

Chapter 1: Understanding Science-Policy Interfaces

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Introduction

This article gives a brief overview of the theoretical approaches towards SPIs. Against this theoretical background, the research projects of nine early-career researchers exploring SPIs in their various forms are then presented. These projects all take an empirical stance. The article shows how these projects tackle research gaps in three overarching areas crucial to the understanding of SPIs: a) knowledge co-production, b) communication of research results to decision-makers, and c) policy impact assessment processes as institutionalised instruments for enhancing SPIs. The empirical material from the ESR projects illustrates that SPIs can benefit from greater interaction between scientists, policy-makers and societal stakeholders, but that the functioning of these three groups is highly dependent on contextual circumstances.

Theoretical Approaches to the SPI

Policy-making at all levels and in all sectors of government requires information in the form of statistical data, empirical evidence and scientific analysis. Science-Policy Interfaces (SPIs) are the “social processes which encompass relations between scientists and other actors in the policy process” (Van den Hove 2007: 807). As such, they are a broadly discussed subject among policy-makers, scientists and scholars of policy-making. While the concept of an SPI is general and descriptive, a range of specific normative approaches for the design of interactions between science and policy have been proposed over the years. Generally speaking, we can distinguish three theoretical approaches: the rational, the constructivist, and the pragmatic approach.

The central premise of the *rational* perspective, which arose from a positivist scientific tradition and gained dominance in managerial public policy discourse in the mid-20th century, is that policy-makers should systematically gather information and consider all alternatives before making the (objectively) “correct” or “best” decision (Fischer 1998; Howlett et al. 2009). Hence, science and policy are thought to interact via a linear model: science supplies knowledge required by policy-makers. However, empirical evidence shows that scientific findings are often disregarded in policy-making processes, even when scientists adhere to criteria of scientific excellence and present state-of-the art results (Jasanoff 1994).

As a reaction to this view, the *constructivist* perspective arose, claiming that knowledge is constructed through social assumptions and norms, rather than existing as an objective truth. As such, its proponents are more interested in creating interactive forms of decision-making that

incorporate multiple views (Fischer 1998; Healey 2008), as opposed to privileging science as an input. However, studies show that broad stakeholder participation alone cannot legitimate decisions if they contradict the findings of the scientific community (Jasanoff 1994) – essentially, neither scientific findings nor political consultation are particularly effective inputs to the policy process if used independently of one another and they are often conflicted.

The *pragmatic* perspective addresses this complexity by deferring to the acquired experience of experts who navigate SPIs on a regular or formal basis. It acknowledges the skills, knowledge and judgement of experts (Flyvbjerg 2006). In this view, experts may consider stakeholder participation necessary for credible scientific knowledge production – for instance, to accommodate uncertainties related to a diversity of knowledge perspectives on the topic or a diversity of values among the involved groups. In ensuring the relevance of information, they may also pay attention to the timing, scope, and perceived legitimacy of research (Cash et al. 2002). Essentially, the pragmatic perspective assigns a role to the expert judgement of what kind of knowledge is needed: knowledge that is credible, relevant, and legitimate to all actors involved in decision-making processes (Weiland 2011). Each of the three perspectives has something to offer.

Research Gaps – Knowledge Co-production, Science Communication, and Policy Impact Assessments

Considering the three perspectives together, it is widely acknowledged that both the consideration of scientific findings as well as the integration of stakeholders' knowledge in the knowledge production process are crucial for increasing the credibility, legitimacy and relevance of knowledge for policy making; however, the mechanisms for integrating science, policy, and society (i.e. how exactly to manage SPIs) are still not entirely clear. Despite the attempts of constructivists and pragmatists to interpret SPIs as dynamic and interactive settings, problematic linear patterns in SPIs can still be observed, for example:

- Knowledge is deliberately ignored by policy-makers (Innes 1990);
- Scientists overestimate the value of their work and misunderstand how it is used in policy-making (Lindblom & Cohen 1979);
- Scientists present their findings selectively (Barber 1987);
- Knowledge remains incomplete due to exclusion of relevant stakeholders or types of knowledge (Fischer 1998; Healey & Hillier 1996);
- Scientists and policy-makers use different assumptions, values, and language to discuss policy problems (Lindblom 1990);
- There is no widely accepted set of criteria to measure the credibility, relevance, and legitimacy of knowledge and compare them against one another so far (Jahn et al. 2012);

In investigating how to best view, analyse, and facilitate SPIs so that these barriers might be mitigated, several issues seem to be crucial,

which we address in our research projects.

First, knowledge co-production emerges as a concept for more useful science and more effective policy. That is, scientific knowledge can be seen as being produced by an integral process involving both scientists as well as other social actors, who come to a mutual understanding where possible, and also communicate their respective needs and limitations to one another (Jasanoff 2004). Research questions that still need to be addressed in this context are:

- What are the general preconditions to enable knowledge co-production?
- What are the criteria for measuring the quality of research that was co-produced?
- Which methods are best suited to facilitate knowledge creation processes that involve scientists as well as policy-makers and other societal actors?

Secondly, communication of scientific findings to other actors remains a crucial aspect of SPIs, not only because the ideal of co-production is not always possible, but because information still needs to be interpreted and synthesised for general use even if policy-makers and other societal actors are engaged in the production process to begin with. Questions that still need to be answered are:

- How can scientific findings be presented so that they are regarded as legitimate, credible, and relevant for policy-making?
- How can knowledge be contextualised in terms of relevant policy issues to be tractable and easily accessible for policy makers?
- Which actors should be involved in the communication process? How should they be involved?

Thirdly, institutionalised processes such as policy impact assessment (IA) can serve as formal SPIs. IA was introduced as a tool to collect evidence on the likely future impacts of proposed policies with the aim to minimise unwanted side-effects and to maximise the benefits for society. Although IA systems are in place in all OECD countries and the EU, the IA systems vary considerably in terms of actors involved, the methods and models used, as well as their implementation and use in the policy-making process (Jacob et al. 2012). Research gaps still exist regarding the following questions:

- How do political, cultural, and institutional contexts influence the set-up of the IA process?
- Which actors need to be involved in the process to ensure the relevance and legitimacy of the IA?
- How might tools be designed to support the IA process?
- Under what circumstances does IA lead to a better integration of sustainable development goals into policy-making?

Against this background, our research projects, which are introduced in the following section, attempt to put forward a fresh perspective on SPIs and address some of the above gaps, though they do so in very different

ways. Each of us moves beyond a primarily theoretical discussion to concentrate on how SPIs function in reality using in-depth, empirical studies. We investigate a wide range of SPIs that deal with diverse policy problems over a wide range of jurisdictions, acknowledging the importance of context in managing and understanding the SPIs of any given case effectively. In this way, we contribute to the development of a broad overview of conditions that must be met to establish well-functioning SPIs. Our conclusion illustrates how networks like LIAISEoffspring can improve the understanding we have of our own projects by giving us the opportunity to compare them against others which are rooted in various disciplinary and jurisdictional backgrounds.

Perspectives on Science-Policy Interfaces

As elaborated above, our collective research explores the function of SPIs, addressing three key issues: a) knowledge co-production: how knowledge (i.e. in its wider meaning, not simply the interpretation of evidence produced by the scientific community) can be generated so that it is meaningful in policy-making processes, b) communicating scientific findings: how communication about existing research results between science and policy can be improved in various institutionalised settings of SPIs, and c) policy impact assessment as an institutionalised SPI: how a specific SPI instrument, IA, can be used to improve the evidence base of policy-making and facilitate the interaction addressed under the two above issues.

Knowledge Co-production

Although we are writing about SPIs, all of our research projects acknowledge that science is not the only source of knowledge, though it is important. Consider the notion of knowledge co-production (Jasanoff 2004), the generation of data and information by including policy makers and other stakeholders in the knowledge production process, which is sometimes interchangeable with the term science-policy interface (Cash et al. 2003), showing an important overlap amongst the concepts. In this context, we address the question of which criteria and conditions must be met to successfully produce results that are relevant for knowledge users. Hence, several of our research projects look at the knowledge production process, as well as its background conditions, from very different angles in order to contribute to the discourse on criteria for transdisciplinary, policy-relevant research.

Plans, indicators, and institutions: An examination of urban sustainability governance in six U.S. and German cities

Lisa Pettibone's research seeks to understand empirically and specifically how sustainability indicators generated to help guide policy-making toward a sustainability transition are used by political, administrative, and civil society actors in U.S. and German cities. Her comparative case study approach focuses on how and by whom sustainability indicator sets were created and used in six cities. Her

findings support the constructivist perspective on SPIs: sustainability indicators were often created by civil society actors in order to advocate for a normative shift in policy, for example toward more consideration for environmental protection or social equity. Indeed, not a single scientist-developed indicator set saw measurable use by policy-makers. Most such sets were thus quickly abandoned, highlighting the empirical inaccuracy of the rational approach to SPIs. Instead, she found support for a more deliberative model: indicators have most often been used to share narratives of sustainability and advocate for specific policies as well as to shift values to better align with sustainability principles. Indicators' discursive role in policy-making, however, remains poorly understood and is worthy of further study.

Institutional bridges between climate science and policy in Canada

Garrett Richards also takes a closer look at processes of knowledge production, but specifically regarding the issue of climate change in Canada, where SPIs are in need of further analysis. That is, not only has the country made little progress on reducing its greenhouse gas emissions since the Kyoto agreement of 1997, but its per-capita emissions are among the highest in the developed world. In his PhD project, he examines formal dialogues (e.g. in-person meetings) between scientists and policy-makers at provincial and municipal levels in Canada to gain insights on how to improve the effectiveness of SPIs at the national level. Through an investigation of these subnational interactions, Richards hopes to show that creating similar institutional arrangements at the federal level will lead to more effective action on climate change and better meet the needs of scientists, policy-makers, and other social actors.

Preliminary research has already shown that, while the ideal of co-production is promoted by many scholars of SPIs, formal engagement between scientists and policy-makers (that genuinely attempt to 'co-produce' both knowledge and policy) is actually very rare. The concept of co-production, as it stands right now, might be more practically conceived of as a way to explain the organic, ad-hoc, chaotic nature of SPIs in reality than as a specific prescriptive ideal. More empirical research is needed to test and confirm the suggestions of the theory. The instances of formal co-production that do exist (e.g. those at provincial and municipal levels in Canada), as rare as they are, appear to be incredibly effective at meeting the needs of various groups involved in climate SPIs. We can use them as 'exemplars' to provide specific institutional recommendations for other policy sectors, since such specifics have generally been lacking in the theoretical literature. Such findings appear to support the constructivist and pragmatic perspectives (i.e. it is not so much the resulting knowledge that is important, but the interaction between scientists and policy-makers itself), in part, but also acknowledge the importance of scientific inputs, as embodied by the rational perspective.

Knowledge co-production in a formal SPI setting

Eva Kunseler studies the production of knowledge by researchers in interaction with policy-makers and other stakeholders in formal SPI settings. She examines how researchers at the Netherlands Environmental Assessment Agency (Planbureau voor de Leefomgeving – PBL) increasingly come to terms with knowledge co-production. The questions she addresses are: How do interactive processes influence the activities and conditions of assessment processes? How do researchers ensure the quality of assessment processes and their knowledge output? Comparative in-depth case studies of policy assessment projects at the PBL demonstrate how PBL researchers pragmatically organise interaction with policy-makers and other stakeholders and accommodate the challenges they encounter along the way: they use skill and judgement rather than theoretical reasoning. Interaction with stakeholders strengthens, but also complicates, their attempts to produce knowledge that is perceived of as relevant, credible, and legitimate. As such, Kunseler finds that the idea of knowledge co-production is still fairly idealistic. Whereas training of expertise and skills invokes improved understanding of the co-production rationale, researchers working in formal SPIs feel a need to ensure their independence and autonomy, which prevents them from really engaging in shared knowledge collaboration.

Together, Pettibone, Richards, and Kunseler find support for, but also limitations of, the ideal of co-producing scientific knowledge and policy outcomes. Formal interaction between scientists and policy-makers seems to be rare, and the informal engagement that does occur is complicated, because it must reconcile the tensions between needs of the involved groups. Certainly, co-production is not an easy solution to the science-policy gap (i.e. the barriers to translating scientific findings directly and immediately into policy outcomes). However, the goal of co-production still appears to be a positive force, as it provides scientists and policy-makers with experience in dealing with one another, can help them understand the broader context of their own goals and needs, and may lead to long-term shifts in underlying values.

Science Communication

In addition to involving societal actors and policy makers in the knowledge production process, the communication of scientific findings is a crucial step for integrating science into policy-making. Effective methods of communication can help ensure that scientific knowledge is meaningfully considered in the policy-making process, so that its potential does not go to waste. However, the best way to do this is not always clear, and researchers are faced with various challenges in this regard.

Social knowledge about urban air pollution in Warsaw

The research of Anna Gayer and Dominika Mucha involves conducting

health impact assessments regarding urban air pollution. An important part of this issue is social (or public) knowledge. Social knowledge is a necessary part of raising awareness about the state of air quality in areas frequented by citizens and can help improve the (scientific) knowledge about the influence of air pollution on human health. As an extension of this, their research project is also interested in how society reacts to more information about consequences of air pollution – for example, whether they take action to improve their personal situation. Perhaps most importantly, because policy-makers often cite expected social resistance as a reason not to move forward with pollution-mitigating action (e.g. entry fees or restricted access for vehicles travelling to central areas of the city, regulations for vehicles that do not meet environmental standards, or restricting the use of certain fuels for heating households), improving social knowledge can often make such policies more acceptable to the public, showing that they are based on more objective research. Essentially, the study aims to discover how to enhance social knowledge about air pollution and thereby encourage policy-makers to take measures to reduce emissions in urban environments.

In this vein, the scientific team of Gayer and Mucha concentrates on determining the exposure of individuals to traffic air pollutants and its risk factors for human health. They seek to communicate those findings to a wide audience of policy-makers, the public, and other scientists in a flexible and adaptive process involving a broad range of stakeholders. For example, impact assessments help determine the economic, social, and environmental consequences of transport policies, environmental management, and urban development decisions (e.g. it may not always be ethical to suggest an increase in cycling activity because the cyclists will be more exposed to air pollution, even though they are helping to address the problem). They have already faced some difficulties in communicating with policy-makers, despite the generation of policy-relevant findings, but it is nevertheless hoped that this socially-relevant research will lead to stronger arguments in favour of air quality protection and change the perception of the public. Gayer and Mucha demonstrate the importance of close cooperation and communication between scientists, policy-makers, and the public (i.e. there is overlap with the co-production theme here).

Goals and strategies of SPIs in the Wadden Sea area

Wanda van Enst and her colleagues argue that the current scientific debate provides them with little clarity on questions such as: Which SPIs are most useful to solve which science-policy interaction problems? What strategies should be employed? How do contextual factors influence the performance of the SPIs? Or, in short, when it comes to SPIs, what works when, where and how?

Broadly, van Enst claims that the scientific literature on environmental policy discusses a wide array of science-policy interaction problems,

which could be characterised into three main issues: the strategic use of knowledge by policy-makers (e.g. Michaels 2009; Owens et al. 2006; Sarewitz 2004; Van Buuren & Edelenbos 2004), the strategic production of knowledge by scientists (e.g. Lackley 2007; Pielke 2007; Bäckstrand 2003), and the operational misfit between demand for and supply of knowledge (e.g. Pohl 2008; Wardekker et al. 2008; McNie 2007; Sarewitz & Pielke 2007). This same body of literature suggests the use of SPIs to enhance interactions by promoting the production and use of more credible, legitimate and salient knowledge, which ought to lead to 'enriched decision-making' (Van den Hove 2007).

Specifically, van Enst focuses on SPIs by researching the process of participatory knowledge production and the role of boundary organisations and science-policy mediators, which may facilitate the science-policy dialogue and contribute to improving the interactions between science and policy makers. Her empirical research is focused on the Wadden Sea area, a UNESCO heritage area where environmental science-policy interactions and SPIs are known to be controversial (Runhaar 2009). She examined three boundary organisations: the Wadden Academy, a research institute; IMSA Amsterdam, a consultancy firm; and the Netherlands Commission for Environmental Assessment, a government institute. All are situated in, or have close ties with the Dutch Wadden Sea area. Currently, representatives of the organisations as well as stakeholders who encounter these organisations in practice are being interviewed, and an analysis of these organisations as 'boundary organisations' is being put together, supplemented by desk research. Conclusions, however, are still preliminary.

Van Enst's following research will focus on individual science-policy mediators: interviews will be conducted with 15-20 individuals, who are thought to fulfill a mediating role between science and policy. The emphasis of this research will lie on the (formal and informal) strategies these individuals employ, and how this can influence the increased use of credible, legitimate and/or salient knowledge in 'enriched decision-making' (Van den Hove 2007). While still in its initial stages, van Enst's research, overall, illustrates the importance of boundary organisations and science-policy mediators for addressing interaction problems.

The various roles of scientists who give policy advice

Pita Spruijt takes a closer look at individual researchers acting as policy advisors. The aim of her research is to gain more insight into the different roles they might fulfill, in order to enable more effective and accepted policy measures through greater uptake of scientific information in the policy process. For example, whereas some researchers may feel their primary task is to carry out fundamental research, others may actively engage in the policy dialogue. To better understand the roles of scientists who provide policy advice, empirical research was conducted on the complex issues of electromagnetic

fields, particulate matter, and antimicrobial resistance. These cases were chosen because they are all complex environmental health issues surrounded by scientific uncertainty, which makes it possible for scientists to interpret the uncertainty differently when they generate policy advice.

The preliminary results indicate that experts indeed differ in their interpretation of uncertainty surrounding these three complex issues and consequently give different policy advice. These differences can affect the decisions of policy-makers. The topic of electromagnetic fields is illustrative: uncertainty about the potential health effect of electromagnetic fields has led to a situation where some countries have adopted a precautionary approach and others, based on the same scientific knowledge, have emphasised the absence of proof of adverse health effects and therefore have not implemented any policy interventions (Kheifets et al. 2001; Van Dijk et al. 2011). Furthermore, based on a literature review, Spruijt notes that research on expert roles has remained largely theoretical (Funtowicz & Ravetz 1990; Weiss 2003; Pielke 2007). Nevertheless, publications on scientific experts who provide policy advice affirm that they should and do hold different roles (Hoppe 2009; Spruijt et al. 2013; Turnhout et al. 2013). These different roles depend on, for example, the type of problem, the values and the type of knowledge of an expert, the national and institutional context, and other factors. More insight in the different roles of experts can lead to improved interactions in SPIs.

Policy Impact Assessments as an Instrument to Improve Science-Policy Interfaces

The research projects presented above examined the options for interaction between researchers and policy-makers, looking at actors such as boundary organisations or the individual researcher. However, policy impact assessment (IA) is an institutionalised process that aims at integrating scientific findings into policy making and hence improving the base of evidence for policy-making. These processes are now established in all OECD countries as well as the European Union at large. However, it is still unclear under which circumstances environmental issues are considered, how these IA processes contribute to considerations of sustainability in policy-making, and what tools can support the process.

Do IA processes promote environmental policy integration?

In her research, Johanna Ferretti focuses on policy impact assessment processes as one type of SPI. In principle, IAs are evidence-based (i.e. evidence produced by stakeholders or the science community) formalised procedures that assess beforehand the intended and unintended impacts of policy proposals on economic, social and/or environmental concerns, in order to inform decision-making. Steps of an IA include the analysis of impacts, interdepartmental coordination, and stakeholder consultation. Specifically, Ferretti's research investigates

how far IA processes promote environmental policy integration (EPI). While IAs have been considered as instruments for EPI (Jordan & Lenschow 2008), the environmental dimension in IAs is usually weak and varies, particularly in contrast to economic concerns (e.g. Jacob et al. 2012).

The question of how far IAs actually promote EPI is tackled by examining IA processes in Great Britain and Germany on the implementation of two EU Directives. Ferretti compares the IA processes of the English 2007 Renewable Transport Fuel Obligation and the 2006 German Biofuels Quota Act, both implementations of the EU Biofuels Directive. As well, she analyses the EU Waste Framework Directive, implemented in England as the 2011 Waste Regulations and in Germany the 2012 Circular Economy Act. The comparison uses actor-centred institutionalism theory. It focuses on the interactions between involved actors and how the institutional structures enable or constrain the behaviour of such actors. By comparing the IA processes on the implementation of the same EU Directives, though in different member states and in different policy domains, Ferretti is able to examine the role of two dimensions of context: What role do institutions and actors play in the course of IA processes and their effectiveness in terms of EPI? This will contribute to a better understanding of IA processes, their driving factors, and what determines higher or lower levels of environmental integration in IAs and policies; and it will allow lessons to be derived for improved EPI in future IA processes.

Preliminary findings show that the environmental evidence produced by actors in IA processes in implementing the same basic directive can diverge dramatically in different states; moreover, the role the evidence plays, and the way it is used and presented (e.g. in form of IA reports) contrasts sharply in both EU countries. Further analysis of the IA processes has to tackle the question of how far this depends on institutional conditions or the relevant actors, and what other factors influenced the level of EPI in the policies.

Sustainability Check Luxembourg

In many countries Sustainability Impact Assessments (SIAs) have been introduced to assess whether proposed policies would contribute to sustainable development. They aim at harvesting scientific knowledge as well as stakeholder interests into the policy making-process. In the research of Anna-Lena Guske, SPIs are conceptualised as the interaction between science and policy-makers in these impact assessment processes.

Her project was conducted at the Environmental Policy Research Centre (FFU) at the FU Berlin and commissioned by the Luxembourg Ministry of Sustainability. It aimed at constructing a SIA process tailored to the specific institutional and political contexts in Luxembourg. To design a procedure that reflects the background conditions, fits into

the existing policy-making process and facilitates the development of guidelines for conducting the assessment, a spreadsheet tool was created, which could support the SIA by presenting scientific findings on the impacts of a policy proposal on the different dimensions of sustainable development. Moreover, it allowed for the comparison of options while making transparent which assumptions underlay the assessment. Hence, this tool helped to foster discussion on the impacts of a proposed policy on sustainable development and the role science played in analysing and rating the policy options.

Furthermore, the project showed that these sustainability impact assessments often follow similar procedural approaches that ensure that scientific knowledge and stakeholders are both included in the assessment process. However, it is often difficult to simply transfer these concepts to other jurisdictions. The specific national contexts in which the impact assessments are carried out have to be taken into account when setting up a sustainability impact assessment (SIA) process – for example, the existing regulations for drafting policy bills, the actors involved in the policy making process, and also the political culture. Hence, the specific framework conditions, which may include institutional, political, and cultural aspects, have to be analysed carefully to ensure the IA process is designed so that it is perceived to be legitimate. However, general frameworks or concepts regarding how these contexts could be systematically included in the design of SIA processes are still missing and could be subject to further research.

Conclusion

Overall, our research projects demonstrate the importance of SPIs as a research focus relevant to a broad range of policy problems and particularly important for contemporary environmental challenges such as climate change and urban sustainability. They also illustrate the diversity of nuanced venues that can be used to study SPIs, such as formal institutionalised settings, deliberative processes, as well as specific procedural instruments such as policy IAs. The current literature that addresses these issues is not especially cohesive. We can address some of this evident complexity by examining the collective findings of our research projects. Doing so, we make two general observations.

First, the context that surrounds any given SPI – i.e. the policy issue being addressed, the institutional and cultural constraints of the surrounding jurisdiction, and the type and level of knowledge held by relevant experts – is important in determining how to understand and manage that SPI. Ferretti shows that the evidence produced and used by actors in IA processes in implementing the same basic directive can diverge dramatically in different states. Guske finds that, although tools can be developed to facilitate discussion and assess impacts in one jurisdiction, they may not be easily transferable to others. More generally, Spruijt notes that context matters for the role played by scientific experts in an SPI and van Enst puts forward a useful

framework to determine what SPIs work when, where, and how (i.e. boundary organisations and science-policy mediators are important for accommodating the diverse complexity of various SPIs).

Second, SPIs generally appear to benefit from stimulating interaction between the involved actors. In one case, Gayer and Mucha found that scientists run into barriers when trying to communicate directly with policy-makers, who may not be equally willing to engage. Kunseler suggests that researchers who embrace a more pragmatic approach can lead to the emergence of more effective interaction with policy-makers and other stakeholders. Pettibone's findings support this: sustainability indicators serve most frequently as a tool to change the terms of debate rather than to support concrete decision-making. Richards observes that true dialogue between scientists and policy-makers can be purposefully facilitated and does not have to emerge organically, although this occurrence is quite rare. It is often best to look at the level of genuine interaction taking place in an SPI, rather than attempt to assign blame to scientists or policy-makers when SPIs appear to be lacking.

While we hope the lessons emerging from our research will be useful to other researchers and SPI actors, but there is also something to be learned independently from the process of meeting with one another and discussing our work together. Communicating with other SPI researchers has helped us understand the complexity of the field, just as the engagement of SPI actors helps them manage the complexity of a given policy issue. Similarly, we all come from different academic backgrounds and take different approaches to studying SPIs. We should continue to engage academically with one another, and we should respect the unique context of each researcher in doing so.

In the end, many open research questions remain: there still exists great potential for additional fruitful research in the field of SPIs. However, we have shown the importance of conducting empirical investigations in addition to theoretical analysis, and hope we have generated some useful guidelines about co-production, communication, impact assessment, context, and engagement for other SPI researchers and actors to keep in mind. Although we did not resolve the ongoing debate related to the role of science in policy-making (i.e. how the three perspectives might be productively reconciled), we hope that we have provided some direction to make that debate more productive or less of a barrier to effective policy research.