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Co-producing the science–policy interface: towards common but differentiated responsibilities

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Formulating adequate responses to pressing socio-ecological challenges requires effective and legitimate knowledge production and use. The academic debate has gradually shifted from a linear model of science–policy relations towards co-productive alternatives. Yet, in practice, the linear model remains lingering. This paper uses a case study of a collaboration between a Dutch research institute and a ministerial department to examine how and why this linear model is so persistent. Our analysis shows the dominance of the linear model in this collaboration, while openings for a more co-productive relationship remain largely unexplored. Our findings illustrate that an important reason for this persistence of the linear model is the lack of a convincing and attractive alternative imaginary of science–policy practices, which defines clear roles and competencies for researchers as well as policy actors involved. We argue this is symptomatic of a wider tendency among both researchers and policy actors to construct science as an obligatory passage point towards policy. However, this tendency not only enables policy actors to offload their responsibility but also fails to capitalise on the opportunities offered by these practices to explicate the politics embedded in and foregrounded by knowledge production. Such an engagement with the politics of knowledge by experts as well as policymakers can encourage more effective and legitimate knowledge production and use.

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Introduction

The world is facing several socio-ecological challenges, with issues like climate change and biodiversity loss having unequal impacts on humans and requiring urgent and integrated responses. It is generally uncontroversial to state *that* knowledge is required to formulate such responses. However, the question of *how* to produce and mobilise this knowledge both effectively and legitimately is less self-evident (Oliver and Boaz, 2019). A large variety of science–policy arrangements exists, for which the concept of boundary organisations has become an emblematic term (Guston, 2001). However, as pointed out by Pallet and Chilvers (2015), it is crucial to understand such arrangements as co-produced through particular practices enacted by different actors from science, policy and society. These science–policy practices embed particular assumptions about what expertise is useful and credible, and how expertise should relate to policy and society. Examining these assumptions and how they shape science–policy practices is important to understand and strengthen their effectiveness and legitimacy.

In academic debates on science–policy interactions, we discern a gradual shift from a linear model of science–policy arrangements towards more co-productive alternatives (Arnott and Lemos, 2021; Kunseler, 2017; Sienkiewicz and Mair, 2020; Turnhout et al., 2020; van der Hel, 2016). This shift responds to inadequacies in the linear model resulting from a problematic separation of facts and values and the messiness of policy processes (Owens, 2015). Conversely, co-productive alternatives acknowledge that all actors involved hold relevant knowledge and expertise, recognise the intertwined character of facts and values, and consider knowledge production to be embedded within processes of change rather than outside of them (Chambers et al., 2022; Turnhout et al., 2019; Wyborn et al., 2019). A crucial difference between linear and co-productive models lies in how they deal with political dynamics. In the linear model, a separation between science and politics is upheld through careful boundary work and stage management (Halffman, 2003; Hilgartner, 2000), with ostensibly straightforward criteria like credibility, relevance and legitimacy guiding knowledge production (Cash et al., 2003). Co-productive alternatives consider science and politics as inherently inseparable and co-constituted, but face the challenge of using this view productively to improve effectiveness and legitimacy (Brown, 2015). Nonetheless, co-productive science–policy arrangements are argued to carry great promise in addressing sustainability transitions (Schneider et al., 2019). Especially their frequent emphasis on inter- and transdisciplinary collaboration has been widely adopted as hallmark of this promise, even if the practical and institutional development of this arguably leaves much to be desired (Chilvers and Kearnes, 2019; van der Hel, 2020).

Despite broad recognition of its shortcomings, and the potential of alternatives, the linear model remains prominent. Studies have shown how the linear model regularly continues to inform science–policy practices at public research institutes (Kunseler, 2016), in global environmental assessments (Borie et al., 2020; Castree et al., 2020), by scientists operating in the public debate (Karhunmaa, 2020), and in the way policymakers approach science–policy arrangements (Kowalczewska and Behagel, 2019; Thoni and Livingston, 2019). Markedly, the public outcry surrounding the concept of post-truth also shows little signs of co-productive alternatives becoming common practice (Jasanoff and Simmet, 2017; Marres, 2018). This persistence may relate to a discrepancy between the conceptual developments in science–policy theory and the degree to which these theoretical lessons are drawn on in practice (Oliver and Boaz, 2019), as well as to a reluctance within parts of the scientific enterprise to embrace the implications of these lessons (Lahsen and Turnhout, 2021). We think a better understanding of this persistence is required if we are to achieve more effective and legitimate science–policy practices. Such understanding will need to pay attention not only to the approaches to knowledge production taken by researchers, but also to the way policy demands materialise in the way science-policy practices are organised (Dunn and Laing, 2017).

In this paper, we study the evolving relationship between the Dutch Ministry of Foreign Affairs and a government research institute for environmental policy analysis. The ministry and institute collaborate in repeating memoranda of understanding (MoU) to establish a joint science–policy arrangement. Since 2019, explicit efforts have been made in this arrangement from a shared sense that there is untapped potential for a stronger relationship. In our study of this arrangement, we focus on how linear and co-productive models of science–policy practices are enacted. By analysing how science–policy practices are co-produced, the paper contributes to understanding the persistence of the linear model. In our discussion we use this understanding to highlight how efforts to make science–policy practices more effective and legitimate can only succeed by taking serious the roles and responsibilities of all actors involved, illustrating the interconnectedness in this special issue's research agenda of transforming knowledge production, translation and mobilisation, and decision-making (Oliver and Boaz, 2019).

Conceptual framework

There is a wide body of literature discussing the different ways science-policy arrangements are organised (Guston, 2001; Wilsdon and Doubleday, 2015), including global environmental assessments (Borie et al., 2021; Maas et al., 2021; Turnhout et al., 2016), government science advisors (Obermeister, 2020; Palmer et al., 2019), expert commissions (Bijker et al., 2009; Owens, 2015), government research institutes (Halffman, 2009; Huitema and Turnhout, 2009) and transdisciplinary research programmes (van der Hel, 2016). Others have focused less on organisational matters and more on how individual scientists can operate in such arrangements (Oliver and Cairney, 2019; Pielke, 2007). All in all, this literature has tended to focus on scientists and the organisations they are active in, which leaves the position of policymakers in these arrangements relatively under-examined.

Studying the roles of scientists as well as policy actors involved requires an analytical approach that allows for a more symmetrical perspective of how science–policy relations are co-produced. To this end, we conceive of science–policy relations as constituted in and through social practices. Social practices are routinised patterns of behaviour, combining "forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz, 2002, p. 249). A practice is more than a well-delineated action: practices are composed of multiple elements that cause it to exist beyond individual moments of enactment (Shove et al., 2012). As such, social practices can be seen to address the agency-structure debate by incorporating individual, intersubjective, and institutional factors. This combination yields a perspective that allows a better understanding of the actions of individual practitioners, while acknowledging their embedded agency. Practices thereby offer an analytical approach to study both the reproduction of particular models of science–policy relations as well as their transformation (Shove and Walker, 2010). We distinguish a *linear* and *co-productive* model of science–policy practices, noting that these form extremes on a spectrum of possible arrangements. While these two models co-exist, they are essentially incommensurable in what they see as required for effective

Table 1 Summary overview of the characteristics of the linear and co-productive models of science-policy practices.

		Linear	Co-productive
Repertoire How is one expected to operate in the science-policy practice?	Knowledge brokering	Supplying, Bridging	Facilitating
	Logics of decision-making	Consequentiality and appropriateness	Meaning
Competencies What makes practitioners able to perform the practice well?		Boundary work & stage management	Co-productive agility
Context In what ways do context factors stabilise the practice?		Expert-driven policy context in which institutional and spatial configuration promotes separate domains of science and politics	Normatively driven policy context in which institutional and spatial configuration promote conjunction of science and politics

Table 2 Summary of the three repertoires, based on Turnhout et al. (2013) and Dewulf et al. (2020).

	Supplying	Bridging	Facilitating
Knowledge brokering repertoire	The science-policy practice aims to provide policymakers with knowledge produced by experts	The science-policy practice aims to answer questions policymakers have with relevant knowledge produced by experts	The science-policy practice enables policymakers and experts to collaborate to co-produce more-than-knowledge
Logic of decision-making	Logic of consequentiality: decisions are based on their expected consequences	Logic of appropriateness: decisions are based on rules prescribing what to do in what situation	Logic of meaning: decisions are based on what is meaningful to decision-makers

and legitimate science–policy relations (Kunseler, 2017). Central to the linear model is the assumption that science and politics are neatly separable (Latour, 1993), whereas the co-productive model departs from the position that the production of knowledge and the social order are deeply intertwined (Jasanoff, 2004).

Building on the work of Shove et al. (2012), we can think of science–policy practices as composed of three elements: repertoires, competencies, and context, which we discuss in more detail below. Variation in science–policy practices, and in the models they mobilise and reproduce, follows from different ways in which these three elements are configured and interpreted, even if they serve a similar overall purpose. The next sections describe the characteristics of the three elements of science–policy practices and their relation to the linear and co-productive models in greater detail (see also summary overview in Table 1).

Repertoires. Repertoires present practitioners with an indication of how they are expected to operate in the science–policy arrangement. They offer a "vocabulary of justification" (Karhunmaa, 2020) by making "a more or less coherent statement about perspectives and concomitant activities" (Gilbert and Mulkay 1984 cited in Turnhout et al., 2013). Repertoires thus contain a conception of the link between knowledge production and use. In our analysis, we build on the repertoires of knowledge brokering identified by Turnhout et al. (2013) and combine them with Dewulf et al.'s (2020) logics of usable knowledge in decision-making (Dewulf et al., 2020). Table 2 summarises the three repertoires.

In the *supplying* repertoire, knowledge users are provided with relevant expertise or experts appropriate to answering users' questions (Turnhout et al., 2013). Interaction between producers and users of knowledge is restricted to elucidating the questions users hold. In this repertoire, decision-making is seen to follow a logic of consequentiality (Dewulf et al., 2020), which holds that decision-making is presumed to depend on science-based options and their consequences, from which a decision-maker will choose the best one in a rational process. The supplying repertoire thus conforms to a linear science–policy practice. Knowledge production and knowledge use are separate activities, with the science–policy practice functioning as the locus through which knowledge from a wider reservoir of expertise flows into decision-making. This repertoire implies a view of knowledge as an intrinsically desirable good, of which more is always better, and works best when experts can deliver uncontested facts.

The *bridging* repertoire aims to bring the production and use of knowledge closer together. While they remain separate activities, they are seen to require intensive interaction to translate and transfer questions and answers (Turnhout et al., 2013). The science–policy practice is what enables these activities to interact. In this way, this repertoire relates to a decision-making logic of appropriateness (Dewulf et al., 2020). Here, decision-making is seen to follow institutionalised rules prescribing what to do in specific situations. The knowledge required for decisions is not just any knowledge, but knowledge that is produced in line with particular institutional and cultural rules itself (cf. Jasanoff, 2005) and which answers specific questions. Knowledge is still seen to be contained in a reservoir, but efforts focus not so much on transferring as much knowledge as possible to decision-making, but on ensuring that the right knowledge is communicated in the right way. This means that the bridging repertoire is useful for issues where the role of interpretation in knowledge production and use is acknowledged, by enabling the most fitting interpretation to be found. Since knowledge production itself is considered to take place outside the science–policy practice, this repertoire leans towards a linear model of the science–policy practice.

In the *facilitating* repertoire, the perspective on where knowledge is produced is altered and the boundary between knowledge production and use is blurred (Turnhout et al., 2013). All actors involved in the science–policy practice are seen to hold relevant knowledge and it is impossible to distinguish between active producers and passive recipients of knowledge (Smit and Hessels, 2021). This repertoire contains a decision-making logic of meaning, in which decision-making is considered to be a struggle over the relative significance of different possible dimensions of a problem (Dewulf et al., 2020). Here, knowledge is usable when it fits with existing frames, provides a meaningful new perspective, or facilitates a process of mutual learning between different frames. Consequently, this repertoire is useful for issues around which multiple contesting frames exist. In the facilitating repertoire, the science–policy practice becomes a site in which

'more-than-knowledge' is both produced and mobilised. With 'more-than-knowledge' we mean to highlight that the outcomes of this co-productive repertoire are not necessarily recognisable as knowledge in a traditional or formal sense (e.g. by being codified).

Competencies. The repertoires not only indicate different expectations on how actors should operate in science–policy practices but also point to the competencies that are required of them, taking competencies to mean "the ability to do something well" (Cambridge English Dictionary, 2021). Competencies can be derived from formal or informal training, as well as from on-the-job experience. For instance, there is a growing literature on learning processes among science advisors (Obermeister, 2020), that has e.g. analysed how broader concepts like boundary work translate from organisations to the approach taken by individual governmental science advisers (Palmer et al., 2019). Regardless of the model, competencies are not only held by those working in research positions, but also by those more closely situated towards decision-making. Both in the linear and co-productive model, competencies are demanded from all practitioners (Faasse et al., 2020). Nonetheless, differences in the competencies required from individual practitioners may exist in relation to their respective responsibilities and roles in the practice, including in relation to their professional expertise (Kuus, 2020).

The linear and co-productive model require different competencies from science-policy practitioners. In the linear model, careful stage management is required to avoid upsetting the unidirectional image of science → policy (rather than science ↔ policy) (Karhunmaa, 2020). This often means that good science–policy practitioners are seen as those able to communicate and translate between science and policy, including through building and maintaining high-trust relations that enable iterative exchanges between science and policy (Bednarek et al., 2018; Tinch et al., 2018; Young et al., 2014). In turn, such exchanges help practitioners to understand what would make for useful knowledge in a specific decision-making context, as well as what other actors and sources of knowledge influence that context. In line with both the supplying and bridging repertoires, these activities are not considered to produce knowledge, but merely to allow researchers to produce more relevant knowledge and to enable the use of knowledge. Furthermore, terms like scientific literacy imply a pre-requisite to knowledge use, in which prospective users have the skills to understand and act according to scientific facts (see e.g. Bäckstrand, 2003; Wynne, 1995).

Conversely, competencies required in the co-productive model are founded on the ability of practitioners to combine both scientific and other forms of knowledge and to integrate them in practices of decision making (van Kerkhoff and Lebel, 2015). The term 'co-productive agility' (Chambers et al., 2022) emphasises the need for practitioners engaging in co-productive processes to be open and able to understand different viewpoints, be sensitive and responsive to changing objectives or new knowledge, and—crucially—constructively navigate the tensions that inevitably arise in such settings. Co-productive competencies thereby incorporate norms like humility and pluralism advanced for scientific practices (Turnhout et al., 2019), but highlight that these are required from all who enact the science–policy practice. In line with the facilitating repertoire, co-productive competencies thus underline the entwinement of knowledge and action, thereby recognising that the outcomes of co-productive processes go beyond what is traditionally understood as knowledge in a formal sense.

Context. The context of a science–policy practice is crucial for the questions of *how* and *where* stabilisation of the practice occurs. The context is where the materiality of a practice can be located, by enabling and constraining particular compositions and possibilities of the practice (Schatzki, 2010). Thus, applied to our case, context is vital to the question of which science–policy model can be mobilised in practice. We subdivide the context of science–policy practices into its institutional aspects, policy context, and spatial configuration. With institutional aspects, we refer to the statutory status, formal mandates and formal procedures limiting individual practitioners' manoeuvrability. For instance, are there formal directives in place describing a research institute's degree of independence when deciding what work to perform? The policy context around which a science–policy practice operates is formed by characteristics such as the scale at which the policy discussion is relevant (e.g. local, national, global), and the political and public debates surrounding the issue targeted. For example, less politically volatile issues may require different science–policy arrangements than highly contentious issues (Hisschemöller and Hoppe, 1995; Pielke, 2007). Furthermore, science–policy practices are influenced by their spatial configuration, i.e., how the practice is arranged in space. Through its spatial configuration, a science–policy practice and its practitioners are presented with (or withheld of) particular affordances (Mahony, 2020). For instance, Palmer et al. (2019) cite a government chief scientist using the layout of their offices to lurk at the elevator to 'spontaneously' interact with a minister. Furthermore, there may be expectations of how a useful science–policy practice is to be arranged spatially that can influence how models of science–policy practices are shaped and reproduced (Smit, 2021). Compared to repertoires and competencies, context is what is most stable across individual practitioners and enactments of the practice, including through country- or institution-specific epistemologies, styles, or cultures (Borie et al., 2021; Halffman, 2005; Jasanoff, 2005). Despite this stability, the ways in which practitioners describe observed or desired contextual factors are informative about how they think science–policy practices should be organised.

Methods

Empirical materials for this study were collected over a 2.5-year timespan (2019–2021) starting with one of us (TM) being hired at PBL to strengthen the relationship between PBL Netherlands Environmental Assessment Agency (hereafter: PBL) and the Dutch Ministry of Foreign Affairs' Directorate-General for International Cooperation (hereafter: MFA). PBL is a governmental research institute for environmental policy analysis that echoes many of the characteristics of science–policy boundary organisations elsewhere and in other domains (Bijker et al., 2009; Guston, 2001; Owens, 2015). Its official mission is to "improv[e] the quality of political and administrative decision-making" (PBL website, 2021). PBL has a prominent position in Dutch policy debates, stemming from a combination of its expertise, its authoritative status as independent and scientific institute, and its arbitrating and stabilising function in a historically corporatist and consensus-driven political culture (Halffman, 2009). Earlier work on the PBL has examined the different roles it assumes and boundary work practices it engages in (Huitema and Turnhout, 2009; Pesch et al., 2012) and has shown that staff have different views on how to organise science–policy relations (Kunseler, 2016). The MoU between PBL and the MFA aims to contribute to strategic policy development and strengthening of the scientific basis of policy at the intersection of environment and international development. The PBL-MFA science–policy practice is thus situated in a specific policy context, but shares many other characteristics with environmental science–policy practices of the PBL and in the Netherlands more broadly. Concretely, the MoU provides funding for roughly 10 PBL researchers to conduct research projects that aim to provide input

for policymaking processes at the MFA. The MoU is thus the setting of a paradigmatic case study that allows us to gain a finer understanding of the practice of a science–policy arrangement (Flyvbjerg, 2006; Hitchings and Latham, 2021).

In addition to the fieldnotes and experiential knowledge obtained by being situated in this particular practice, we conducted 29 semi-structured interviews with PBL researchers (R1–11), policymakers at the MFA (P1–11) and policymakers at other ministries and other stakeholders (S1–7). These interviews served foremostly to explicitly explore questions around the way these individuals organised and participated in the MoU's knowledge production. Following Hitchings (2012), interviews are suitable for talking about people's practices, particularly when being open to ask the "seemingly obvious". Nonetheless, it could be challenging to dig deep enough and avoiding to "bore" the informant (Kuus, 2014), which can be related to a combination of the fact that these informants are all highly educated as well as that they know the interviewer is himself an active participant in the practice he is asking questions about. In addition to this epistemological objective, the interviews also served an ethical purpose. TM's position as direct colleague meant that ideas and interpretations of this science–policy arrangement inevitably developed organically and 'through the grapevine' as well. In such cases, a formal interview provides an opportunity to openly discuss and exchange such ideas and interpretations, acknowledging that transparency about the project is an important factor to foster the trust necessary to gain deeper insight (Harvey, 2010). Finally, and in a similar vein, TM presented preliminary results to the group of PBL colleagues on several occasions and discussed them with an MFA representative in the context of an externally mandated evaluation of the MoU.

These data were analysed in an iterative coding process, sensitised by literature on science–policy interactions and societal impact analysis, which proceeded in tandem with the development of the conceptual framework as laid out in the previous section. In our analysis, we focused on the ways in which the three elements and their characteristics are reflected in the way our informants describe the science–policy practice. The illustrative quotes provided were translated from Dutch to English by the authors.

Results

Our findings show that the repertoires invoked, competencies called on and context factors in the PBL-MFA science–policy practice, largely reflect the linear model. Despite this general predisposition, we have also observed that expectations about roles and views differ between researchers and policymakers. Researchers tend to expect that policymakers play a more active role to fulfil the joint ambition to produce usable knowledge than is currently the case. Conversely, policymakers have difficulty positioning themselves as anything other than passive recipients of knowledge, seeking knowledge that is readily applicable without attributing themselves a role of significance in producing that knowledge. Our findings are in line with other recent work that finds the linear model to be rather persistent in practice (Karhunmaa, 2020; Kowalczewska and Behagel, 2019; Kunseler, 2016). However, the inclusion of policymakers' perspectives in our analysis contributes to understanding why this persistence exists. In the following subsections, we present in more detail how repertoires, competencies and contextual factors feature in our informants' discussion of the PBL-MFA science–policy practice. While we describe the three elements separately for analytical purposes, we emphasise that they are intertwined in constituting the science–policy practice.

Repertoires. Interviews with researchers contain characteristics that correspond to a predominantly linear model, emphasising elements from the supplying and bridging repertoires, with the co-productive model surfacing through characteristics of the facilitating repertoire in some instances. Many researchers seek an active relationship with the policymakers they see as prime beneficiaries of their work. In line with the bridging repertoire, some argue such an active relationship is required to articulate and define research questions: "We should put in a lot of time at the front to discuss with policymakers what they want to know, why, and how it will feature in their decision-making" (R3). It is also seen as beneficial to tailor presentations to the specific needs of the audience, by discussing a draft set of slides or outline with a contact person. Echoing the logic of appropriateness found in the bridging repertoire, one researcher highlights how he adapts his terminology to the diverse frames of reference used by his policymaker counterparts:

> "In focusing my work, I talk to several policymakers to get them on board as much as possible. With some, this means talking in terms of data—like remote sensing or other types of geo-information—whereas others are more interested in governance and civil society. You have to find out what they find interesting. […]. The right term to use in different policy domains can be very specific, while I might think they link quite nicely to each other". (R8)

Nevertheless, in line with the facilitating repertoire, one researcher explicitly mentions trying to amplify a diversity of voices in her work, so as to facilitate the exchange of different views: "In my opinion, the story becomes much stronger if you give a voice to different stakeholders and get insights from different angles" (R7). To this end, she puts considerable effort into building a network not just within the policy community, but also with a range of non-governmental organisations who hold various forms of expertise relating to her research focus.

Yet, characteristics of a linear model dominate. Sometimes very explicitly, with researchers pointing to a boundary between knowledge production and decision-making that PBL is not permitted to cross:

> "The mission of PBL is to get good knowledge to the tables of decision-makers. Clear, objective knowledge. What the decision is, is not our impact. We must not confuse this, because then we are political actors, which we are not. For us, the word 'impact' stops at 'being heard'; if they use our documents in policy preparation, we have impact". (R5)

But the linear model recurs more implicitly as well. For instance, an active relationship with policymakers can also be seen as instrumental to a supplying repertoire, by providing opportunities to transfer knowledge through direct interaction: "I talk to my policy contact person about every four weeks. Sometimes I also attend the policy cluster meeting to present something. I think these are the moments you make an impact" (R11). Another even more subtle aspect that can be seen to reflect a linear model is the emphasis on scenario studies and integrated assessment modelling in PBL. Notwithstanding the value and contribution such scenario studies can make to policymaking, they are but one approach to anticipating the future (Geels et al., 2016; van Beek et al., 2020). As one researcher expresses, this approach operates from a logic of consequentiality that may not be as prominent with policymakers as is presumed:

> "Our target group of policy makers wants to know what the problem is, and what will happen if they do X. 'What will my world look like in 2050 in that case?' 'And what will my world look like if I do Y?' That way, you can adjust your budget accordingly. But: we think they operate like that, but do they really?" (R4)

These points echo a paradox in science advice, in which co-productive principles like humility and participation inform a science–policy practice founded on a linear model. While this paradox has been identified within PBL and elsewhere (Karhunmaa, 2020; Kunseler, 2016), few studies have explicitly coupled it to the question of how policymakers operate in science–policy practices.

The repertoires invoked by policymakers in the PBL-MFA MoU also mostly speak to the linear model. Several policymakers express an explicit desire for "science-based" policy (P2) or "credible and objective data on the basis of which to write a policy advice" (P3). In line with a wider societal call for evidence-based policy and similar terms (Parkhurst, 2016), such a desire assumes a neat separation between science and politics exists, and that depoliticising discussions through the use of knowledge is desirable: "I think most civil servants have the feeling that there is sufficient decision-making in politics based on gut feelings, assumptions, worldviews and human ideals. What we call fact free politics" (P3). As a consequence, decisions that can be construed as "science-based" are idealised. A PBL-researcher describing this struggle in determining how far to push the conclusions in his work laughs that "the MFA often wants you to push it as far as possible, so they have less to decide. Or to have clearer recommendations, that is always nice too" (R9). And recalling an instance in which the science–policy practice was seen to work particularly well, one policymaker said:

> "A PBL-report should be used to sharpen and shape your policy. Last year, some colleagues of mine had a discussion with a group of PBL-researchers, on climate policy. They almost completely adopted from that what they were supposed to do in terms of policy. Such cases show that impact can arise at a certain point. I can see people adopting the PBL way of thinking there now". (P5)

The supplying repertoire is evident when asking policymakers to reflect on the niche they think PBL can fulfil for the MFA. Many express a desire for PBL to work on what they describe as agenda-setting, in which PBL signals trends that may be relevant to the MFA's activities. In a way that is, as one policymaker puts it: "independent and ahead of the troops" (P11). Implicitly or explicitly, such an agenda-setting function means that the role of policymakers in the science–policy arrangement is foremostly as a recipient of information. It paints a picture of knowledge as being an object, a product that can be obtained through a simple market transaction (cf. Faasse et al., 2020), rather than something that is embodied by individuals and has to be mobilised through their sense-making. As one external stakeholder highlights: "the MoU should work as a research agenda: 'what do we collaborate on'? But the MFA likes to commission research" (S5). Tellingly, the main alternative identified to this agenda-setting function is one that closely resembles commissioned contract research: "PBL signals trends. We shouldn't stuff PBL with assignments, except for when there is a specific question, because of the opportunity costs we would incur" (P8). In this perspective, PBL is not necessarily the only party having knowledge "on offer", but can be seen as one of several potential internal or external sources:

> "Policy, maybe we should just call it choices. You have to substantiate these choices, and that requires knowledge. Sometimes that knowledge is experience found within the apparatus, sometimes it comes from external parties". (P1)

While this policymaker's approach to obtaining knowledge to substantiate choices can be seen to follow the linear model, it is interesting to note that she highlights the potential for internal knowledge—policymakers' experience—as another potential source. Arguably, this hints at the blurred boundary between knowledge users and producers found in the facilitating repertoire. Even so, whether this broader view of relevant knowledge has consequences for the science–policy practice depends on what competencies practitioners are called on.

Competencies. The prominence of the linear model among policymakers also becomes clear from the difficulty encountered when asking them to elaborate on their own role in the science-policy practice. Our findings show that few policymakers perceive themselves as an active participant, let alone co-producer of knowledge, in a science-policy practice. The key science–policy competency that is widely stressed to be held by MFA policymakers is strongly aligned with the supplying repertoire: they are described as quick learners or generalists who are able to rapidly absorb knowledge. Their perceived core task is to ensure that Dutch development resources are spent in an acceptable manner. MFA policymakers are used to change their posting about every four years, which means they must be able to quickly get up to speed on a new dossier. Consequently, attention is directed towards ensuring that researchers deliver knowledge in a format that is easily digestible. One policymaker for instance pleas for short publications like two-pagers, arguing that "as a policymaker, you must have your network sorted, so that those two-pagers reach you. Then you read them and take them with you" (p. 11). This suggests that the most important competencies for policymakers relate to a linear model, in which the science-policy practice supports the transfer of knowledge to policymaking.

Some other policymakers describe their role in a slightly more active way as "supporting and coaching, to indicate roughly in what direction questions and answers might be found" (P2). A more practical description of that role is given by a policymaker from another ministry: "Ideally, I come over for a cup of coffee to talk through your activities. Then I can indicate what my view is of what the project is about, or should be about, and what I think the approach could be" (S1). These descriptions can be seen to match a bridging repertoire in which researchers need to know what questions need answering. Nonetheless, in the MFA the idea seems to be rather alien that this relationship could go beyond a straightforward back-and-forth, to jointly explore potential knowledge needs (an approach that still mostly resembles the competencies called for by a bridging repertoire), or to engage in a dialogue with mutual understanding or other forms of more-than-knowledge as its outcome (which would benefit from co-productive competencies):

> "When I suggested to a colleague that we might ask [PBL] for a [PBL-MFA] dialogue, I was met with confused looks, saying '*is that even possible??*'. We have to focus much more on that, the dialogue, because then we understand each other much better than by just sending you requests for knowledge. I need to identify the topics where we have a semi-need for knowledge that we don't have articulated, and which we can talk about". (P1)

This quote also highlights another point, namely that many policymakers find it difficult to know what it is they want to know, in other words: they struggle to articulate their knowledge needs or demands. Both researchers and policymakers recognise that being able to ask the questions that can help policymaking is not a given for the MFA: "We cannot leave articulating the knowledge demand to the MFA alone, we don't have the substantive knowledge that that would require but we do see where things are happening in general." (P5). A researcher also notes the need for collaboration in defining research questions: "Policymakers don't have the answers ready, but often neither do they have the questions. That's not a problem per se, but does ask

for collaboration to get to these questions" (R3). Importantly, these statements suggest that the onus to engage in a process of demand articulation lies primarily with PBL researchers. Demand articulation thus requires stage management: while it is not considered a problem for policymakers to communicate with researchers, there should be no room for doubt that the *actual* knowledge production takes place independently, at PBL.

The difficulties encountered with demand articulation also raise the question of what need for knowledge there is within the MFA in the first place. When prompted with this question, few informants are able to articulate this need other than it being an intrinsically desirable need. One policymaker contends this is a problematic stance:

> "Our policy field doesn't really have knowledge agendas or questions. Maybe there is no need for knowledge. Still, few people dare to say that there is enough knowledge. Everyone feels an intrinsic need for more knowledge, but it is difficult to determine where you want to go in terms of knowledge". (P6)

Other informants argue that authoritative knowledge is required to substantiate statements and claims in international diplomacy. In this view, a policymaker should ensure that "emotions" are kept separate from "substance" in the diplomatic process, with the former seen as undesirable and to be limited as much as possible and the latter to be supplied by neutral, independent researchers. The role of the policymaker is thus to ensure that the diplomatic process is as much as possible about objective knowledge:

> "In negotiations, one part is about substance, and the other part is about emotions. The goal is to have the part about substance be as large as possible. So, if you can substantiate a certain ambition scientifically, your position becomes much stronger." (S2)

This ability to separate emotions from substance is founded on a strongly unidirectional view of science–policy relations and limits the scope for re-defining or re-interpreting policy problems and potential solutions with its accompanying norms of humility and pluralism. In this way, it draws strongly on linear rather than co-productive competencies.

Context. The competencies that informants see as required closely relate to the broader context of the science-policy practice. What is the role of knowledge in the policy domain the MFA focuses on? What does that require of each respective organisation? The same policymaker who problematised the view of knowledge as an intrinsic need suggests this view is related to the policy domain of international development. He claims it is possible to operate rather uninformedly in this domain, because complexity and indeterminacy are the default:

> "We are all deeply aware that our interventions are so steeped in complexity and unpredictability that the outcome can never be guaranteed anyway". (P6)

> "A large part of our work is inspired by realising that we do not know and understand everything". (P2)

By bringing up this complexity as a distinct feature of the MFA's policy domain these informants highlight the importance of the policy context to the science–policy practice. In this respect, there may be a difference between the MFA's policy domain of international development and the environmental policy domain PBL is used to operate in. The latter has been argued to often contain technocratic tendencies at the expense of normative debate (Biermann and Kim, 2020; Wesselink et al., 2013), at least in part stemming from the central role the natural sciences play in understanding environmental issues (Turnhout et al., 2019). Conversely, the policy domain of international development arguably has a history of normative debate (WRR, 2010), in which ideas of measurement and proof gained prominence more recently —as evidenced by for instance the awarding of the Nobel Memorial Prize in Economics to Banerjee, Duflo and Kremer for their use of randomised controlled trials in development economics. Meanwhile, the Dutch MFA aims to increase the degree to which research feeds into its processes by employing a Chief Science Officer who is also a part-time professor (Koch, 2017). Such trends can be seen to create a policy context to the science–policy practice in which the importance ascribed to formal expertise is growing.

In line with this growing importance of formal expertise, the PBL–MFA MoU's objective to improve policymaking at the intersection between environment and international development can be seen to borrow from PBL's authoritative position in national environmental policymaking. This illustrates how institutional factors influence the science–policy practice, because this authoritative position is obtained through a combination of PBL's statutory status (there is a law dictating PBL's existence and mandate) and work on other environmental topics. Many researchers and policymakers highlight this position of PBL as a quintessential characteristic of the science–policy practice:

> "I am very enamoured of how PBL can operate as a knowledge supplier for us. […]. PBL in its position as independent research institute, with solid expertise, good access, and an international reputation. The models are validated and internationally renowned". (P5)

> "[Talking about a specific research project]. The MFA had a very polarised policy discussion internally on part of our climate strategy. To achieve a breakthrough, we needed an advice with sufficient authority. For that we sought a role for PBL comparable to its role in the national climate debate". (P2)

This leads various informants to point to the importance of visibility as an important factor in such an authoritative position. In some instances, the importance of visibility can be seen to be constructed as a precondition to develop a more collaborative relationship between PBL and the MFA, with one researcher describing the aims of their project to encompass "becoming a more natural partner to the MFA" (R11). In other instances, visibility seems to resemble brand awareness, in parallel with the idea that the MFA is primarily a consumer of externally produced knowledge. While such instances can be brought up with relatively little reflection, some researchers also more directly relate it to a question of institutional accountability, in which that which is most visible does not necessarily correspond to the most effective forms of knowledge production.

> "Beyond the individuals, you have to make sure that the ministry apparatus sees you at some point. 'Oh indeed, PBL'. The World Resources Institute [(another knowledge partner of the MFA)] has a high profile in the MFA. I notice that the PBL has a lower profile, and is less visible in the MFA. PBL could do more in terms of visibility, mightn't your director give a talk on the big themes, for instance?" (P5)

> "By being visible among other partners of the MFA, you try to ensure that people at the MFA are being told from different sides that what we do is useful". (R8)

> "Peer-reviewed publications are "handy" for your credibility. I think a combination of policy briefs and scientific

> publications is most effective. But as PBL, you want the occasional iconic publication as well; institutionally, you want to be able to showcase your work". (R1)

Another point that is widely mentioned and in which institutional and policy factors come together is the limited capacity in the MFA to engage in knowledge (co)production and mobilisation. Policymakers spend the majority of their time answering parliamentary questions, preparing for international summits, and operating the day-to-day requirements for the implementation of policy programmes. This leads to a lack of both the time and calmness required to think and reflect: "we are understaffed to really think strategically. People in government are too busy with the issues of the day. We have all these globally renowned advisory bodies with an awful lot of knowledge, but no time to do anything with it" (P9). This can also be seen to limit the degree to which co-productive competencies are called upon. This capacity issue is compounded by the individualistic learning culture at the MFA. There are few institutional mechanisms to absorb knowledge into the wider organisation, leaving the degree of engagement with knowledge largely to the interests and priorities of individual policymakers.

Regarding the final contextual factor, the spatial configuration of the science–policy practice, it is important to highlight the high proximity between PBL and the MFA in multiple ways (cf. Boschma, 2005). Several policymakers point out that PBL and its researchers are relatively approachable. PBL is also part of government—and thus seen to pursue similar goals—and knows the Dutch policy context better than most other knowledge institutes the MFA has a relationship with. This also lowers the barrier to request PBL to give a presentation or contribute to a meeting, although as mentioned this materialises irregularly. In fact, PBL moved to The Hague in 2016 to be located closer to the administrative centre, and the respective offices of PBL and the MFA are only a 10-min walk apart— although the significance of spatial distance has vanished over the past two years due to working from home requirements in response to Covid-19. Furthermore, PBL is regularly invited to contribute to inter-ministerial policymaking processes in which the MFA participates, creating encounters outside of the research projects defined within the MoU. Such encounters can create spaces of engagement where ideas can be exchanged and mobilised in a dialogue without necessarily seeking to produce knowledge that is codified—akin to the more-than-knowledge that is co-produced in the facilitating repertoire. At the same time, such encounters raise challenges for PBL in terms of being seen to conform to traditional expectations around objectivity, authority and independence. Precisely because these expectations are held by both researchers and policymakers, navigating these challenges requires co-productive competencies from all practitioners (cf. Kunseler and Tuinstra, 2017).

Discussion

Our findings suggest that the linear model of science–policy practices remains influential in the PBL–MFA science–policy practice. The repertoires invoked by practitioners largely reinforce a separation between facts and values, with knowledge being approached as a product to be obtained by the MFA and for which the science–policy interface provides a suitable point of transfer. The respective competencies for PBL and MFA practitioners continue this separation by the division of labour they imply, in which PBL produces knowledge for the MFA to use. In terms of the context, ongoing developments in line with the rhetoric of evidence-based policy suggest a search for knowledge as an objective truth rather than knowledge about value-based choices. This results in an emphasis on the authority and visibility of partners able to provide such knowledge.

At the same time, some points of entry for a more co-productive science–policy practice can also be discerned. Some researchers perceive the value of their work also in terms of making a diversity of perspectives visible by amplifying the expertise of others. One policymaker tries to spur colleagues to feel free to approach the PBL with yet-to-be-defined questions, in order to achieve a mutual understanding and engage in an iterative process of knowledge production. And the fact that PBL and the MFA are mutually approachable means the barriers for potential collaboration are low. Moreover, the structure of the relationship as a recurring MoU means that regular opportunities for change and innovation exist, because lessons learned and their respective requirements from both parties can be adopted in the renewal of the MoU.

However, what seems to be missing to turn these points of entry into a concrete shift to more co-productive modes of interaction is an imaginary of what an effective science–policy practice might look like if not linear. Crucially, the combination of individual, intersubjective and institutional factors in social practice theory shows that this imaginary is something that is not just missing at the level of individual practitioners—as if they themselves simply lack creativity or imagination—but is absent throughout the science–policy practice as distinct object of analysis. Indeed, the interplay between the elements of the practice imposes barriers for co-productive practices to emerge. Hence, the obduracy in the science–policy practice does not only stem from a context that favours the linear model, but also from an absence of co-productive imaginaries of the relation between knowledge production and use, including the contributions individual practitioners can make herein. For instance, while the limited capacity at the MFA clearly imposes a practical constraint to the potential intensity of interaction, there is little reason to assume that more capacity would result in changing the science–policy practice, if this capacity is not also accompanied by an institutional culture that approaches competencies more symmetrically. Such a culture would recognise the need for policymakers to be able to engage in co-productive science–policy practices themselves. In other words, spur them to e.g. co-articulate research questions, contribute their expertise (and see it as worth contributing), and imagine forms of knowledge production beyond calling for shorter written reports. Instead, the separation between science and policy continues in descriptions in which researchers are expected to produce relevant research, and policymakers to quickly absorb existing knowledge and turn value-laden policy debates into science-based ones. Similarly, the researcher who aims to amplify a diversity of voices in her work faces an uphill battle in a context that prefers expertise that is ostensibly objective and independent. In this light, it is remarkable that the policy context of international development, with a history of normative debate, does not seem to prompt policymakers to invoke characteristics of the facilitating repertoire, considering its suitability for navigating contested issues. In sum, this means that despite the explicit attempts in the MoU to strengthen the PBL–MFA relationship, the science–policy practice shows little indication of shifting to a more co-productive model.

Common but differentiated responsibilities. In part the absence of a co-productive imaginary is due to the fact that while co-production has become a common ideal in local participatory processes, it has not yet become a convincing and actionable alternative to the linear model in science advice and science–policy interfaces more generally. In that domain, dominant imaginaries increasingly emphasise interaction, as our findings also demonstrate, but do not fundamentally deviate from powerful assumptions of the linear model

about objectivity, independence, and the need and possibility of separating facts and values. We believe that such a lack of alternative imaginaries stems, at least partly, from a wider shortcoming in science–policy theory and praxis, in which the focus tends to remain on what is required from the science side to enhance effectiveness while ignoring the policy part of the science–policy conjunction. While we do not think it is possible to provide a ready-made solution to this issue, an alternative imaginary of science–policy practices should start from the question of what different responsibilities the various actors involved have in achieving an effective practice. The one-sided focus on the science part side-lines this question and as a result, neglects to explicate what roles might be played by policy-makers engaging in science–policy practices, what this implies in terms of competencies required, as well as how contextual factors and researchers themselves could stimulate this broader responsibility. After all, assuming that the science-policy practice is part of a wider democratic institutional arrangement, it should be at the core of policymakers' tasks to consider the question of "what is" and "what might be" in relation to "what ought to be". And ironically, the ostensible neat separation between science and politics actually leads to conflate "is" and "ought", as a wide body of research in STS and other disciplines has discussed (Brown, 2015; Forsyth, 2019; Jasanoff, 2004; Turnhout, 2018). This hidden conflation makes it possible for policymakers to offload their responsibility: after all, how can they be kept accountable for the consequences of decisions if they were merely doing what science tells them is best. Indeed, such a discrepancy in responsibilities means that science and knowledge production will be blamed for decisions that are considered unfavourable or seen to fail, eventually risking an equally undesirable overall discrediting of expertise (Hulme et al., 2020; Jasanoff and Simmet, 2017).

An alternative imaginary in which responsibilities are more legitimately shared requires science–policy practices to accommodate the political dimensions and implications of science–policy practices head-on. This involves explicating the politics embedded in and foregrounded by knowledge production and resisting policymakers offloading their responsibility onto researchers (Pielke, 2007; Stirling, 2010). Because knowledge production is always partial and uncertain, political and normative judgement is required to determine what course of action is most desirable (Hulme et al., 2020). This means it is important to "open up" knowledge production and present a diversity of explicitly value-laden decision-making options (Castree et al., 2020; Stirling, 2008). In other words, science-policy practices must make evident what political choices need to be made, what options might be available, and what considerations could come into play in choosing what options are feasible and desirable. This combination is crucial because in a plural society multiple possible courses of action exist and preferences of actors differ accordingly, while it is "simultaneously necessary, inevitable, and desirable" to make a choice between them (Brown, 2015; Mouffe, 2000; Stirling, 2008, p. 284). A science–policy practice that employs this approach will activate the responsibility of policymakers in this process and spur them to play their part as co-producer of usable knowledge by co-articulating research questions and contributing their own expertise and that of their networks. Although it is unlikely that policymakers can play this part without allocating some additional capacity, our suggestion by no means implies a fully shared workload between all practitioners. Instead, we suggest to strive for equal levels of commitment, but seek differentiated responsibilities and tasks. For policymakers, the crucial shift lies in realising that they have a role as co-producer *throughout* the knowledge production process. For researchers, this shift will more clearly highlight that each knowledge practice has its limits, thereby leading to humility with regard to claims made and a continued curiosity for potential unanticipated negative effects of science and knowledge (Turnhout et al., 2019).

We contend that such an approach will not only benefit the legitimacy of science–policy practices but will indeed also boost their effectiveness. The downsides of current ways of working are clear. The consequence of the focus on depoliticised research continues to construct science as an obligatory passage point, from which a unified voice and stamp of approval is to be obtained before any action can proceed. This leads to an "over-dependence on fact-finding" (Jasanoff, 2007, p. 33) that slows down much needed change and action. Not only is this harmful for those hurt most by the status quo, but it also plays into the hands of those who have a vested interest in the status quo since these actors can use the reliance on science to forestall change by sowing doubt and by questioning the existence of consensus (Pearce et al., 2018). Alternative imaginaries of science–policy practices are needed to catalyse productive and generative discussions on how to move towards desirable futures. Specifically, an approach that foregrounds the political can embed an ethos of care in science–policy practices, which requires "knowledge and curiosity regarding the needs of an 'other'" (Puig de la Bellacasa, 2011, p. 98). Recognising that the transformations required to address contemporary socio-ecological challenges are inherently political (Scoones et al., 2020), such an ethos is much-needed in order to develop governance solutions that do justice to these various needs.

Conclusion

This paper departed from the question of why linear science–policy practices remain lingering. We have analysed the PBL–MFA relationship, showing that even though improvements in this science–policy interface are aspired, this has not yet led to a significant shift towards a co-productive model. Rather, we highlight how the linear model is kept in place by neglecting to imagine possible improvements in science–policy practices in a symmetrical way that considers both scientific and policy actors. In other words, a broader institutional outlook on what democratic science–policy practices might look like is still missing. This results in an asymmetrical emphasis on the roles and activities of scientists which detracts from the potential legitimacy and effectiveness of science–policy relations. We have argued that the alignment of responsibilities can be improved if science–policy practices explicate the politics of knowledge. While ample literature discusses how such a politicising approach can benefit both the effectiveness and legitimacy of science–policy arrangements, it often remains unclear how this might be operationalised in practice. To this end, we think valuable insights could be gained from studies considering how established co-productive science–policy arrangements distribute responsibilities among their participants. Social practice theory provides a useful lens to analysing such arrangements symmetrically.

We close by briefly remarking on the relevance of our analysis for the broader public debate on science–policy–society relations. There, in response to the pressure of outright science denialism, we increasingly see naïve calls being made that reinforce the linear model, asking policymakers to 'listen to the science'. However, while such calls underline the important responsibility policymakers have, we feel they are asking the wrong question, because it gives policymakers an opportunity to hide behind science (Rovelli, 2021). This regressive development makes the task of developing alternatives all the more urgent; alternatives in which policymakers are both responsible and accountable for the choices they make in, and the political implications that result from, programming, funding, creating, and using knowledge and evidence for decision-making.

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Competing interests

The authors declare no competing interests.

Ethical approval

This study was exempted from ethical approval by Wageningen School of Social Sciences, based on the fact that informants are highly educated government officials, and that the research objective was disclosed prior to the interviews.

Informed consent

All people interviewed for this study received prior information on the background and objectives of this study upon invitation.

Additional information

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