europe (Sections “Science advisory units in European legislatures” and “Case study of three European science advisory units”) demonstrated considerable diversity in their conceptions of impact, influence and mission of these units, and in how those in turn translated into institutional practices. This diversity in objectives, and the variety of routes identified through which a science advisory unit can accomplish those different

objectives, appears to be broader than the range typically discussed in the current literature focused on executive science advice. For example, the participatory methods undertaken by OPECST and TA-Swiss that engage the public and media as a route to influencing legislative decision-makers is not generally seen in executive environments. Given the political agendas shaping the context of executive science advice discussed earlier, this is perhaps not surprising; direct appeal to the public in such executive contexts could be seen as undermining the authority of the politically-mandated executive officials.² In the context of legislative environments, however, such direct engagement of public stakeholders does not seem—at least in two of the contexts examined in this study—to engender such tensions. Rather, there is evidence from other studies that such routes enhance legislative engagement and uptake of science advice (Salo and Kuusi, 2001: 457; Enzing *et al.*, 2012: 20). The examination of legislative advice thus opens up new and important conversations regarding the interface between science advice, generally framed as for specifically identifiable communities of decision makers, and public debates and deliberations within our increasingly educated and discursive democratic societies.

With well over a dozen legislative science advice units in Europe alone, and new units being established or considered around the world, this is a rich, largely unexplored domain of potential data for the growing community of scholars, researchers and practitioners examining and evolving contemporary science advisory systems. A more in depth comparison of the legislative science advisory units of a larger number of countries would very likely provide deeper and broader new insights into different possible models for the structures and practices of science advice. That said, mapping and analysing the diverse influences of science advice on the activities of a national legislature is a complex undertaking. Even if the goal is simply to evaluate the influence of a single institutional source, such as a national legislative science advice unit, the results of the last section highlight the challenge of first needing to understand the impact objective(s), and the practices being deployed to accomplish that objective. Moreover, as discussed in the section “Science advisory units in European legislatures” and highlighted by the case study presented in the supporting information, advice about the scientific dimensions of legislative activities comes from a range of sources, not just institutionalised science advisory bodies. To develop a comprehensive understanding of how scientific knowledge is effectively mobilized to support legislative responsibilities and functions, research examining legislative science advice needs to consider the full range of actors involved in providing scientific advice into legislative activities.

The main challenge for any such comparative study would be in evaluating how effective the different science advice models are at actually supporting and influencing legislative functions (Hennen, 2000; Bütschi *et al.*, 2004; Cruz-Castro and Sanz-Menéndez, 2004; Hennen *et al.*, 2004; Hennen, 2012). As discussed in the section “Case study of three European science advisory units”, conceptions of who to influence and how to deliver that influence vary between the three units we examined, adding to the complexity of evaluating and comparing the effectiveness of different units. To be effective, an internationally comparative research programme would need a common framework for examining these issues in each independent national context.

In parallel with this study, three of the authors of this study (JJB and CT as principal investigators; CK as lead researcher) have developed and deployed a research framework for comprehensively examining the diverse impacts of multiple sources of science advice on the activities of the UK Parliament.³ This framework explores not only the work of a legislative science advice unit, but also maps the broader science advisory

“ecosystem” in which that unit operates. While the details and results of this ongoing research are beyond the scope of this study, early results reveal a dynamic science advisory ecosystem in action (Kenny, 2015), and our emerging understanding from that study has strongly informed this work. In particular, the research framework and protocols developed within that project stimulated questions about other legislative science advisory units (the focus of this small study), and led us to consider the potential value of this framework as a foundation for an effective comparative programme. While not yet rigorously examined, the core elements of the research framework—based on embedding researchers within the Parliamentary setting, and equipping them to deploy a mixed-methods approach that includes primary document analysis, surveys, semi-structured interviews and ethnography—provides at minimum a rough starting-point for further consideration.

Further developing and expanding this research framework to a large international comparative study would require a notable investment of researcher effort. Applying this approach would require embedding researchers with mixed-method social science expertise into each legislative environment for an extended period. Ensuring coordination in methodology and case selection between the researchers examining different legislative environments would also require regular international research planning meetings and dissemination of results. However, based on the institutional diversity and insights identified by the initial comparative study presented in this paper, the potential learning derived from a comprehensive comparative study appears considerable. Moreover, the substantial and increasing time, resources and energy being devoted to delivering and enhancing science advice activities (OECD, 2015: 20) emphasizes the importance of continuing to expand and improve our global understanding of contemporary science advisory structures and practices. Given these factors, we suggest that the learning from such an international comparative study of legislative science advice would be well worth the invested time and resources.

Notes

- 1 The House of Commons Library is made up of eight specialist subject teams. Staff in the Commons Library are subject specialists. In contrast, staff in the House of Lords Library are generalists rather than specialists.
- 2 An example of this playing out can be seen in the 2009 case of Professor David Nutt being asked by the UK Home Office to resign as Chair of its’ Advisory Council on the Misuse of Drugs because of an article he published “[claiming] that alcohol and tobacco were more harmful than many illegal drugs, including LSD, ecstasy and cannabis” (Tran, 2009), which contradicted the Government’s stated policies. While there are differing accounts of events from Professor Nutt and the Government, the potential tension created by an executive science adviser directly engaging the public is clearly evident in this case.
- 3 Funded by the UK Economic and Social Research Council (ESRC) and run as a collaboration between the Parliamentary Office of Science and Technology (POST) and University College London (UCL), this on-going research programme maps and examines the ways that science advice feeds into legislative processes and how it interacts with other types and sources of evidence.

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Data availability

Data sharing not applicable to this article as no data sets were generated or analysed during the current study.

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