What has been the impact of public dialogue in science and technology on UK policymaking?

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Declaration

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed:

Date:

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Abstract

In this research, I set out to understand more about how society influences the course of science and technological development. Specifically, I wanted to know whether the UK's 10 year-long experience with public dialogue has brought science policy closer to the values of the public. Using a computer assisted text analysis technique, I have looked at the substance of the discussions that take place within these dialogue events and compared them to analogous expert and policy discussions, not only to understand how these discussions have impacted on policy, but also to shed light on how we as a society learn to live with technoscientific developments and on how expertise and evidence is understood, valued and used in policy.

I have found that public dialogue has had little effect on policy for three reasons: Firstly, the public in these debates describe a sociotechnical imaginary of science that is more complicated, less manageable and therefore more difficult to fit into policymaking structures and objectives than the imaginary described by scientific experts; Secondly, since they do not come from 'experts', the outputs of public dialogue are not considered to be appropriate sources of evidence by policymakers; Thirdly, public dialogue activities take place outside the networks from which UK policymakers draw advice.

The outputs of public dialogues do however show that the activities generate some interesting discussions and that the public do have contributions to make to public policy around science and technologies. I conclude that to increase impact, thought needs to be given to the type of decisions that dialogues seek to influence, to engage policymakers in discussions about the sociotechnical imaginaries that are shaping their perceptions of policy and the public, and to ways in which public dialogue can be brought into policymaking networks and coalitions.

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Chapter 1: Introduction

The past 20 years of science in public has been characterised by a move from deficit to dialogue. In the 1980s and 1990s, the 'problem' with the relationship between science and society was seen to be the public's lack of understanding of science – people were mistrustful of science because they didn't understand it; education and information was the answer – the so called deficit model (see for example The Royal Society, 1985). During the mid to late 1990s however, evidence emerged that the relationship between knowledge and attitudes was more complicated – that people's attitudes to science and technology were case specific, shaped by their own values and world views and usually had more to do with the social and ethical issues surrounding the science, rather than the nuts and bolts of how the science worked (Evans & Durant, 1995b; Frewer, Howard, & Shepherd, 1998; Slovic & Peters, 1998). At the same time, scientific controversies such as the BSE crisis, and public concerns around GM foods and the MMR vaccine, created a view that across the industrialised world, trust in science and in scientific institutions was declining (Durant 1999). The argument developed, documented most significantly in the 2000 House of Lords report 'Science and Society' (House of Lords Science and Technology Select 2000) but also presented in the literature by authors such as Wynne, Durant, Irwin and Grove-White (Durant, 1999; Grove-White, 1997; Irwin & Wynne, 1996; Irwin, 2001; Wynne, 1998), that instead of expecting people to develop more positive attitudes to science by giving them more information about science (the deficit approach), dialogue between experts and lay people should be seen as a precondition to establishing socially acceptable policies that command the confidence of the general public.

In 1999, John Durant described these two views of 'PUSET' (public understanding of science, engineering and technology) as almost parallel approaches. He argued that from the launch of the Public Understanding of Science journal in the early 1990s, it was clear that no single paradigm governed research and practice in this field, not least because the PUSET community was "an uneasy coalition of many different professional and social interests" and that "these very different groups bring different aims and assumptions to the field." (Durant 1999). Yet in the decades that have followed, what Durant termed the 'democratisation' approach to public understanding, which focuses on ways to enable public dialogue, has come to form

the basis of the UK's science in public activities and policies. In particular, since 2004 the UK Government's support for science and society activities has entirely focused on the ScienceWise programme, that aims to embed participatory techniques in government policymaking.

But given the complexity of public relationships with different aspects of science, it might seem surprising that dialogue has come to be seen as the only, or at least the most powerful, approach for mediating science's role with society. Furthermore, over the past 10 years numerous papers have described how there is very little credible evidence to show that public dialogue has had any impact (see for instance Abels, 2007; Emery, Mulder, & Frewer, 2014; Kurath & Gisler, 2009; Rowe & Frewer, 2000; Rowe, 2005; Wilsdon, 2005).

Evaluations have tended to focus on the process of dialogue – whether particular groups have had a say, whether the discussions were framed by the participants and organisers, for instance. And the explanation often given for public dialogue activities' lack of impact on policymaking is the lack of reflexivity of policymaking institutions and their dominance by technocratic viewpoints (see for instance Macnaghten & Chilvers 2014; Emery et al. 2014; Welsh & Wynne 2013). As a result, both the nature of public discussions and institutional responses to them appear to be under-theorised in the STS literature. Why are institutions unable to accommodate public responses? Is it to do with how the public see and discuss science, and if so, why is this view problematic? Does it have nothing to say to policy? Is it impractical? Or does it undermine wider policy objectives? Why would a technocratic viewpoint automatically exclude public perspectives? What does this say about reliable sources of expertise within our democratic structure and how the public do and could fit into that?

There is however work in STS and in political science that can help further our understanding of the institutional response to the outputs of public dialogue and I seek to draw on this work in my research. For instance, Sheila Jasanoff's work comparing processes of decision-making, forms of public reasoning and the imaginaries at the heart of these processes in different countries, sheds some valuable light on these questions. She describes how decision-making in different countries reflects different understandings of what counts as evidence and expertise

in a policy context (Brickman et al. 1985), and how different societies have different 'civic epistemologies' or use different modes of public reasoning when making decisions involving science and technology, modes of reasoning that shape how policy issues are framed and processed by the state (Jasanoff 2005). More recently she has described how scientific and technological projects and policies are shaped by "collectively imagined forms of social life and social order" which she calls "sociotechnical imaginaries". The machinery of science is produced by people, institutions and societies that have a particular view of how things should be and that these views – the sociotechnical imaginaries – serve both a normative and descriptive function, producing collective visions of good and attainable futures while at the same time shaping how we understand and regulate science and providing legitimacy for the role and power of science (Jasanoff & Kim 2009).

Alongside this, understanding how public views are seen in terms of expertise and in comparison to 'scientific' expertise by policymakers will also help us understand further how institutions respond to the outputs of public dialogue. I will therefore also draw upon work in the STS literature around the nature of expertise, to try to shed light on why public perspectives might be difficult to accommodate in policymaking. In particular, I will look at my findings in light of discussions about the substantive or relational nature of expertise (for instance Irwin, 1995; Wynne, 1998) and of the different 'types' of expertise proposed by Collins and Evans (Collins & Evans 2009). Collins and Evans make the distinction between 'ubiquitous' expertise' – abilities that people acquire as they navigate through life, such as fluency in natural language, moral sensibility and political discrimination – and 'specialist expertise', which is gained from the mastering of the tacit knowledge of a particular specialist field via a process of 'enculturation' – driving a car, or having expertise in a particular field of science, for example. They further divide the 'specialist' category into 'contributory expertise' which enables those who have acquired it to 'contribute' to the field of expertise; and interactional expertise, which is expertise in the language of a specialism (Collins & Evans 2004).

For Collins and Evans, this distinction between ubiquitous and specialist expertise is important in the public dialogue context because of what they term 'the problem of extension' – "how far should technical expertise be taken to extend among the public?" (Collins & Evans, 2004 p4). They argue that since it is impossible for the

public to have expertise in every specialist technical domain, space needs to be preserved for expertises that are not the property of the general public (Collins & Evans, 2004 p4). Do policymakers make the same distinctions?

Further to this, I will also draw on work in political science, especially that around the importance of groups in policymaking, to understand more about how the outputs of public dialogue activities are received within policymaking institutions and how they interact with other sources of evidence. Such research acknowledges that policy is not just shaped by institutions and individual policymakers, but that groups and associations (such as pressure groups or industry groups) help generate and shape the policy agenda, through lobbying or behind the scenes negotiations. In particular, I will consider how the outputs of public dialogue might fit into Rhodes's conception of 'policy networks' (Rhodes 1997; Marsh & Rhodes 1992; Rhodes 1990) which are based around shared resources and power dependency, and into Sabatier's idea of an 'Advocacy Coalition Framework' (AFC) in which groups are organized around common agency and beliefs (Sabatier & Jenkins-Smith 1993; Weible et al. 2011; Sabatier 2006; Sabatier 1998). Together, these understandings appear to build a complex picture of the institutions and process that the outputs of public dialogue seek to influence. I will therefore draw on this work to try to develop our understanding of why institutions appear to be unable to accommodate public responses.

Beyond the focus on the process of dialogue and under-theorising institutional responses, I have argued previously (Smallman 2014) that research in this area has tended to focus on particular examples or case studies. As a result, larger over-arching lessons have not been learned. Others (Irwin et al. 2012a; Stilgoe et al. 2014) have criticised this case-study approach for putting limitations on the wider understanding of the 'higher order game' of which public dialogue is a part. By focusing research and discussions on the strengths and weaknesses of particular instances or technologies, the wider discussion of the shape of the world that science is creating and is created by, and the place of dialogue and the public within that, is restricted.

In this thesis, I set out to move beyond evaluations of process and case studies, to understand more about what is said within these dialogue events and what that

means for policymakers and institutions being asked to act on the outputs of such events. Specifically, I will use a computer assisted text analysis technique to identify the underlying themes, discourses and sociotechnical imaginaries that can be detected in almost 10 years worth of public dialogues. By comparing these discourses and imaginaries to those identified in analogous expert documents, I characterise the public and expert discourses – and the key differences between the two and ask what these differences mean in terms of impact on policy – are public discourses and imaginaries reflected in policy?

I set out to go beyond simply answering the question of impact. As I have described above, a common conclusion of the evaluations to date is that the impact of dialogue has been limited because policymaking institutions are insufficiently reflexive and therefore tend to close down issues that need to be opened up (Stirling 2007; Chilvers 2012; Macnaghten & Chilvers 2014; Stilgoe et al. 2014; Wynne 1993). In explanatory terms, this conclusion appears to be extremely limited. It leaves open the very big question of why this might be so – what is it about public institutions that make it so difficult for the outputs of public dialogue to be taken into account? I will explore this question further in interviews with policymakers and by drawing on the literature from political science, to understand more fully whether public dialogue has had an impact on policymaking in the last 10 years and if not, why not.

In considering these questions, as well as shedding light on the practice of public dialogue, I hope to illuminate further some of the key questions for STS scholars – how does the public come to know and think about new and emerging science and technologies? How is expertise understood and valued by policymakers? How does the public influence the course of scientific and technological development and what is the role of public dialogue in bringing such co-production into the open?

Chapter 2: Literature Review – Background and what we know so far.

Background: Where did the mood for dialogue come from?

The 'new mood for dialogue' for science in public activities in the UK, was heralded in by the 2000 House of Lords report (House of Lords Science and Technology Select 2000). Responding to a perceived public crisis in confidence in the government's use of science following BSE and Foot and Mouth Disease, the report effectively marked a line in the sand for UK government policy on science and society. The old one-way communication methods had failed to halt the collision course over BSE, so it was time for a new way of talking, if we were to avoid another clash over issues like nanotechnology. But the idea of public participation in decision-making around science and technology, and the techniques to enable that, was by no means new at this point. It drew upon long-developing thinking in fields as diverse as Science and Technology Studies (STS), environmental management, technology assessment and political science.

In STS, for the past 30 or more years, scholars have been coming to understand the social nature of scientific and technological developments. For instance, in 'Leviathan and the air pump', Shapin and Schaffer (1985) describe the disputes between Hobbes and Boyle about experimental method and the generation of knowledge in restoration England. They argue that the way in which the dispute was resolved had as much to say about the political and social context as the science. The solutions to the problems of knowledge were solutions to the problems of social order; Collins, in his early research into gravitational wave physicists described how the problem of 'experimenters' regress' (whereby verification of experimental evidence relies upon theory, while proof of theory relies on experimental evidence) is broken by social negotiation (Collins 1981); Latour and Callon's Actor Network Theory, in emphasising an equality between technology and human, natural and artificial in terms of the role they can play in creating technoscientific knowledge, again shows how important machines and the material are in elucidating scientific 'facts' – such 'facts' do not simply emerge from nature, but need the social and material to be made tractable (Latour 1987). Feminist scholar Donna Haraway, in

describing the tendency to masculinize stories about reproductive competition and sex between aggressive males and receptive females, thereby facilitating some and precluding other theories, showed how theories (of primate evolution) reflect the social norms and expectations of the researchers more than reality (Haraway 1990); Wynne, in his case study on the effects of Chernobyl, described how local farmers and radioactivity experts had very different understandings of the local soils, grazing conditions and uptake of radioactivity by the pastures – and how these different understandings stemmed from their different life worlds (Wynne 1998). Jasanoff's concept of 'co-production' – the idea that natural knowledge and social order are coproduced through the same process and that the ways in which we know and represent the world are inseparable from the ways in which we choose to live in it (Jasanoff 2004) – brings many of these ideas together. Gibbons and Nowotny describe a process of how science and society co-evolve, in their work looking at the complex and networked structure of scientific knowledge production (Gibbons et al. 1994). Again, rather than society being the passive recipient of knowledge which has been produced autonomously, they argue that the way scientific knowledge is produced and used has changed in a way that connects science and society more closely – what they term Mode-2 knowledge. As a result of the more direct effect that scientific knowledge now has on society, society reacts by trying to influence science more forcefully than before, such that science and society co-evolve.

One understanding of the move to dialogue then, is that public dialogue was seen in STS as a way to bring the 'social' part of the scientific endeavour into the open. Indeed, a key feature of Mode 2 knowledge production, for instance, is 'social robustness' – the idea that the social quality of the process of knowledge production ensures innovations are likely to be met with acceptance among those affected by it. Public participation is seen as a key way of achieving this social robustness (Gibbons et al. 1994; Nowotny et al. 2001; Nowotny 2003).

Importantly, alongside the understanding that the social and the natural are more difficult to separate out than previously thought, STS scholars and sociologists have also been developing an understanding that science and technology is increasingly uncertain and unpredictable. Beck and Giddens in particular, in their work around 'Risk Society' (Beck 1992; Giddens 1999) describe how western society has been transformed in the late 20th Century, at least in part by the increasing influence of

science and technology, such that we now live “on a high technological frontier which absolutely no one completely understands and which generates a diversity of possible futures” (Giddens 1999). Importantly, this preoccupation with the future (and controlling the future) puts a focus the notion of risk (rather than hazard). But where we were previously concerned with externally caused dangers “from the gods or nature” (Beck, 1992 Chapter 7) today’s risks are created by the very processes of modernity or human progress – particularly scientific progress. Giddens calls these internal risks “manufactured risks” (Giddens 1999), which he argues we can’t “quantify accurately in terms of probability tables”, or even know. As a consequence, whereas once “science faces a practice and a public sphere whose resistance it can sweep aside, supported by its success, with promises of liberation from constraints not yet understood” (Beck 1992, Chapter 7) science is now not just targeted as a source of solutions to problems but also the cause of the problems – it is simultaneously “one of the causes, the medium of definition and the source of solutions to risk…Science becomes more and more necessary, but less and less sufficient for the socially binding definition of truth” (Beck, 1992 Chapter 7).

Functovicz and Ravetz (1993) describe a similar shift in our understanding of science in modern times: “Whereas science was previously understood as steadily advancing the certainty of our knowledge and control of the natural world, now science is seen as coping with many uncertainties.” Using the term ‘Post-normal science’ to characterise science in these modern circumstances, they argue that the best way to cope with this change in policy situation is to create an extended peer community of all those affected by an issue who are prepared to enter into dialogue on it. Callon, Lascoumes and Barthe (2001) echo the point that contrary to past expectations, scientific and technological developments have brought us more not less uncertainty and a “feeling that our ignorance is more important than what we know” (Chapter 1). The resulting public controversies – around issues like BSE or nuclear waste – increase the visibility and underline the extent of these uncertainties. They go on to argue that the situation now exists whereby science and technology cannot be managed effectively by the political institutions we currently have. They conclude that “when the uncertainties about possible states of the world and the constitution of the collective are dominant, the procedures of delegative democracy are shown to be unable to take the measure of the overflows [the unforeseen consequences of science] provoked by science and technology.

Other procedures of mobilisation and consultation must be devised" (Chapter 7). Specifically, they describe the importance of 'hybrid forums', which are open places where groups from all backgrounds can come together to discuss technical options facing society at a variety of levels and in different domains.

Alongside this thinking in STS and sociology, a parallel conversation has taken place in political science. While some date deliberative or participatory democracy back to 'the city states of ancient Greece', whereby the process in which citizens publicly discuss and debate laws was seen as a way of reaching better decisions than by experts acting alone (Carpini et al. 2004), many of the modern ideas around public participation and experiments in democracy refer back to the ideas of John Dewey in the early 20th Century. Dewey is widely regarded in political theory as most strongly recognising the value of dialogue for democracy in post-industrial society (Marres 2007; Westbrook 2005). In response to two books by the journalist and public intellectual Walter Lippmann (1927;1922) in which he argued that as politics in the industrial world was becoming increasingly complex, ordinary citizens were unable to perform the governing role that democratic theory gave them, Dewey made the case for participatory democracy (Dewey 1927). Whereas Lippmann's solution to increasing complexity was a stronger role for expert advice in government decision making, with limited input from citizens, Dewey argued that technological societies needed more public input not less. Indeed he did not see public involvement to be simply necessitated and mediated by controversies that other institutions were unable to resolve, but he saw it as also providing a way of resolving these controversies – not least because 'the public' in his terms is made up of citizens whose common interest is focused on alleviating these negative externalities.

In more recent times Abels (2007) describes "a participatory revolution [during the 1960s]... where demands for 'more', 'better' and 'enhanced' citizen participation are frequently raised." This gave rise to new forms of political participation – from boycotts and demonstrations, to formal processes to involve citizens in local planning decisions. Participation became of particular interest in the 1990s however, when concern grew around an emerging 'democratic deficit', whereby citizens were becomingly increasingly distant and disillusioned from traditional decision making structures, seeing participation rates in elections dropping and cynicism about

government and politics rising (Barnes et al. 2007). Explanations for this included concentration of power into central government which left citizens as passive observers (Ostrom 2000), social and economic change that resulted in reduced social connections and capacity to participate in civic life (Putnam 2001) and increasing global capitalism that was leaving nation states powerless to act (Klein 2000). In the UK in particular, Barnes et al (2007) argue that while the Conservative government of the 1980s and early 1990s reconceived citizens as consumers, the New Labour Government of 1997 responded to the inadequacy of this limited conception of citizens as consumers, by putting forward a broader idea of citizenship (Barnes et al. 2007). This new idea of citizenship emphasised the role of public participation in local governance as a way to develop a more involved and responsible citizenship – participation in specific local initiatives was seen to lead to increased levels of public interest, involvement and influence in local issues. It was also seen very much as a way to raise standards and find the best possible fit between local needs and local capacity (Barnes et al. 2007). As a consequence, numerous public and citizen participation opportunities and exercises arose – the 'best value' regime, which was New Labour's alternative to the Conservative's compulsory competitive tendering process, introduced a duty on local authorities to involve citizens in reviewing local services and considering alternative means of service delivery (Barnes et al. 2007); communities were involved in decisions around regeneration through the New Deals for Communities initiatives; and a variety of methods such as deliberative polling, citizens juries and citizens panels were used to inform local health care priority setting decisions (Abelson et al. 2013).

More widely, significant social changes were taking place during the second half of the 20th Century. Ulrich Beck described how citizens' initiative groups across Europe took power unilaterally without waiting for policymakers and politicians (Beck 1992). He argued that citizens not politicians brought about the unification of Europe and put issues like ecology, gender equality and animal rights on the agenda, creating a sense of the importance of the citizen versus those traditionally holding power. In his book 'The Third Way' Anthony Giddens (1998) makes a similar point in saying that as a result of the power of citizen groups and NGOs, "Governments will have to be ready to learn from them, react to the issues they raise and negotiate with them". He also argues that partly as a result of globalisation, the pace of science and innovation has sped up, such that the boundary between nature and technologies is

becoming increasingly complex. Consequently, all of us "live in a more interrogatory relationship with science and industrial innovation than ever before…Decision making in these contexts cannot be left to the 'experts', but has to involve politicians and citizens. In short, science and technology cannot be left outside the democratic process" (Giddens 1998). The democratisation of science and technology in this context, was therefore, very much part of the modernisation of social democratic politics in the UK.

Liesbet van Zoonen (2012) has recently documented a further sociological change that builds on this notion of powerful citizens and is significant both for the rise of public engagement but also the role of traditional expertise. She reflects on the current tendency towards epistemological suspicion, whereby all knowledge appears to be tied to social and material interests and therefore not to be trusted. While this was once particular to feminist, critical and postmodern theory, in Western cultures such suspicion now seems to have become a dominant mindset. She argues that this suspicion has been coupled with the emergence of 'self' as the source and arbiter of all truth – people have come to believe that "the truth is in there; in the self, in personal experiences and feelings, in subjective judgement and individual memory" rather than in traditional sources of knowledge and expertise. She terms this "turn into the self as the origin of all truth" as 'I-pistemology' and argues that it has arisen, at least in part, as a result of the uncertainty in the world around us – in a situation of high-epistemological insecurity, people have turned to themselves as an alternative source of knowing or understanding. Our personal experience and perspectives are something we can be certain of if nothing else.

The concept of I-pistemology is interesting in the context of science in public for two reasons. Firstly, it provides at least a partial explanation for the occurrence of science and society conflict points where government information is contested and alternative facts and truths produced, or at least the tendency of some to believe the alternatively produced facts – for instance the various arguments around the causes of climate change. Secondly, and perhaps more importantly for this thesis, it sheds further light on the ideological viewpoint from which the move towards dialogue appears to have come from. Van Zoonen argues that while first person narratives have become the privileged position from which to speak in political and popular culture, it is not exclusive to these contexts. It has also been a key part of

progressive politics in the late 20th century – especially the politics of feminist, civil rights and gay movements where the personal was not only political but also true. In feminism in particular, "the individual experiences of women were thought to add up to a collective truth about women's subordinate positions" (van Zoonen 2012). If official knowledge was produced from a white, male, heterosexual perspective then, part of the progressive political project was to produce the alternative knowledge coming from the experiences of women, black people and gay people. Not all of these voices were given equal interest however and a preference for progressive, 'against the grain' views has remained in many areas of study (van Zoonen 2012).

Understanding that many STS perspectives on science in public developed within this academic context during the late 20th Century, it is possible to see how democratising science and technology is also the logical extension of this political academic project. Looking at the issues of science and society through the lens of progressive social movements, the focus falls upon the power imbalance between scientific experts and citizens. The right solution (as it was with feminism and civil rights before) would be to tell the personal stories that were up until now hidden. It is possible to see such a perspective in some of the early work of proponents of dialogue – for instance, Brian Wynne's work looking at the lay-expertise of the Cumbrian sheep farmers following the Chernobyl nuclear disaster (Lash et al. 1996; Wynne 1998) tells a story of how the (working-class) farmers' expertise and understandings were side-lined in favour of the (typically white, middle-class male) scientific experts understandings; or Tom Wakeford's work on citizen's juries, in which he argues that the role of participatory techniques is specifically to involve excluded voices: "key to their [Citizens' Juries] future is the development of citizens' juries that are not only fair, representative and transparent, but are able to form part of longer-term initiatives particularly aimed at those currently excluded from political processes" (Wakeford 2002).

Bringing together many of these ideas around democracy, uncertainty and the social nature of science and technology, a practice called Participatory Technology Assessment (PTA) arose in Europe during the 1980s and 1990s (Griessler et al. 2011). PTA is a process (or series of processes), which aimed to broaden the knowledge base of decision making by taking an interdisciplinary approach to identifying the possible positive and negative implications of a technology in order to

make political decision-making more informed and rational. Durant (1999) describes it as a "response to the structural changes in democratic society at the end of the 20th Century", while Abels (2007) argues that the motivation for developing such and approach was two-fold: Firstly as a response to demand for policy-making procedures that allow integrating the factual and social dimension of conflicts over the role of science and technology for society; secondly, for normative reasons – because involving people in decisions around science is the right thing to do. Joss and Durant track the idea of public participation in decisions around science and technology back to the 1970s where the USA's National Institute of Health (NIH) first instigated organized dialogues between panels of medical and other professional experts. These medical consensus conferences aimed to facilitate professional assessment of new medical technologies (Joss & Durant 1995b). Joss and Durant argue that such participatory processes were rooted in a 'dialogue model' of the public understanding of science, in which the key activity is two-way or multi-way communication between scientists and non-scientists, with the aim of creating greater mutual understanding, which may or may not lead to greater accord between scientists and non-scientists (Joss and Durant 1995).

A number of European countries took up this approach during the 1980s and 1990s, most notably the Danish Board of Technology, which developed and ran a series of 'Consensus Conferences'. The Netherlands also took up the idea, organising a consensus conference on genetic modification of animals in 1993. In 1994 London's Science Museum organised the UK's first consensus conference on plant biotechnology (see Dale, 1995; Joss & Durant, 1995a, 1995b for descriptions of the event). Funded by the BBSRC, which felt that it had a responsibility to communicate with the public about the new biotechnologies and wished to obtain a clearer view of public attitudes towards these technologies, the consensus conference made recommendations to government about how GM foods should be labelled and handled in the future. But without any formal links to government, it was largely seen as an "experiment" in participatory democracy (Joss & Durant 1995b). Durant later (Durant 1999) stated that it achieved only part of the organisers aims as it was "delivered and received in a cultural context largely dominated by the deficit model". The conference organisers were keen to point out that success was not only measured in terms of impact on "the formal institutions of political decision making" however, concluding that "arguably, the very existence of constructive and open

dialogue between experts and laypeople may help to build useful bridges between the scientific community and the wider public" (Joss & Durant 1995b).

Subsequent socio-technical controversies around BSE, disposal of the Brent Spar oil rig and GM crops themselves led to increasing calls for public perspectives to be built into the decision making process in the UK (see for example Grove-White, 1997; Irwin & Wynne, 1996). This culminated in the 2000 House of Lords 'Science and Society' report, which recommended a "new mood for dialogue" that would "help the decision-maker to listen to public values and concerns; and give the public some assurance that their views are taken into account, increasing the chance that decisions will find acceptance."

Following the recommendations of the House of Lords, and the Agriculture and Environment Biotechnology Commission (AEBC) report 'Crops on Trial' (Agriculture and Environment Biotechnology Advisory Board 2001), the UK government set up the first national-scale public dialogue on a science topic in 2002 – with the heated issue of GM foods as the focus (Horlick-Jones et al. 2006). The AEBC, in looking at the value of the Farm Scale Field trails of GM crops and the reasons why the trials had created such public controversy, concluded that the development of GM crops had "suffered as a result of the lack of opportunity for serious debate about the full range of potential implications of GM agriculture, on the basis of clear understandings of what is involved, away from concern that had been created by campaigning elements of the media." Consequently, they argued that the government needed to "encourage comprehensive public discussion of the ecological and ethical – including socioeconomic – issues which now have arisen" (Agriculture and Environment Biotechnology Advisory Board 2001).

Comprising a series of open public meetings, a dedicated debate website and a series of closed discussions (which acted as control groups) the GM Nation debate ran over the summer of 2003 and is believed to have reached more than 20,000 people (Rowe 2005). Its stated aims were twofold: "to promote an innovative, effective and deliberative programme of debate on GM issues, framed by the public, against the background of the possible commercial production of GM crops in the UK and the options for possibly proceeding with this; and through the debate provide meaningful information to Government about the nature and spectrum of the

public views, particularly at grass roots level, on the issue to inform decision-making." (GM Nation website http://www.gmnation.org.uk)

Overall, from a number of perspectives, the debate was not considered to be a success. From the government and scientists' perspective, it was seen to do little to take the heat out of the debate (Gaskell 2004; Horlick-Jones et al. 2006). Others criticised the approach taken by the government, arguing that it was impeded by lack of time and money (House of Commons Environment Food Select Committee 2003), that it failed to engage with a sufficiently wide array of people, that is was primarily a legitimatory exercise and that it lacked focus (Irwin 2012, Council for Science and Technology, 2005; House of Commons Environment Food Select Committee, 2003). The GM debate was however seen to be foreshadowing a controversial new and emerging science – nanoscience. While the UK was leading the way with this promising new field, public opposition could dramatically curtail this. In 'See through Science' (Wilsdon & Willis 2004), Demos used the launch of a Royal Society report on nanoscience as the backdrop against which to make the case for improved dialogue (upstream engagement), contrasting the potential to get things right now, with how things went wrong with GM. At least in part to learn the lessons from the GM debate, and to forestall any potential public opposition to this new area of science, the UK government launched the ScienceWise programme, to encourage, fund and support policymakers to involve the public in decisions around science and technology. This is the point where I take up the story in my research. While the normative case for doing dialogue has been made strongly, what has been the impact of this shift from deficit to dialogue? Has it been effective in ensuring the views of the public have been heard and reflected in policy? And if not, why not?

What do we know about the impact of dialogue already?

Given such an established history of public dialogue over more than 20 years, what outcomes and impacts does research to date suggest has been produced? Despite the dominance of the technique within science and society relations in the UK, many argue that much of the literature around the benefits of dialogue and public participation are advocacy rather than empirically based (Culyer & Lomas 2006; Abels 2007). Evidence of impact on policy is still very limited and this appears to be

both because there has been little research into policy impact (Rowe and Frewer 2005; Emery et al 2014) and because that research which has been done has found little evidence of impact (Loeber et al. 2011; Hansen & Allansdottir 2011; Kurath & Gisler 2009). For example, Goodin and Dryzek's work (Goodin 2006) which specifically set out to chart the ways in which 'mini-public' events, which bring together small groups of selected 'publics' to discuss particular issues, have an impact on policy found few examples of mini-publics influencing policy. They state that cases of mini-publics making policy "are still rare" and cite the example of the Danish Consensus Conferences of the 1980s as instances where the ideas of mini publics were taken up by policy. Even in this instance though they acknowledge that it was impossible to say for sure that these wouldn't have been the policy outcomes anyway. Other examples they give include the UK GM Nation debate, which they argue might not have resulted in an anti-GM policy, but did prevent a pro-GM one (Goodin 2006) (although it is questionable whether this position was imposed by the EU).

Impact appears to be limited – and focused on benefits of participation

Furthermore, those instances where impact has been evidenced are usually focused on the benefits of participation (rather than any fundamental change in policy). For instance, participants in GM Nation reported that they had found the experience enjoyable and constructive (Rowe 2005); Durant and Joss (1995b), reporting on the first UK consensus conference on plant biotechnology, concluded that a key learning point was that "it is possible to facilitate constructive dialogue between laypeople and experts in socially sensitive areas of science and technology" (Joss & Durant 1995b). Molster et al 2013, interviewing participants following a deliberative forum on biobanking, found that participants said they felt more informed about the issues they had discussed and had greater trust in government policymakers, who they believed would take reasonable account of their recommendations (Molster et al. 2013). Niemeyer 2011 looked at two case studies and compared views before and after participatory events. He found that participatory deliberative processes had an 'emancipatory mechanism' in freeing the public views from distortion by powerful symbolic influences in the media (Niemeyer 2011). He argued that participants' stated preferences in the deliberative events more closely reflected their underlying will. Looking at the impact on the

policymaking process itself in the UK, US and Canada, Einsiedel and Jones (2011) found that despite the lack of substantive policy change coming from citizens' juries, the exposure to the method of public deliberation facilitated a shift in institutional culture, which was reflected in a greater openness to including a broader set of actors in the policy process (Einsiedel et al. 2011); Abels (2007) reported that while there is empirically insufficient proof that pTA has an impact on policy-making, there is still the enlightening function for the general public; Carpini et al (2004) describe how, in certain contexts dialogue can encourage the majority to consider new alternatives and perspectives and to more generally empathise with minority positions (Carpini et al. 2004); and Loeber et al (2011) argued that even if participatory technology appraisal exercises have little 'formal' influence on the decision making process, they can provide an opportunity for citizens to become active and for new coalitions to emerge (Loeber et al. 2011). While these outcomes are important and undoubtedly valuable, they do not match the high aspirations relating to the democratisation of science decision-making, attributed to dialogue by many. Reports of impact also often appear to be based upon a small selection of illustrative examples (Evans 2014), or are instances where public dialogues are supportive of the policy approach (Risk and Policy Analysts, 2015). It has also been reported that there is a tendency to over-report the positive outcomes and neglect the negative outcomes in evaluations of participatory exercises, particularly where evaluations are not independent (Daykin et al. 2007).

Why this lack of impact?

a. Impact difficult to measure

To a large extent this lack of evidence of impact is a methodological issue relating to the difficult of measuring impact. For instance Rowe et al (2005) argue that evaluating outcomes is difficult because it is never clear when the end of a dialogue process is, and because outcomes are affected by external factors such as simultaneous events or external pressures of policy. As a consequence, they point-out that "although the evaluation of outcomes is perhaps preferable to processes, because these will correspond more directly to the desired aims of the exercise, evaluation of exercise processes must often serve as a surrogate to outcomes. That is, if the exercise process is 'good' (conducted well according to one's definition) then it would seem more likely that the outcomes will be good than if the process is

'bad' (Rowe et al 2005). Culyer and Lomas similarly argue that measuring the ultimate outcome of a deliberative or participatory process is problematic because of the difficulty in attributing cause and effect with confidence. They point out that "a deliberative process might be as excellent as it possibly could be, but the ultimate outcome might fail to emerge because of failures elsewhere in the system" (Culyer and Lomas 2006). Boaz et al (2014) pointed out that the focus on methodological aspects of dialogue is sometimes at the expense of a more deep-rooted exploration of the practices – looking at the values, norms and codes that shape scientific practice. Others have argued that we need to look at the wider political context within which dialogue takes place (Stilgoe et al. 2014; Irwin et al. 2012a; Stirling 2007). And, as I have argued in the introduction and will describe later, it is possible that there is something in the substance of the discussion that is taking place – and the way the messages from the discussion are received – that affects the impact of dialogue as much the process undertaken.

b. Lack of reflexivity of policymaking institutions

The challenge of measuring impact however only appears to be part of the reason why there is little evidence of the impact of dialogue on policy. Where there has been work to evaluate the impact of dialogue, there is wide agreement that little evidence of impact has been found (Loeber et al. 2011; Hansen & Allansdottir 2011; Kurian & Wright 2010). Typically, the reasons given for the lack of impact of public dialogue in the STS literature focus on the lack of reflexivity of the policymaking institutions. As a result the role of the public is limited to discussion questions of values and ethical issues, rather than exposing 'expertise' to scrutiny (Kurath & Gisler, 2009; Wynne, 2006). Institutions see public dialogue as an opportunity to gain trust for a predetermined approach, rather than to rethink their policies and practices (Wynne 2006; Thorpe & Gregory 2010; Chilvers 2012; Macnaghten & Chilvers 2014; Stirling 2007).

Why might policymaking institutions lack reflexivity and why would this exclude alternative viewpoints?

a. Credibility of participatory procedures

So why and how might policymaking institutions develop this lack of reflexivity and resist alternative perspectives and voices? Some have suggested that policymakers do not consider social knowledge as equal to 'expert' knowledge (Kurath 2009). For instance, research looking at the policy impact of public debates around GM in New Zealand found that the value focus of public discussions led to public views being deemed 'alternative science' and therefore not credible, in preference for technical expertise. This, the authors argue, demonstrates the sponsoring organisation's entrenched ideological belief in the benefits of science – and the view that science was the only possible arbiter of GM risks (Kurian and Wright 2010). Others have highlighted a paradox for the credibility of participatory procedures. On one hand, for dialogue to offer genuine alternatives to politics as usual, they need to distinguish themselves from other modes of alternative policy advice. On the other hand, if they are too 'alternative' they risk being ignored (Biegelbauer & Hansen 2011).

Taking these arguments further, Lovebrand et al (2015) used the text of the 2007 European Commission report "Taking the European Knowledge Society Seriously" (Felt & Wynne 2007) as the basis for arguing that public dialogues lack legitimacy – or at least have questionable legitimacy. They make the case that while proponents of dialogue draw heavily from deliberative democrats' normative accounts of legitimacy in order to legitimise science decision making, in practice they are drawn on different logics in evaluating the legitimacy of real life public deliberations – focusing on diversity and dissent, rather than questions of reciprocity, accountability and reason. As a consequence, proponents of dialogue fail to justify why deliberate governance deserves primacy over other ways of decision-making (Lovbrand et al. 2010). Others question legitimacy on the basis of representativeness – who is present at the dialogues and who do they speak for (Sturgis 2014)?

b. Links to policy

The relationship to policy – in particular weak links to policymaking – are seen as further significant inhibitors of impact (Abels 2007; Kurath 2009; Emery et al. 2014).

Durant (1999) argued (in advance of the event), that the UK's second consensus conference (on the long term management of nuclear waste) would have more impact than the first consensus conference because the UK government had lent its support to the second conference. This is in keeping with political science work, already mentioned, looking at the role and influence of groups in policymaking – in particular work describing the way in which different groups have different levels of power and influence, with some on the inside with good access to policymakers, while others have less access (for instance Richardson & Jordan 1979; Marsh & Rhodes 1992; Rhodes 1997; John 2013; Beyers & Braun 2013). ScienceWise deliberately set out to ensure the links to policy for their dialogue activities, formalising the links by asking that each dialogue project has a policy sponsor. Understanding whether this link has been enacted and if so whether it has brought the expected improvement in impact on policy are questions I set out to address in this research.

c. Shared interests between scientists and policymakers

The idea that policymaking institutions are dominated by an elite technocratic viewpoint which excludes any other has been described a number of times, particularly in relation to GM crops. For instance Dryzek (Dryzek et al. 2008) has described how participation exercises on GM tend to evoke a 'precautionary public' which is set against a 'promethean elite' worldview. More recently, Chilvers and Macnaughten (2014) have also described the same problem in explaining why the ScienceWise public dialogue programme has had little impact on policy. But why do different viewpoints necessarily exclude the perspectives of others? Bora (Bora 2009) sheds some light on how elite relationships works to exclude the views of public participants. In looking at the impact of participation on the licencing of GM crops, he argues that in cases of legal administrative decision making, law and science create "regimes of technoscientific normativity", excluding political (i.e. values based) perspectives. Bora argues that since both science and law speak to 'facts' and 'truth', they are able to come together to define concepts of risk, nature, citizen and the public. Participatory decision making challenges this authority by bringing other perspectives to bear and so in such circumstances a collusive coupling between law and science takes place, thus excluding political discourse (Bora 2009).

Echoing the idea that shared interests in groups makes it difficult for them to accommodate the views of others, Slaughter (Slaughter, 2013), looking at the role of participation in the governance of the G20, argues that it seems unlikely that radical voices from various publics could be considered by the leaders of the G20, given their history of prioritising capitalist and neo-liberal ideas. Similarly, as I have already mentioned, Dryzek et al (2008) similarly points to an 'elite' attachment to 'promethean' views of science, which leaves no space for more precautionary public perspectives that might be viewed as slowing down progress, arguing that "... One of the first priorities of contemporary national governments is to ensure economic competitiveness in a globalising world. Large costs can be expected when the state departs from a Promethean facilitation of technological innovation, diffusion and adoption" (Dryzek et al., 2008). Beynon-Jones and Brown (2011) also explain this dominance of technocratic viewpoints in terms of shared interested between the scientific and policy community, but argue that this also has the effect of closing down the timescale at which decisions are made – which could potentially exclude other viewpoints with longer time-frames. Based upon their study of UK decision-making relating to xenotransplantation, they argue that decision-making tends to be guided by narratives generated by scientific entrepreneurs, which encourage short-term decision making and perpetuate institutional amnesia about the long-term dynamics of research, precluding deliberation (Beynon-Jones & Brown 2011).

d. Democratic Context

Taking a wider view, there are arguments that the lack of impact of public dialogue in the UK relates to the type of democracy that we have. More specifically, participation is generally considered to be suited to participatory democracies, whereas the UK works within a representative democracy, which means that it is more difficult to integrate participatory practices into policy making (Beigelbauer and Hansen 2011). For example, in their comparison of participatory technology assessments in different European countries, Loeber et al., (2011) concluded that in countries such as Austria, the "neo-corporatist and expert driven" form of policymaking, which tends to exclude the public, is not conductive to PTA. In contrast, the Swiss political culture has a system of checks and balances that emphasises consensus and gives the public a power of veto through its provisions

for direct democracy. As such, the institutional structure is better prepared to incorporate results from a PTA (Loeber et al., 2011). Looking at decision-making relating the regulation of xenotransplantation, Biegelbauer and Hansen (2011) similarly argue that the constitutional context and general openness of the political system in question matters as much in terms of impact, as the design of the dialogue process. In comparing the impact of public participation on policy in countries which have different democratic structures, they point out that it seems difficult to make the processes and results of participatory processes compatible with representative democratic processes, which in theory have no problem with reliance upon experts. Nevertheless, some countries have been more 'susceptible' to public engagement institutions – most notably those with a general openness of policymaking and where there is an absence of closely-knit policy communities. In the case of science and technology governance, since many issues do not involve politicians but stay at the civil service level, they argue that it is important that the "bureaucracy is not paternalistic but heeds accountability, transparency and openness as important factors of democratic decision making" (Biegelbauer & Hansen 2011).

e. Substance of what is said in dialogue cannot be incorporated into policy

Besides problematizing the policymaking institutions however, research looking at the content of the outputs of participatory exercises has found explanations for lack of impact within these outputs and the views they express. Participatory procedures, especially those dominated by lay people, tend to produce very unspecific and broad results that are hard to integrate into policy-making (Abels 2007; Kurath 2009). Braun and Schultz (Braun & Schultz 2009) have argued that the way in which public dialogue activities tend to focus on 'pure public' and 'affected public' as the most important participants means that views given tend to be individualised 'naïve' perspectives which can be respected but hardly criticised and which tends to fragment, ethicise and depoliticise the issue at stake. As a result, public dialogues have little to say on issues of distributive justice, research priorities, economic interest or impact on society as a whole, as these matters require speaking positions of social or political groups (Braun & Schultz, 2009). Van Eeten (van Eeten 2001) argues that it is the problematic nature of reaching conclusions in public dialogue activities that makes the substance of what is being said difficult for

policymakers to incorporate. Discussions generate varied views, which are difficult to focus into clear outcomes or conclusions that would be policy relevant and a basis for collective decision making.

Problems resulting from dialogue

Finally, as well as there being a lack of evidence of impact and evidence of a lack of impact, there is also evidence that in some instances dialogue can have negative impacts on people's perceptions of democratic legitimacy and accountability of policymaking in science and technology (Abels, 2007; Kurath, 2009; Carpini et al 2004). A number of reasons are put forward for this, including questions about who the public represents and is accountable to, the fairness of the process by which ideas are discussed and filtered within the dialogues (Abels 2007), evidence that views have had an impact and participants' sense of procedural justice (Carpini et al. 2004; Ulbig 2008). Discussions tend to move collective opinion in the direction of the pre-existing views of the majority (Carpini et al., 2004). Rather than bringing people together, this tends to exacerbate already present tensions and differences.

In the following chapters, I set out to build on this rich history of STS and Political Science literature. In moving beyond a case study approach, I aim to draw overarching lessons about how participants discus technologies in dialogue events and the impact on policy of the UK's first ten years of public dialogue in science and technology. Drawing on the political science literature in particular, I also set out to examine the institutional context of the outputs of public dialogue – to explain why this apparent lack of reflexivity exists and what practical lessons can we learn to improve practice and impact on policy in the future.

I begin (in Chapter 3) with a description of my methodology and the theoretical concepts that I will be drawing upon.

Chapter 3: Methodology

As I have explained in the introduction, in this research, I wanted to move beyond the scale of the case-study, to consider all of the discussions that have taken place about new and emerging science and technology in the UK over the past decade. In so doing, I wanted to find out if taking this broader view can provide any new insight about the way people discuss and understand new technologies, beyond the insight gained from individual case studies. Are there patterns or themes emerging across topics or are discussions very particular to the issue in hand, for instance?

Further to that, I also wanted to understand whether public dialogue has had any impact on policy and to explore the reasons why impact might be difficult to achieve. In particular, to understand more about previous claims that policymaking institutions are resistant to outside voices because they are dominated by technocratic viewpoints – is this claim evidenced across all public dialogues? Why does this viewpoint dominate and why is it difficult to accommodate different points of views in policymaking?

Previous evaluations of the impact of dialogue (for instance previous evaluations of the ScienceWise programme) have attempted to track individual reports on a case-by-case basis, looking for precise elements and ideas of the public report being reflected in the policy documents. Tracking the impact of individual dialogue comments into particular policy documents is a notoriously problematic approach however as there is often a long time-lag between a dialogue and policy being made, and because policy is subject to so many influences (Emery et al. 2014). Rather than trying to find direct lines between public dialogue and policy documents then, here I am seeking to look at how the high-level ideas and visions – and general approaches to the subjects in hand- are reflected and expressed in the different corpuses. I have taken a comparative approach that compares how participants in public dialogues, scientific experts and policymakers talk about the same range of technologies. Specifically, I have been looking at the sociotechnical imaginaries (described in more detail below) expressed by these three groups, to understand whether there is indeed a clash of viewpoints and what that means in policy.

Conceptual Framework

1. Discourses

For the purposes of this research, I use the term 'discourse' simply to refer to a unit of language organised around a particular subject matter and meaning. The first stage of my analysis identifies a series of subjects or discourses that are discussed within the public dialogues, based upon the words being used to discus them.

I am however interested in discourses in order to understand the world that speakers describe with their choice of words – and the values and social norms revealed in these choices and descriptions. I therefore engage in these discourses more critically at the second stage of analysis when I consider the sociotechnical imaginaries at play within these discourses.

2. Sociotechnical Imaginaries

Sociotechnical imaginaries are defined as:

> "Collectively held, institutionally stabilised and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through and supportive of, advances in science and technology". (Jasanoff & Kim 2015)

Simultaneously normative and descriptive, they both express and prescribe the meanings, purposes and priorities of science and technology.

The concept has been developed by Jasanoff and Kim (2009 & 2015) to help examine the complex relationship between knowledge, its applications and power. They argue that conceptual frameworks that help situate technologies within the material moral and social landscapes are in abundance in science fiction yet are scarce in STS. Nevertheless, STS acknowledges the normative dimensions of science and technology. For instance, the concept of coproduction (Jasanoff 2004) describes how science and technology do not uni-directionally shape our values and norms, but, in symmetry, our sense of how we ought to organise and govern ourselves shapes how we make sense nature, society and the world. Coproduction does however lack the specificity to understand why particular problems, viewpoints

and ideas persist – it helps us understand how things fit together, but not how they come to be as they are. They argue that "the idea of sociotechnical imaginaries confronts some of these challenges head on" (Jasanoff and Kim 2015).

Originating in their work on the US and South Korean response to nuclear power (Jasanoff & Kim 2009), the concept also draws on literature around the construction of imaginaries from political and cultural theory. For instance, Jasanoff and Kim (2015, p6) specifically attribute the work of Durkeheim and Weber as helping us take for granted the idea that societies share common narratives of who they are, where they have come from and where they are going. Benedict Anderson's work 'imagined communities' (Anderson 1991) is also cited as being foundational to the concept. In this, Anderson brings together ethnography and political science, to understand the Nation state, and nationalism, as an imagined community – a construction of individuals that don't meet but that are tied together thorough shared practices of narrating, recollecting and forgetting.

Widening the gaze beyond nationhood and onto questions around the grand patterns of historial and political thought, Charles Taylor (2003) also develops the idea of imaginary further. In considering how did the modern world – and its distinctive structures, institutions and practices – come to be, he concludes that imaginaries changed, defining social imaginary as "the ways people imagine their social existence, how they fit together with others, how things go on between them and their fellows, the expectations that are normally met, and the deeper normative notions and images that underlie these expectations." (Taylor 2003, quoted in Jasanoff and Kim 2015 p7). Arjun Appadurai's (1990) work on globalisation and diaspora is also cited as significant. In particular, Jasanoff and Kim (2015) argue that in this writing Appadurai turns the notion of the imagination as a fantasy or "opium for the masses whose real work is elsewhere", nor "simple escape from a world defined principally by more concrete purpose and structures", but is contributing to the shaping of our material world by defining what could and ought to be (Appadurai 1990, cited in Jasanoff and Kim 2015).

What is however missing from all of these accounts of social imaginaries however is any detailed investigation of science and technology, which Jasanoff and Kim argue, have been modernity's most salient forces. The notion of "technoscientific

imaginaries" developed by George Marcus (1995) might appear to address this omission, but Jasanoff and Kim (2015, p11) argue that the context of these technoscientific imaginaries is the scientific workplace and their aims and achievements tied to scientific production. They argue that instead, sociotechnical imaginaries are necessary in order to continue the STS tradition of symmetry, to investigate "how, through the imaginative work of varied social actors, scicence and technology become enmeshed in performing and producing diverse visions of collective good, at expanding scales of governance from communities to nation-states to the planet" (Jasanoff and Kim 2015, page 11).

As illustration, Jasanoff and Kim (2009) describe how "sociotechnical imaginaries" have proved particularly useful for policymakers in late modern societies:

> *"Imagined futures help justify new investments in S&T; in turn, advances in S&T reaffirm the state's capacity to act as responsible stewards of the public good. Sociotechnical imaginaries serve in this respect both as the ends of policy and as instruments of legitimation."* (Jasanoff & Kim 2009)

Importantly for this research, Jasanoff and Kim (2015) argue that while National governments are important sites for the construction and implementation of sociotechnical imaginaries, others might hold different imaginaries, based on different values, cultures and perceptions of the good life. These imaginaries will in turn shape how power and the role of science and technology in our society are understood, legitimized, valued and assessed. Understanding the sociotechnical imaginaries at play would appear to be a useful step towards identifying similarities and differences in the views of the public, experts and policymakers, as well as to making sense of how different groups come to know and form positions on particular new and emerging technologies (Jasanoff & Kim 2009).

Also helpfully for this research, Jasanoff and Kim (2009) have gone some way to explaining how to identify sociotechnical imaginaries. They suggest that documents and texts relating to science, technology and power – such as policy reports, speeches, judicial opinions – are some of the most accessible resources as, by their nature, official documents tend to favour the imaginaries of elites. Other documents, such as those produced by NGOS or social movements (arguably the reports of

public dialogues) are likely to reflect alternative imaginaries. They also suggest that open-ended interviews with key social actors are also useful to "understanding the performative, non-codified dimensions of collective self-identifications and ideologies" and to relate discourse to practice. In terms of analysis, they suggest going beyond formal techniques of discourse analysis, to look at linguistic and symbolic elements, such as rhetorical devices, articulations of the public good, risk or responsibility (Jasanoff n.d.). To further the use of the concept, Jasanoff has also produced a series of questions to ask of a text when trying to understand sociotechnical imaginaries (Jasanoff & Hurlbut 2014).

Despite these useful features, the concept of sociotechnical imaginaries is not without its drawbacks for my research. Most notably, it puts science and technology at its centre. While I am interested in how the public talk about science and technology, I am also aware that perceptions tend to be shaped by wider societal issues than science alone, and so I have some concerns about putting technology at the centre of my analytic frame.

John Dryzek (Dryzek 2005), in his work looking at environmental discourses, uses the term 'worldview' to describe the values framework or vision of the good life that he argues shapes attitudes to environmental technology. While the term 'worldview' lacks the specificity of 'sociotechnical imaginaries' – Dryzek goes no way towards defining what it means, nor characterizing any mechanism by which it may function or exert influence – and appears to discuss a more personal rather than collective concept, it does appear to look more widely than sociotechnical imaginaries. Dryzek has also detailed a series of questions to ask of discourses in order to identify environmental worldviews. These questions have considerable overlap with Jasanoff's questions and so I have drawn the two together to form a series of questions (described later in the chapter) to apply to my texts, that will allow me to both identify the sociotechnical imaginaries, but at the same time remain alert to wider influences.

Approach

To understand these sociotechnical imaginaries, I have taken a four-step approach:

1. Analysis of discourses and imaginaries expressed in reports of public dialogue exercises and in the analogous documents submitted to policymakers by 'expert' bodies. (Chapter 4)
2. Analysis of discourses and imaginaries expressed in relevant policy documents (Chapter 5)
3. Comparison of public, expert and policy discourse and imaginaries and development of initial hypotheses to explain the policy impact of public dialogue (Chapter 6, Part 1)
4. Semi-structured interviews with policymakers, with questions focused on testing the initial hypotheses, in order to draw firm conclusions. (Chapter 6, Part 2).

Analysis of discourses in public, expert and policy documents

Sources

Documents are considered to be important sources for understanding the relationship between evidence and policy (Evans et al. 2014). For instance Freeman and Maybin (2011) argue that 'when evidence informs policy, the findings and conclusions of research and the problems and purposes of policy are distilled into documents' (Freeman & Maybin, 2011 p155). The national public dialogues on science and technology that have taken place in the UK have all been well documented. The majority have been sponsored by the ScienceWise programme (www.sciencewise-erc.org.uk), which is the UK Government funded programme aiming to help policymakers commission and use public dialogue to inform policy decisions relating to science and technology issues (further details given in the appendix 1) and each one has produced a report for policymakers. Importantly, since I wanted to understand what is unique about public discourses on science and technology, the public dialogue reports either fed into or were accompanied by 'expert' reports, also produced for policymakers. These were independent reports produced by groups of expert stakeholders, most typically involving senior researchers active in the subject, industry representatives, senior funders and in some instances ethicists and consumer representatives. Furthermore, a third set of documents was available which recorded the government responses to these two sets of input.

There are however significant limitations in documentary analysis – they will only report part of what has happened in the course of discussions and they represent limited perspectives (Shaw et al. 2004). The reports of public dialogue will have been mediated and the expert reports will reflect those elements that the scientists wish to display (Hilgartner 2000), for instance. The strengths of these sources outweighed the limitations in this case however, particularly as these are the sources presented to policymakers and I was keen to see dialogue and advice from this perspective. While taking these limitations into account, together, these three sets of reports nevertheless provided a good basis for analysing and contrasting public and expert discourses on new and emerging science and technologies, and for comparing these to policy discourses to understand where impacts had been made on policy.

A full list of the documents included in the analysis is given in Appendix 1.

Computer assisted text analysis

The scale of the data did not lend itself easily to traditional content analysis in any systematic way however: Using 'traditional' discourse analysis techniques, I would have taken one of three approaches – either unsystematic sampling; systematic sampling; or making use of other data reduction techniques (Bara et al. 2007). But in recent years, particularly with recent and on-going developments in natural language processing, there has been an increasing use of computational methods for statistical text analysis (often called text mining methods or computer assisted text analysis) in fields including discourse analysis, sociological analysis, corpus linguistics, amongst others (Chartier & Meunier 2011). While this approach is yet to make any significant impact within STS, it has had recent use in identifying media frames (Parales-Quenza 2004) and in analysing answers to open ended questions which were given as part of the 2010 Wellcome Trust Monitor of public knowledge, interest and engagement in biomedical science (Stoneman et al. 2013). It is also widely used within political science, particularly in analysing parliamentary debates (see Bara et al., 2007; Schonhardt-Bailey, 2005; Laver, Benoit & Garry 2003 for examples).

While we are still nowhere near having computers that are able to understand and extract meaning from a text, this approach can only be of use in assisting human analysis. At best, the software presents the researcher with a simplified pattern of the words making up the text, for interpretation by a process of abduction. Such a technique does nevertheless appear to offer some benefits to the social researchers toolkit. Cheryl Schonhardt-Bailey (Schonhardt-Bailey 2005) has argued that CATA techniques offer four particular benefits to researchers:

- They guard against researchers and coders infusing their own biases into the coding and analysis
- They can provide an impression of voluminous data in a short space of time
- Issues with coder reliability are dealt with (as the text does not need to be coded for analysis)
- Issues with sampling are dealt with (as sampling is not required).

Given my own personal past involvement in the field being analysed in my research project, it is this first reason (guarding against bias) that makes the technique particularly appealing for this research.

It is however important not to think about the software used in these analyses as a 'black box' where you put data in and an analysis comes out. Instead, we need to think about the software as the implementation (or automation) of a series of methods designed to gain a statistical understanding of the words on the page – which must still be understood and interpreted by the researcher. In the following sections I will explain this process in more detail, along with the conceptual and methodological choices I have made in approaching the analysis.

Conceptual background to CATA

Computer assisted textual analysis draws very much on ideas of structural linguistics, particularly the work of Saussure (Saussure 1916).

Saussure described a linguistic unit or 'sign' as a "double entity" which is made up of two inseparable elements – the signifier, or sound image, and the signified, or concept. For Saussure, language is not a nomenclature or collection of names for

objects, so the ‘sound image’ is not a material concept, but belongs to the system. The sign therefore is ultimately determined by the other signs in the system which delimit its meaning and possible range of use. Saussure uses an analogy with the game of chess, noting that the value of each piece depends on its position on the chessboard (Saussure 1916). He describes the sign, as determined by the other signs in a system, as the ‘value’ (or the meaning and sound together).

For Saussure then, meaning in language is structural and relational rather than referential. To illustrate this point Saussure describes how 'The French word *mouton* may have the same meaning as the English word *sheep*; but it does not have the same value. There are various reasons for this, but in particular the fact that the English word for the meat of this animal, as prepared and served for a meal, is not *sheep* but *mutton*. The difference in value between *sheep* and *mouton* hinges on the fact that in English there is also another word *mutton* for the meat, whereas *mouton* in French covers both' (Saussure 1916).

The linguistic model behind CATA is the Word Space Model (Chartier & Meunier 2011). This is a computational model of meaning that builds on Saussure’s work and describes how meaning for words is derived by looking at the way in which words are distributed and situated across a large textual data source (Sahlgren 2006). It is based on two assumptions:

1. The meaning of a word is built through its use

Or put another way – it is easier to express meaning through a combination of words and as such you can measure the meaning of a word by looking at the set of words that co-occur with it in a given sentence or paragraph.

For example, looking at the following phrases:
Catch a ball
Catch a disease
Attend a ball

In a) the meaning of catch, when combined with ball, is similar to grab but in b), when it is combined with disease, the meaning of catch changes to be similar to contract.

In a) the ball being referred to is a spherical object, while in c) it is a dancing event. (Erk 2010).

2. Words that have similar co-occurrence patterns have similar meanings.

Another way of thinking about this would be to imagine all of the words in a text presented in a multidimensional space that showed their relationship to every other word in the text, such that words that are often used in the same sentence would be plotted closer together than those which never occur in the same sentence. Those words with similar meanings would be used in similar contexts and would therefore be closer to each other in this multidimensional space. By looking at the distance between words, it is now possible to see how a computer might be able to help us analyse and extract meaning from a text.

For the purposes of the analysis, I am trying to understand how the public and experts understand and consider different new and emerging science and technologies by analysing the way in which they speak about them. If different stakeholders have different meanings and purposes attached to particular words, then differences will be reflected in the way they use these words. On the basis of the Word Space Model, it will be possible to identify any common underlying narratives by looking at the way in which words group together.

Further to that, (Lahlou 1995) has developed a methodology for using computer assisted text analysis to understand social representations, but which appears to be equally useful for discourse analysis. He argues that although each statement about a social representation is always a contextual lexical instantiation of that social representation, the semantic content of a social representation is never fully communicated within a single statement. By grouping various statements (which might have been produced in different context or spoken by different actors) together according to their lexical content, it will however be possible to build up a ‘semantic map’ that becomes a ‘model’ or simplified version of the social representation (or discourse in this case) being studied.

Software selection – IRAMUTEQ

There is a variety of CATA software packages available, most of which draw upon the word space model, but with each taking a slightly different approach – some look at word frequencies, others at co-occurrences, some are effectively visualisation techniques while others provide an automation of many of the steps, for instance (for a fuller description of the different types of software available, see Lowe (2003)). Selecting the right software depends upon how the researcher wishes to carry out the analysis – which aspects of the data do you want to focus upon.

The software currently available can be split into two main categories – those with an inbuilt dictionary (automated) and those in which the researcher creates a dictionary of key terms (semi-automated). In the latter, the meaningful content of words in the text are specified by the researcher in advance. In the former, the meaningful content words in the text (i.e. those words which are included in the analysis, since not all words are important) are defined by the words within the programme's own internal dictionary (Bara et al. 2007). There are two ways of doing this – grammatical filtering focuses on words with lexical meaning (i.e. nouns, adjectives, verbs or adverbs) while discarding 'empty' or 'functional' words (articles, prepositions and pronouns). Statistical filtering excludes words common to all statements (or sentences) on the basis that they have low discriminative power (Chartier & Meunier 2011).

Bara, Weale and Bicquelet (2007) have assessed how far these two approaches yield different analyses. Using Hamlet (semi-automated) and Alcesete (automated) software, they looked at a July 1966 House of Commons debate around a private member's bill on abortion. They concluded that there were similarities of analysis despite the detailed differences in the two approaches. The strength of the automated software was in its ability to analyse dimensionality and identify the textual location of words, while the semi-automated software was better able to produce material that could test hypotheses relating to linguistic patterns and to deal with smaller corpuses of material. There was however a greater scope for 'human contamination' in the case of the semi-automated software (Bara et al 2007).

For the purposes of this research, a software package with an in built dictionary seemed to be the best option for two reasons. Firstly, I have been a practitioner in science communication and public dialogue for the last 20 years and have worked on some of the dialogue projects being examined. While this gives me valuable insight, it also brings with it a particular perspective and expectations on the material being considered. I wanted to use the computer-assisted analysis to challenge my own conclusions or provide a more robust evidence base for my argument. Using an in-built dictionary was the best way of ensuring my own bias didn't affect my work. Secondly, I was keen to be confident that there weren't any issues that I had missed in my preliminary reading. If I had built the dictionary of key words, any bias in my expectations and oversight at the reading stage would have been replicated in the final analysis.

Beyond this decision, the further choices available depend upon how you would like to conduct the analysis. For instance, the software can stem or lemmatize words, use spatial mapping or hierarchical clustering techniques. The differences in each case are subtle (see for example (Bara et al. 2007) and (Schonhardt-Bailey 2012) both of which compare two or more different approaches to the same analysis and conclude that each approach is effective in certain subjectively different circumstances). The choice of statistical approach is therefore a subjective judgement depending upon what gives you the best information – rather than producing answers, the software simply provides a lens or map, through which the researcher can view and interpret the data. The choice of which lens to use is down to the researcher and task in hand. None of the software will produce clear 'results', but instead the researcher uses all of this material produced by the software, along with the original text, to build an understanding of the discourses and to help identify the most plausible inferences from the data.

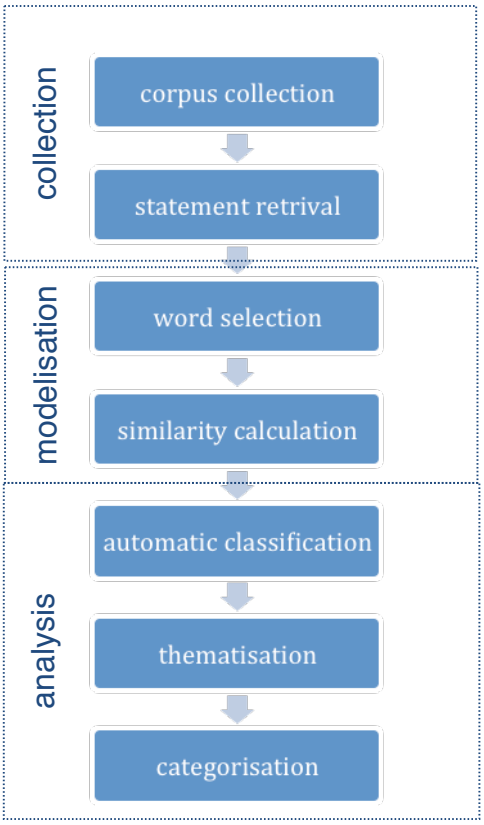
Another big difference between the various softwares available is their accessibility – most are proprietary but one, IRAMUTEQ, is open source and therefore available free of charge. While it is relatively new and currently still in a 'beta' phase, it has been developed around the analytic technique within the Alceste software (Ratinaud & Marchand 2012) which has been well documented and tested (see for instance Reinert, 1983 and Reinert, 1990). Despite slight differences in the precise nature of

the algorithms,[1] IRAMUTEQ has been shown to produce results comparable to those of ALCESTSE (Ratinaud & Dejean 2009; Ratinaud & Marchand 2012). IRAMUTEQ does however have some advantages over ALCESTE: Besides the low barriers to entry, it is open source and written in the computer language R, so can be customized to perform particular calculations; it uses less computing power so can process bigger corpora; it also offers additional functionality, particularly in producing graphical representations of the findings. For these reasons, I have chosen to use IRAMUTEQ (0.6 version 3) for my analysis.

CATA Methodology

Beyond describing the lexical basis of CATA approaches, Lahlou (1995, translated in Chartier & Meunier 2011) has developed a three-step methodology for using CATA in mapping social representations from texts. I have adopted this methodology because as well as setting out a clear process for applying the approach, it also makes transparent the parts of the analysis which are automated by the software and those which involve the researcher. I will discuss this in more detail below.

[1] For further details of the differences between IRAMUTEQ and ALCESTE, see (Mutombo 2013).



The three phases of a text mining method for social representation and analysis. Adapted from Chartier & Meunier (2011).

The Process

a. Corpus collection

This analysis has drawn on three corpuses for analysis:

- ***Corpus A:*** *Reports of public dialogue activities, funded by the UK government and taking place in the UK from 2002-2011.*

  The majority of the reports in the analysis were produced from events sponsored by the ScienceWise programme, which is the UK Government funded programme aiming to help policy-makers commission and use public dialogue to inform policy decisions involving science and technology issues. In order to ensure that the analysis was not simply the product of a possible 'ScienceWise' voice however, any other publicly-funded UK based events that were identified as taking place during the relevant time period were also included in the analysis.

- ***Corpus B:*** *Expert reports produced by learned societies and submitted to government alongside public dialogue reports*

  The majority of the ScienceWise reports either fed into or were accompanied by an 'expert' report – independent reports produced by groups of expert stakeholders, most typically involving senior researchers active in the subject, industry representatives, senior funders and in some instances ethicists and consumer representatives. These analogous reports formed the Corpus B 'expert documents' for this research.

- ***Corpus C****: Policy documents relating to issues considered in public dialogue and expert reports*

  The reports in Corpus C are typically 'government responses' to the expert submissions, but also include select committee investigations into which the public and expert reports were submitted for evidence, as the public and expert reports fed into various stages of the policymaking process. These documents do not span precisely the same timeframe as the public and expert reports, as there is a time-lag in policymakers producing their responses.

The list of documents included in the corpuses is given in Appendix 1.

Three of the public dialogue reports did not have analogous expert and/or policy reports (The Big Energy Shift , ScienceHorizons and DNA database), These public reports were still included in Corpus A however as they were significant projects in the ScienceWise programme and were therefore important in developing a comprehensive overview of the public discourses. In order to check that their inclusion in one corpus and not the other was not distorting differences in results, I ran the analysis of public documents using the Corpus A containing these three reports and a version which did not. Their presence/absence did not appear to significantly alter the classes found – there were of course small difference in the lists of significant words, but the overall sense of the discourses understood from these lists remained the same.

Using the reports, rather than the verbatim transcripts of the discussions that produced the reports, does however raise some important interpretive issues. We are looking at a mediated and filtered account of the discussions, and therefore the discourses identified are the discourses written in the reports. This is not the same as the discourses discussed by the participants themselves. While they should reflect the discussions taking place at the event, decisions about language, vocabulary and discourse will have been made by the report authors and will therefore affect what we see. This will be discussed further in the discussion section.

Nevertheless, with this in mind, the reports of the discussions were selected as source material for a number of reasons:

First, these are the documents presented to policymakers. Apart from those few policymakers who attend the dialogue event itself, this is how policymakers encounter public dialogue.[2] If we want to understand the content of dialogue from the policymakers' perspective, then this is the most valuable evidence to examine.

Secondly, discussions at dialogue events often take place in multiple parallel small groups, which are not all recorded or transcribed. Furthermore, not all of the discussions are spoken. Participants are often asked to write on flip-charts and post it notes, for instance. Transcripts of what was spoken at the meetings would not have given a complete picture of the discussions – and indeed in many instances full transcripts do not exist for all projects.

Thirdly, there would be ethical issues around using the transcripts. ScienceWise did not ask participants to allow the transcripts to be shared with people outside the dialogue project. Nor were participants invited to be research subjects when signing up to participate in the dialogue events. The reports are however public documents.

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[2] This is based upon my experience of working within Government and within the ScienceWise programme. There is however very little [nothing] in the literature about how policymakers encounter public dialogue exercises. I will discuss this further in the context of my interviews with policymakers.

Given the identification of the source material, a number of sections of the reports were removed prior to analysis:

- Chapter and section headings.
- Footnotes
- Figures and graphs
- References, sources, and details of consultees.

These elements were removed as they did not contribute to the substantive material and would have distorted the analysis because of their frequency of occurrence. We did not want words such as ‘chapter’ ‘section’ ‘figure’ and ‘appendix’ featuring prominently in the final clusters, for example. Descriptions of the process and briefing materials provided by the organisers were also removed from the public documents as they were not part of the public discussions.

In addition to that, a number of formatting changes had to be made to the text in order to be processed by the Iramuteq software we were using. Specifically:

- [£] were changed to [pounds]
- [$] changed to [dollars]
- [“] and [‘] removed
- [*] removed
- All capital letters changed to lower case

b. Word selection

For this analysis, we were only interested in the ‘meaningful’ words in the text. Iramuteq automatically identifies these words in two steps:

Words are lemmatized (i.e. reduced to their root forms, so that run, running, ran would all appear as run). The point of this is to make sure that functionally similar words are not treated as separate entities in the analysis.

Grammatical filtering divides the vocabulary into two classes – function words (articles, prepositions and pronouns) and content words (nouns, adjectives, verbs and adverbs). While the function words are not used in the analysis, they are not

discarded altogether as they might be valuable later in understanding the context of context words. For example, whether a word is preceded by his or her, or is or is not could be important in making sense of the analysis.

Iramuteq then breaks down the corpus into text segments, which are based upon the sentences within the text. In order to double check that the length of these text segments does not affect the outcome of the analysis, Iramuteq produces two different sets of text segments. The user specifies the length of these text segments – the default setting is 10 and 12 words. Throughout this thesis, I have described the results produced on this default setting. I have however also carried out the analysis using text segments of 8 & 10 words and of 12 & 14 words. The purpose of this was to verify the stability of the classes – as an additional check that they were not affected by word length. These different settings had no effect on the results and they all produced the same classes.

c. Automatic clustering

Following on from the theoretical argument that how people think about subjects is reflected in the words they use to talk about them, Lahlou (Lahlou 1995) argues that it is reasonable to assume that the words in our texts are structured in a particular way and not randomly distributed but that different sentences or text segments will express different aspects of the discourse or social representation. On this basis, a clustering algorithm which groups together text segments with similar lexical features and separates those which are different, can induce or construct a class structure that will approximate the lexical structure of the text. Iramuteq does this using descending hierarchical clustering (DHC), which aims to find the least difference within classes, using Chi-square as a measure of the relationship between words:

- A contingency table is produced which maps the presence or absence of a particular word in each text segment of the text corpus. Each word in the corpus is assigned a column and each segment assigned a row. The presence of absence of a particular word in a particular segment is marked with a 1 (presence) or 0 (absence) in the appropriate box where that column and row meet.

- Using this table, words are grouped into classes, according to their distribution in the table (and therefore text). The aim is to create classes of words that are used in similar ways. Descending Hierarchical Clustering (DHC) begins with all of the words in one class and iteratively splits the full word list into two classes, then splits the biggest of these two into another two, and so forth. The process stops if the predetermined number of iterations (throughout I used the default setting of 10) does not result in further divisions. Each split is made by considering all of the possible ways in which the classes could be cut into two and accepting the division that produces two classes which are the most dissimilar to each other, according to a Chi-square criterion. Specifically, the text segments are split into two groups, and the group indicator is cross tabulated with the words. The squared difference between the observed and the expected word frequencies is then evaluated and the process repeated until the two maximally different classes are found (Stoneman et al. 2013).

d. Thematisation

Once the classes have been produced, the salient themes of each class need to be identified. This is done by looking at the words most strongly associated with a particular class. The strength of association between each word and its class is expressed by a Chi-squre value, which compares the distribution of words in the class (observed) with the way in which words would be distributed by chance (expected). Those most closely associated with the class are given as a list of significant words, characterising a class's content and forming the basis of analysis for the researcher.

Alongside the DHC analysis, Iramuteq also conducts a correspondence analysis, which crosses the whole list of words with each class, presenting the contingency table produced in stage 1 as a graph – showing the frequency and relationship of each word to the relevant classes. It also maps meta-data with which the researcher has tagged the corpus (in my case, report title and year) onto the classes, so it is possible to see which reports are most closely associated with each class. Although this does not produce any new information, it does help to visualise the way in which vocabulary in the corpus is used.

At the end of the process, the software produces a dendrogram showing a hierarchy of classes, an accompanying list of words that are characteristic for each class (and a Chi-square value showing the strength of that association with the class), along with various visualisations of this analysis – including a version of the original corpus, colour coded for each class; the correspondence analysis graph; details of the sentences characteristic of each class; and co-occurring words.

Once the statistical, graphical and wordlist information has been produced by IRAMUTEQ, the researcher takes over again.

e. Categorisation

Finally, at the last step, the researcher's interpretation and insight are brought into the methodology when meaning or 'descriptors' are assigned to the classes.

The process described above does not produce any clear 'results'. Instead the researcher uses all of the statistical material produced, along with the original text, to build understanding of the discourses and to help identify the most plausible inferences from the data. This is not an automatic process but one of abduction, with the researcher moving back and forth between the text and the statistical information to make sense of the classes and discourses they represent.

I also checked back with the original text to investigate the nature of any text excluded from the analysis. The software produces a version of the original text colour coded with the classes identified – excluded text is left unmarked. Using this, it was possible to check that any sections not included in the analysis were not of material significance.

In order to be confident in the descriptions being assigned to each class (or discourse), I drew at least two possible interpretations of the word lists and tested them against the additional data and original text, amending my interpretations and rejecting the least plausible ones.

Issues to look out for/potential risks with the CATA methodology

1. Robustness.

My analysis relies strongly upon an automatically generated picture of the text. While I have made a number of decisions about the best way to generate this picture (as I have explained above, there is no 'right' picture, just the most useful one), it is still possible that some of the features we are describing are the manifestation of the software rather than the text.

Schonhardt-Bailey (Schonhardt-Bailey 2012) argues that one answer to achieving a reasonable threshold of robustness is to ask whether the data look different from different perspectives or using different methodological toolkits. Traditionally this has meant comparing computer text analysis with traditional analytic techniques, which is problematic when using big data sources which go beyond the human scale (which CATA has been designed to work on), or, as in this case, if there is a strong risk of researcher bias. Alternatively, you could try multiple softwares, an approach that Schonhardt-Bailey tested, carrying out the same analysis of deliberations on US monetary policy using three different softwares (Alceste, T-Lab and Dtm-Vic). This approach to verification is problematic in my view as it implies that there is a 'correct' answer that can be proven. As I have explained above, the statistical software is a tools for viewing – more like a telescope than a calculator. Furthermore, the largest part of the analysis – the understanding and the interpretation is down to the researcher.

For the purposes of this research, I have checked the robustness of the data in three ways – firstly by varying the settings of the software and ensuring that there is internal consistency in the results; secondly by challenging possible interpretations of the classes produced against the original text; thirdly, by re-situating my interpretations of overarching discourses, in the context of the literature which has interpreted particular discourses.

2. Over emphasis on differences

Hohl and Gaskell (Hohl & Gaskell 2008) have pointed out that DHC searches for statistically significant differences. As a consequence, software such as IRAMUTEQ and Alceste might accentuate differences between reports.

The solution they propose is to analyse each variable separately – this is precisely how I have set about the analysis, but looking at three separate corpuses – those containing public discourses, those containing expert discourses and those containing policy discourses. In this way, it is possible to be confident that differences identified between these corpuses are not the manifestation of the DHC algorithm.

This emphasis on difference also makes it possible (although unlikely as the approach categorises more than single words) that similar ideas expressed in different language (for instance synonyms) might be mis-categorised or missed altogether. To ensure against this, the way in which the classes were interpreted set out to keep this in mind, looking out for synonyms in different classes, constantly moving between the word lists and the original text and checking any excluded texts.

Furthermore, when looking within corpuses, this research is not interested in differences between the way in which different technologies are discussed, but the discourses that are emerging across the corpus. While I will discuss how the different discourses relate to particular areas of science, throughout I have kept in mind that there is likely to be more overlap than the analysis suggests.

When looking at the discourses that emerge from the analysis of the public, expert and policy reports then, we should keep in mind that it is possible that differences within the corpuses might be manifestations of the methodology. This is not likely to be the case with differences between the analyses however.

3. Algorithms could miss marginal viewpoints

Certain points of view may be missed if the sentence segment overlaps several categories or if the sentence segment is too short and uses vocabulary too infrequently to be to be identified by the algorithm (Biquelet and Weale 2011). This is a particular concern that has been raised in the context of assessing the potential of text mining software for policymakers to use in analysing consultation responses, where a comprehensive understanding of the text is important. This research however does not seek to be comprehensive, but instead aims to identify the prevailing discourses, which would not fall into this category. This analysis is also situated within the wider body of work on individual cases and so any obvious

divergences or emissions from smaller-scale work can be identified and followed up with the corpus.

Biquelet and Weale (2011) also identify the concern that automated lemmatization or stemming can generate problems by forcing the researcher to overlook important semantic variations. They give as an example the important difference between 'illness' and 'ills', both of which would be stemmed to the same word. This is however amongst the reasons why throughout the analysis I return to the original text to check for sense, meaning and context – relying on the wordlists alone is not sufficient for interpretation.

From discourses to sociotechnical imaginaries

Once these discourses had been identified and described, a series of questions, drawing from the work of Jasanoff (Jasanoff & Hurlbut 2014) and Dryzek (Dryzek 2005), were asked in order to understand the sociotechnical imaginaries at play:

Framework for analysing sociotechnical imaginaries

1. Basic entities recognised or constructed

What boundaries relevant to governance are being drawn in the text and on what authority (e.g. ethics, law, nature, expert consensus, evidence, common sense)?
How does life appear in the text? How is human life distinguished from other forms and on what basis?

2. Assumptions about natural relationships

What statements does the text make about the 'natural order'? What normative assumptions are made about social order? What is taken for granted and what is problematized?

3. Agents and their motives

How do material things 'act; in the text? How is agency understood and allocated?
Are assumptions being made about who has the right to speak on particular matters and how are these assumptions justified?

Does the text show an awareness of power? Does it itself perform power? How?

4. Key metaphors and other rhetorical devices

(Developed from Jasanoff 2014 & Dryzek 2005)

Semi-structured interviews

Following the comparison of public, expert and policy discourses and sociotechnical imaginaries, the initial conclusions were explored further in face-to-face, semi-structured interviews with policymakers.

This approach was chosen for the following reasons:

- As I was only likely to achieve contact with the policymakers on one occasion, semi-structured interviews provided the flexibility necessary to gather all of the information needed in that one sitting.
- I wanted to understand how a range of policymakers understood public dialogue and its outputs, what they saw as appropriate evidence for policymaking and how that feeds into decision making. The semi-structured setting allowed sufficient flexibility to explore various dimensions according to the policymakers' experience, whilst still providing enough structure to allow comparisons to be made (Cohen et al. 2011).
- My research was primarily focused on gaining insight and understanding into perceptions and values and so context, language and depth of meaning was important (Gillham 2000; Ritchie et al. 2013).

The policymakers were selected to represent a spread of seniority, areas of experience and potentially different degrees of experience with public dialogue activities. They were identified by personal contacts and recommendations from previous interviewees. Such 'snowball sampling' or 'chain referral' is problematic because it contradicts many of the principles around random selection and representativeness (Atkinson & Flint 2003), but is considered appropriate to use when subjects are difficult to reach (Faugier & Sargeant 1997). It is particularly appropriate for this research as one of its main strengths is in accessing small or elite groups – such as policymakers (Atkinson & Flint 2003). In such situations where higher levels of trust are required to initiate contact, snowballing helps give

researchers the characteristics of being an 'insider' – which facilitates access (Atkinson & Flint 2003). Indeed, as I will present later, as well as aiding access, in practice the 'insider' status elicited by snowball sampling also appeared to generate some interesting and surprisingly frank answers to interview questions. The interviews were conducted until the same themes appeared to be repeating and no new theoretical insights were being brought to light.

The final group of policymakers for interview comprised:

- 2 x Former Chief Scientists

- 4 x Former Government Ministers.

  Two of these had been ministers in departments which made policy with science, two were from departments with responsibility for the Science Budget. Two were former secretaries of state, two were former ministers of state; Three were from the Labour Party, one from the Conservative Party. Three are MPs, one is a Peer in the House of Lords.

- 3 x Civil Servants

  All three had had responsibility for issues with a strong scientific element or for overseeing a department's evidence base.

- 1x Former Special Adviser[3]

The interviews were semi-structured, based around the same series of questions, but adapted for the particular interviewee's background and the direction that responses took. The question framework is given in Appendix 5. Each interview lasted around an hour and was recorded and transcribed.

The transcriptions were initially interpreted by a deductive approach – using a coding framework based on the hypotheses emerging from the computer assisted

[3] The role of a special adviser is to add "a political dimension to the advice and assistance available to ministers, while reinforcing the political impartiality of the permanent civil service by distinguishing the source of political advice and support" (Cabinet Office 2010). Further descriptions are available in the report "Being a Special Adviser" (The Constitution Unit 2014).

text analyses. They were then revisited more inductively, using thematic content analysis which involves identifying themes within the transcript data and gathering together examples of those themes from the text (Burnard et al. 2008). This dual approach ensured that the text analysis had not biased the reading of the interviews, and that important insight hadn't been missed.

Transcriptions of the interviews have not been provided, as it is not possible to do so and maintain the interviewees' anonymity, in keeping with the UCL ethics approval agreement.

Chapter 4: Results – Analysis of Public and Expert documents

In this chapter, I set out to open up the content of the output of public dialogues – and to compare them to similar discussions that take place in the expert scientific community. By understanding more about the substance of the discussions, and the differences between them, I aim to build up a picture of the public perspectives, with a view to comparing them to policy perspectives and assessing whether or not they have been accounted for in public policy in Chapter 6.

Taking the reports of public dialogue activities funded by the UK government from 2002-2010 first, followed by the analogous expert report, this chapter examines the key discourses presented within these reports and compares them to each other. In particular, I set out to understand more about what it is that policymakers are appearing to ignore – is there anything useful in the substance of the public reports? How do the discourses and sociotechnical imaginaries presented in the public reports compare with expert discourses and which ones are more closely aligned with government discourses around the same subjects? Do the discourses within the reports reveal any fundamental differences between the public/expert/policy views? And what do these differences reveal about the socio-technical imaginaries being enacted? Does this help us understand more about they types of expertise used in policymaking? Finally, what can we learn that will help public dialogue have greater impact in the future?

This chapter focuses on the results and interpretation of the classes produced from Corpus A: Reports of public dialogue activities funded by the UK government 2002-2011, and Corpus B: Expert reports produced by UK learned societies and submitted to government alongside public dialogue reports. A full list of the documents included in these analyses is given in Appendix 1.

I initially present the interpretive labels that I have assigned to the classes emerging from the public and expert documents, along with some illustrations of the words associated with each class. The full list of significant words are given Appendix 2 (public) and Appendix 3 (expert).

Following that, I use Sheila Jasanoff's concept of sociotechnical imaginaries (Jasanoff & Kim 2009) and John Dryzek's work on environmental discourse analysis (Dryzek 2005; Dryzek et al. 2008) to interpret the data further, to build up a picture of the sociotechnical imaginaries at play and to compare discourses and imaginaries across the public and expert texts.

A. Public dialogue reports (Corpus A)

Overall, the 18 texts comprising Corpus A contained 9062 unique words, lemmatised to 6602 words, of which 6055 were active words. The corpus contained 5592 text segments and 3999 segments were classified in the analysis (71.5%). The analysis of the 18 public dialogue reports produced five classes, reflecting five distinct discourses. The full wordlists contributing to these classes are given in Appendix 2, but the top 10 words and their Chi-squared values (which indicates the strength of the relationship to the class, with higher Chi-squared values meaning stronger relationships), along with the documents associated with these classes are given in the table below:

Table 1: Words contributing to the classes produced by IRAMUTEQ analysis of public dialogue documents.

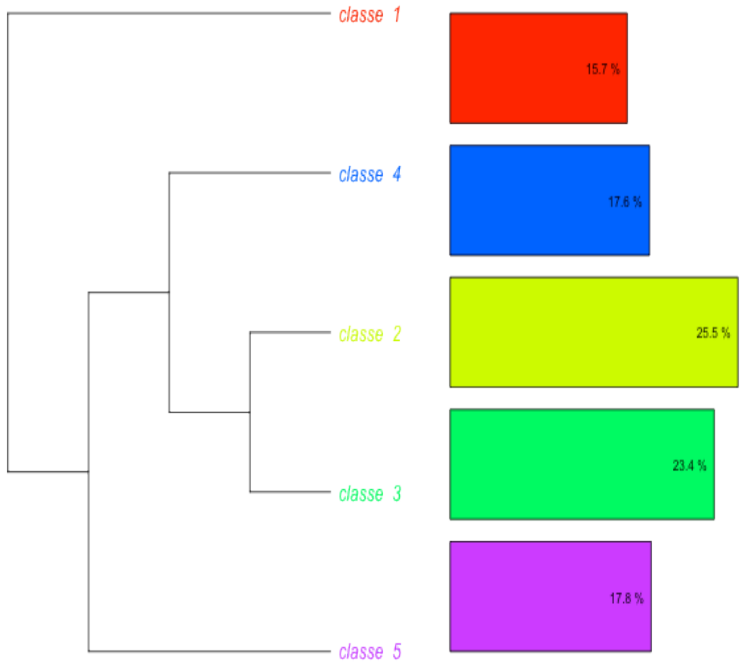
Class	**10 most significant words**	**Chi squared**	**Associated documents**
Class A1 (15.68%)	drug young recreational outreach user person belfast illicit child parent	1701.98 764.02 486.28 433.42 389.79 331.37 327.59 316.51 314.57 271.52	Drugsfutures (2006)
Class A2 (25.48%)	application area	227.42 200.03	Nanotechnology for healthcare (2008)

	treatment biology potential science synthetic disease fund nanotechnology	184.55 160.5 138.19 129.31 114.87 110.46 107.63 106.32	BBSRC Synthetic Biology (2009) Stem Cell Dialogue (2007) Science Horizons small groups (2006)
Class A3 (23.38%)	climate geoengineering change public event mitigation dialogue decision talk member	344.17 289.72 267.31 210.07 180.45 110.57 88.21 76.57 76.17 75.67	Geoengineering (2010) SciHorizons deliberative panel (2006) Big Energy Shift (2008) Nanodialogues (2005) Small Talk (2005) Forensic use of DNA (2007)
Class A4 (17.65%)	industrial biotechnology gm food crop environment product consumer release fuel	834.35 794.78 664.09 618.96 285.04 223.68 198.64 165.86 137.91 136.12	Industrial Biotechnology (2006) GM Foods (2002) BBSRC Synthetic Biology (2009)
Class A5	animal human	1509.84 1320.22	Animals Containing Human Material

	material embryo research create hybrid egg agree welfare	842.35 776.89 405.32 251.13 242.16 180.06 164.41 153.61	(2010) Hybrids and Chimera (2006) Stem Cell Dialogue (2007)

The dendrogram below (Figure 1) shows the relationship between the classes and their interpretive label:

Figure 1: Classes produced by IRAMUTEQ analysis of public dialogue documents 2002-2010, with interpretive labels.



Class A1 (15.7%)
Drugs: cure or cause for medical or social problems?

Class A4 (17.6%)
Challenging our way of life

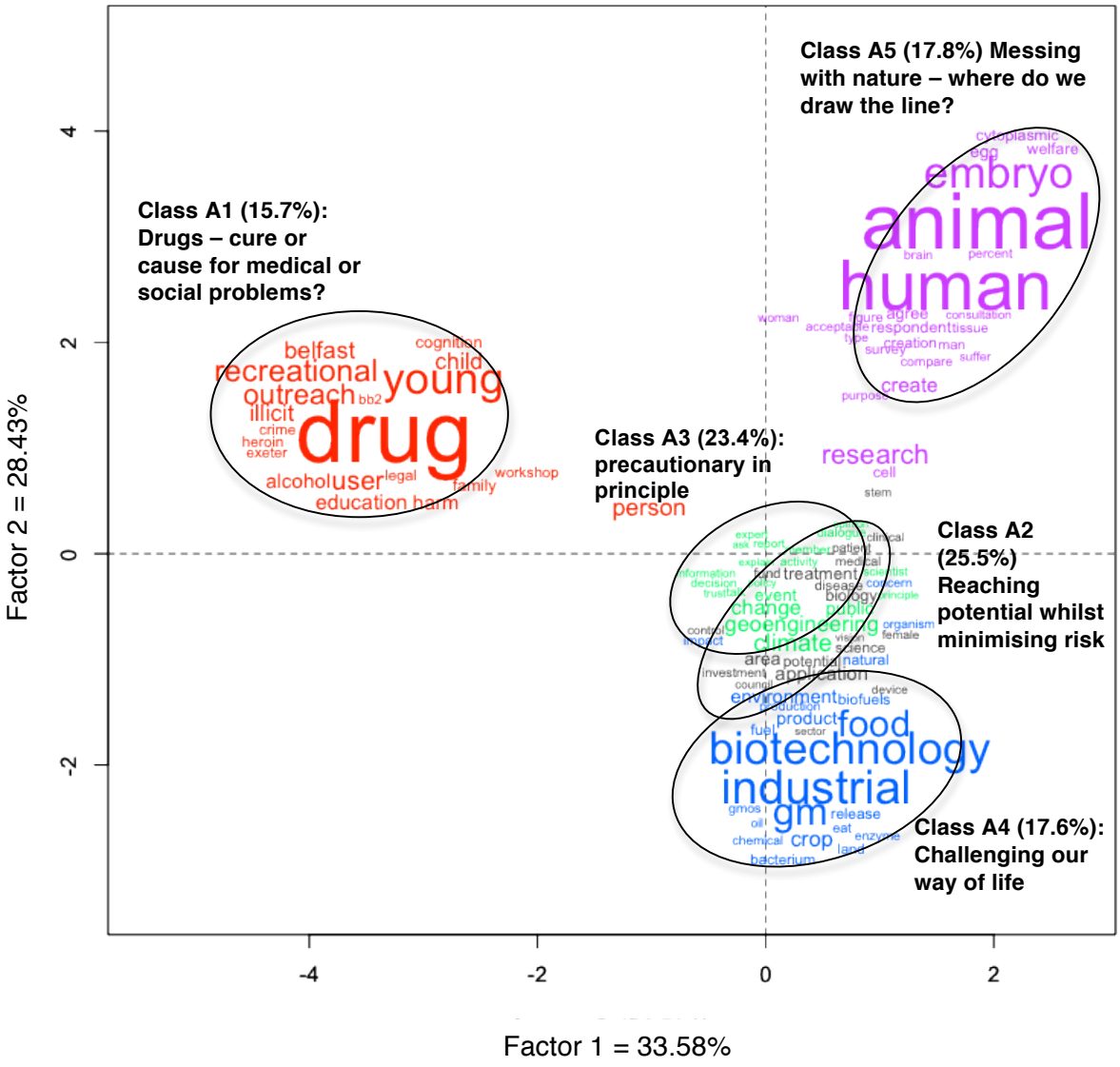
Class A2 (25.5%)
Reaching potential whilst minimising risk

Class A3 (23.4%)
Precautionary in principle

Class A5 (17.8%)
Messing with nature – where do we draw the line?

The figure below shows the results of the correspondence factor analysis produced by crossing the words and classes in the contingency table. The 30 most related words for each class are shown. Word size reflects their association with that class (chi-square value) rather than frequency. It shows that the classes A2, A3 and A4 are most closely related to each other while the other two classes (A1 and A5) are distinct and discrete.

Figure 2: Correspondence Analysis of classes produced by public dialogue documents, with interpretive labels.



Corpus A Initial interpretation: Class descriptions

In the following section, I will describe the five classes that the analysis of public dialogue reports produced and present the most plausible interpretive label. I also present a fictional illustrative paragraph for each class, to help explain its content more vividly. Both the interpretive labels and the illustrative paragraphs have been developed using all of the data produced by the analysis, along with the original text – as detailed in the methodology.

Class A1 (15.1%): Drugs – Cure or cause, treating medical or social problems?

From the dendrogram and the correspondence analysis above, you can see that Class A1, is the discourse that is most different to the others. It is also unique in this analysis as it relates to one issue only (drugs) and is drawn from the vocabulary of a single ScienceWise report – the report from the project DrugsFutures, which looked at public views of drugs, with particular regards to the potential of cognition enhancers. It appears therefore that issues in this dialogue around drugs and cognition enhancers were talked about in a way that is very different to the way in which other new technologies (included in the other discourses) were discussed.

Illustrative statement:

> *"I know that drugs like heroin need to be illegal because of the harm they cause – especially for vulnerable young people. But I suppose we could say the same about other recreational drugs like alcohol or nicotine, which can also be addictive. And while prescription drugs can help people with mental health problems, where do we draw the line with social problems? Should people be allowed to take drugs that help them do well in education, for instance?"*

The majority of this discourse relates to attitudes towards recreational drugs. In particular, it focuses on the complexity of the situation – the way in which drugs have differing impacts on different groups of people (young people and those susceptible to addiction in particular) and our confusing attitudes towards and legal drugs such as alcohol. People were very much the focus of the discourse, with significant words including a long list of 'people' words – users, person, child,

parent, family, addict, teacher, peer, criminal. Regulation was framed as a legal matter with associated words including legal, illegal, law, criminal, prison. The following sentences from the original text illustrate this:

> *"Harm to future health was the primary reason given for restricting drug use amongst young people. Some felt that the legal age for alcohol use should be raised to 21"*
> ***Drugsfutures 2006***

> *"Teachers pointed to alcohol use by young children as the next big issue. They argued that alcohol was more socially acceptable and easily available than illicit recreational drugs."*
> ***Drugsfutures 2006***

The smaller part of the discourse, discussing cognition enhancers specifically, appears to focus on the question of under which circumstances cognition enhancers would be acceptable. Issues of fairness and equality rather than health appear to dominate, with words such as 'inequality', 'stigma', 'weak' and 'vulnerable' being significant. Alongside this, the unforeseen consequences of the drugs and lack of information about them, and the need to deal with underlying social problems that might be giving rise to a desire to use these drugs was important. For example, the following sentence from the original text:

> *"They acknowledged that restrictions on legal use might increase the inequalities about which they were concerned, since the number of people with the money and inclination to try [cognition enhancers] would grow"*
> ***Drugsfutures 2006***

Overall, this class contained no words that might be described as positive (such as cure, promise, potential, value) but instead included negative words such as harm, vulnerable, danger, stigma, weak. That said, the discourse also appears to keep the matters open – while harm and danger is discussed, this is not necessarily in the context of judging whether drugs and cognition enhancers are a good or bad thing. Instead, the discourse explores the issues around these developments and

considers the conditions under which they may be good or bad. Where the line between legal/illegal drugs should be drawn, for example.

Class A2 (25.5%): 'Reaching potential whilst minimising risk'

The biggest class*, Class A2 (25.5%) 'Reaching potential whilst minimising risk'* is a largely positive discourse that discusses how, while there are potential problems with particular new technologies, they also offer significant upsides. It is related to discussions around biomedical science, with the 'Nanosciences for Health', 'BBSRC Synthetic Biology' and 'Stem Cells' dialogues being the most closely associated reports.

Illustrative statement:

> *"These technologies show a lot of promise to develop medical treatments in the future. But there are also risks (some unknown) and the private companies involved will be driven by the need to make a profit. We need to think about how we govern and regulate this tension."*

This is the most positive class produced by the analysis – with significant words including 'aspiration', 'potential', 'innovation', 'advance' and 'progress'. These are however tempered by discussions around risks and downsides, with words such as 'risk', 'concern', 'misuse' and 'uncertainty' being significant too. While the risks are seen as inherent to the technologies, they are nevertheless discussed in terms of the best ways to minimise them without putting the brakes on the potential benefits that these technologies could bring. This is illustrated by the sentence below from the original text:

"There was a view that there were inherent risks involved in developing new technologies but that if we were too careful with the development of nanotechnologies then this could lead to the field stagnating and loosing impetus."
Nanotechnology for Healthcare, 2008

People in this discourse are spoken of in terms of their relationship to the technologies – patient, stakeholder, donor.

This discourse also makes reference to the role of the private sector, its need to turn a profit and questions around who benefits from these developments. The need for and role of governance is discussed in relation to this – in controlling the direction of science and making sure that these financial interests do not have a distorting effect. Associated words include 'profit', 'investment', 'commercial', 'governance', 'control' and 'regulation'. The following sentence from the original text illustrates this well:

> *"Whilst participants generally did not consider academic scientists as doing research with profit as the main motive, the potential allure of private sector investments and the relative inexperience of researchers in brokering effective business deals could mean that ideas and innovations get taken in directions that are much less socially beneficial."*
> ***BBSRC Synthetic Biology Dialogue 2009.***

Class A3: Precautionary in Principle

The next largest class is Class A3 (23.4%) *Precautionary in Principle*, talks about uncertainties around new technologies. It is particularly drawn from discussions about geoengineering, nanotechnology and energy, but also the HGC DNA Database dialogue and ScienceHorizons, which covered a range of technological futures.

Illustrative Statement:

> *"We need to know a lot more about these new technologies and to discuss them further before we can make decisions and policy about them. We need independent advice about whether they will work and what the costs and side effects will be."*

Although only slightly smaller than Class A2 (Reaching potential whilst minimising risk), this class represents a more negative or sceptical discourse. The only positive word associated with the class is 'appreciated' but it is used in the sense of 'understand' rather than 'like' – and indeed most often to indicate a lack of understanding (so preceded by the word 'not'). Rather than seeking to reach a judgement on whether particular technologies are good or bad, this class focuses

on the consequences of technologies and how to control them. These consequences are however discussed using the term 'hazard' (rather than 'risk' used in Class A2). Going back to look at the word in the original text, it appears to be used in the report author's voice (i.e. in sections of commentary rather than direct quotes) and points towards the concept of 'moral hazard' – rather than being inherently risky technologies, the danger lies in the direction that they take us. Illustrating this:

> *"They were keen for new technologies to work with existing ones to maximise efficacy. They also wanted to avoid a particular moral hazard that investing in geoengineering activities might distract attention from mitigation."*
> ***Geoengineering dialogue 2010***

Naturalness is a significant word in this class, and, going back to the original text, it appears to be used as one of the key frames within which the technologies being discussed were considered. In particular, naturalness or nature is talked about in terms of it being a self-contained system in balance, with technology moving us away from nature and further away from this rightful balance.

> *"Naturalness was an important theme underpinning many of the principles. Most participants believed that natural systems are balanced and self contained and that geoengineering should be considered in terms of how well it preserves natural systems"*
> ***Geoengineering dialogue 2010***

In terms of regulatory words, this discourse is more specific about who has ultimate responsibility for the direction and course of science – the state. The vocabulary in Class A3 includes 'decision', 'policy', 'policymaker', 'government', 'political' and 'authority'. People are referred to in terms that indicate their relationship to the state or regulation too – words such as 'citizen', 'expert', 'policymakers' are significant. These regulatory words are however coupled with a scepticism or distrust in these authorities ability to act effectively – trust is an important word in the discourse:

> *"Many people have doubts about regulatory authorities' power and competence"*
> ***Small Talk 2006***

"Participants were somewhat sceptical of the motivation of commercial interest and governments to ensure that the fairest outcomes were achieved"
***Geoengineering dialogue 2010**.*

"Some also believe that past actions and hidden agendas have shown that the government can't be trusted"
HGC DNA Database 2007.

As well as regulating research, two other roles are articulated for policymakers: Firstly they are talked about as recipients of the outcomes of the dialogue discussions – that policymakers should listen to the views expressed by the public; secondly, they are talked about as givers of information. Indeed information and communication was an important part of this discourse, with significant words including 'understand', 'inform', 'communicate', 'explain' and 'information'. This suggests a 'deficit' narrative within this discourse, which, going back to the original text, appears to be driven by the participants' comments expressing a need for more information to make informed decisions. However this deficit narrative also appears in comments by the reports' authors, which consider whether or not the process had informed people and changed their views:

"There was a general concern that participants did not know enough about synthetic biology at this point to make an informed decision about it. They were also concerned that the media would hijack any debate about it."
Royal Academy of Engineering Synthetic biology dialogue 2008

"We should inform people in the country as much as possible about what is being done, so they can get involved in decision making to the best of their abilities"
Geoengineering dialogue 2010

"Reservations and fears tended to be about specific technologies and policies and some of these faded when more information was given."
Science Horizons Deliberative Panel 2006.

Class A4 (17.6%): The slippery slope to challenging our way of life

Class A4 *'The slippery slope to challenging our way of life'* (17.6%) relates to industrial/agri biology's impact on fundamental aspects of the environment and our food. The most associated dialogues are industrial biotechnology, the Food Standards Agency's GM dialogue and the BBSRC's Synthetic Biology dialogue.

Illustrative statement:

> *"These technologies might bring some economic benefits and cheap food, but I don't think we have the right to do this to the natural world. In the long term, I'm worried about whether they are safe, their effects on the environment and where this will lead."*

As with Class A3 (and Class A5, described later), this discourse shows considerable concern for what is natural, and science/technology's potential to impact it. Words such as 'natural', 'environment' and 'land' are strongly associated with the class. But whereas nature was conceived as a system in Class A3, in this class it is conceptualized as a binary rule or law that we must obey or face the consequences. In fact there are no other regulatory words in this class.

> *"Some farmers in Pakistan went into debt to buy GM seed, but they couldn't sell the crops for enough money to afford the next year's GM seed. GM technology violates natural law for economic gain"*
> ***FSA GM Foods 2002***

> *"Science was often viewed as transgressing nature, both in terms of manipulating nature itself, altering distinctions between human and non human and modifying an organism and so on and the idea of natural balances and the revenge of nature."*
> ***BBSRC Synthetic biology 2009***

> *"A key concern was the natural/unnatural dichotomy, which many taking part struggled to reconcile"*
> ***Industrial Biotechnology 2006***

"The origin of the nanomaterials was a concern for participants, with the use of natural materials such as collagen and hyaluronic acids helping to alleviate concerns for certain groups."

Nanotechnologies for healthcare 2008

Linked to that, an important feature of this discourse is questioning where the research/technologies will lead to. Rather than talking about the 'moral hazard' mentioned in Class A3 (which would take us down the wrong path) however, this class contains words such as 'slippery' and 'slope', suggesting a sense of science getting out of control – it's not that we will choose the wrong direction, but that we won't be able to stop it once it starts moving there.

"Another view expressed was that the risks associated with the slippery slope argument are outweighed by the potential benefits"

Hybrids and Chimera 2006

"Concerns expressed about industrial biotechnology were actually a product of a wider fear of science and technological development. In general, people were worried about the capacity for science to take things too far."

Industrial Biotechnology 2006

'Safe' is also an important word of the discourse and is talked about in terms of the reassurances necessary for public approval. Examples from the original text using the words in this sense are largely drawn from participant quotes:

"We should just wait a little bit longer so we know that it is completely safe"

FSA GM foods 2002

"Everything has to be safe and beneficial. That's how they'll win people over"

Royal Academy of Engineering Synthetic biology dialogue 2008

People are talked about in the context of agri-industry, with words such as 'consumer', 'producer' and 'farmer' being significant, suggesting that much of the discussion took place against a backdrop of industrialization. Reinforcing that, the word 'labelling' is important too.

Class A5 (17.8%): Where do we draw the moral line when we mess with humans?

Class A5 'Where do we draw the moral line when we mess with humans?' (17.8%), discusses where the limits of biomedical research should be. This discourse relates most closely to discussions around biomedical developments, specifically the dialogues around animals containing human material, hybrid embryos and stem cells, but with some contributions from synthetic biology, industrial biology and GM.

Illustrative statement:

> "The things that scientists can do with these technologies is not natural and I am not sure we have the moral right to do this. I can see that they might help some people, but I think I can only accept it if it will help humans with life-threatening conditions."

Like the previous classes, the discourse in this class relates to the acceptability or otherwise of (stem cell and embryo) technologies and how we manage this. But unlike the previous classes, talk is not about regulation or policy. Instead, Class A5 discusses whether or not this research should be done and appeals to morality rather than legality. Words such as 'moral', 'acceptable', 'controversial' and 'boundaries' are important, as opposed to safety, risk and governance-related words in previous classes.

> *"Why did you create something that ought to be a human being with the intention of never allowing it to be? Are you morally allowed to do that?"*
> ***Stem Cells 2007***

> *"The first [concern] was around the ethics of using foetal material for clinical or research purposes, with certain participants uncomfortable as to whether this was morally acceptable"*
> ***Stem Cells 2007***

> *"While overall animals containing human material research was seen as acceptable in principle, some things were seen to be towards or beyond the boundaries of acceptability"*
> ***Animals Containing Human Material 2010***

"Many appeared to view a clear rationale for the research as the key to determining whether it was acceptable or not"

Hybrids and Chimera 2006

A judgement about whether or not particular aspects of research is 'unnatural', and a sense of 'meddling with nature' is also an important feature in this discourse. Unlike in Class A3 whereby the term appears to refer to a state of balance, or Class A4 where it refers to a law or rule, words relating to nature and naturalness appear to be serving a boundary or ontological purpose in differentiating particular ways of being. Something is either natural or not natural. This difference demarcates the line between humans and others and between what should and should not be done in science. It is used in a very concrete way, as if it is a concrete and clear boundary that everyone can see and which science and technology should be guided by:

"It seems unsafe to carry out procedures which are unnatural, in the sense of being not possible by natural processes"

Hybrids and Chimera 2006

"Many participants seemed to be more concerned about the possibility of new or unnatural creatures being created than they were about in vitro experiments in laboratories"

Animals Containing Human Material 2010

"The moral rights and wrongs of specific applications were also noted, with certain respondents questioning the motivations of scientists in creating Dolly the sheep or in undertaking cloning research more generally, which was described as an unnatural process."

BBSRC Synthetic Biology 2009.

"Although participants could see the benefits, they would only be acceptable if they did not create something genetically different or unnatural in the process"

Industrial Biotechnology 2006

In keeping with that, people are discussed in terms of 'human', 'man', 'woman'.

Alongside these concerns, the discourse does however contain recognition that these technologies could help in some circumstances – specifically when they could help people with terrible and life threatening diseases. Positive words such as 'possibility', 'supportive' and 'permit' are associated with the class. Interestingly, as some of the quotes below show, some of these expressions of support appear to be interpretations by the report authors, rather than verbatim comments from participants:

> *"There is a strong increase in agreement in creating embryos which contain a small amount of animal material if it may help to understand some diseases"*
> ***Hybrids and Chimera 2006***

> *"Participants were sanguine about the idea of different animals containing human material research experiments because they did not really believe that what was being discussed was sufficient to threaten the boundaries between human and animal."*
> ***Animals Containing Human Material, 2010***

> *"Their outlook was strongly influenced by an underlying view that human life has pre-eminent value and that animals containing human material was seen to extend or enhance human life."*
> ***Animals Containing Human Material 2010***

> *"Nearly four fifths agree with using human embryos in research if it may help to understand some diseases, for example Parkinson's or Motor Neurone disease.*
> ***Hybrids and Chimera 2006***

Summary of key features of public discourses

a. Groups of technologies, groups of views

Overall, the first thing that is clear about discourses identified by looking at the reports of public discussions on science and technology is that people talk about different technologies in different ways.

Importantly, these different attitudes and ways of talking appear to cluster or group in a particular way. Specifically, I have found distinct discourses around drugs (Class A1); technologies with biomedical applications such as stem cells, nanoscience and synthetic biology (Class A2); non-biomedical technologies such as geoengineering, the UK DNA database, energy and non-medical applications of nanoscience (Class A3); technologies that work with the genetic building blocks of life, such as synthetic biology and GM (Class A4); and those which involve combining human and animal material, such as hybrid embryos (Class A5).

b. Focus on people not technologies

In terms of how the different groups of technologies were discussed, in all cases people (rather than the technologies) were the focus. The ways in which people were conceptualised changed however according to the technology being discussed: when talking about drugs (Class A1), people are described in relational terms, with family, child and parent being mentioned and distinctions made between young people (who need to be protected) and adults. Discussions around biomedicine (medical applications of nanoscience, synthetic biology and stem cells, Class A2), refer to people in medical terms – patient, donor, stakeholder. In Class A3, (discussions relating to Geoengineering, energy, nanoscience and the DNA Database) people are talked about in terms of their relationship to decision-making – government, expert, policymaker, citizen, scientist, and in discussions about Industrial biotechnology, GM and synthetic biology (Class A4), people are spoken of in terms of their economic roles: consumers, producers, industry, supermarkets, farmers. Class A5, discussing chimera, animal-human hybrids and stem cells talks at the species level – ‘humans’, ‘animals’, ‘man’ and ‘mouse’.

c. Sense of progress and potential, but also unease

The discourses around biomedical applications of stem cells, synthetic biology and nanoscience were the most positive and in these cases maximising the benefits and minimising the 'problems' associated with them is talked about as the priority. The discourse indicates a belief that science does offer progress and the promise of human advancement, particularly in relation to its potential to cure diseases. While risks are recognised, they are seen as worth taking if it leads to cures. What is unclear however is the extent to which this enthusiasm was introduced by the framing or prompting of the facilitators – I will discuss this further later.

Other technologies are met with a stronger sense of scepticism, or at least a greater need for balance. Importantly, none of the discourses indicated a 'final' view or clear line of action – calls for bans or moratoriums were not evident. There were however requests for more information, time or more control and on-going review and supervision.

While there is no evidence of an outright rejection of any particular technologies, a number of reasons behind this sense of unease were evident in the discourses, including: concerns about unforeseen consequences and the moral hazards associated with technologies that might take us in a direction that we might not want to go as a society; that the science is out of control and is unstoppable; that science is too easily influenced by industry; that new technologies could lead to greater unfairness in society and that we are using them (especially drugs) to avoid dealing with more difficult, underlying social problems; and whether we even have the right to carry out many of the procedures that technologies (particularly those involving putting animal parts into human cells) are enabling us to do.

d. Regulation and governance

There were also differences in the way in which people talked about the regulation of different technologies. Drugs were spoken of in terms of criminal law. For biomedical applications of synthetic biology, nanoscience and stem cells, controlling and regulating the role of industry and the market was important. Controlling the development of non-biomedical technologies such as geoengineering was spoken of as a matter for government policy while regulating GM was discussed in terms of

consumer relationships, with labelling an important word, but also in terms of the laws of nature, and the potential of vengeance if they are not obeyed. Finally, control of more complex genetic technologies involving animal and human DNA was discussed in terms of morals – that morality rather than legality would be the basis of judging whether a technology should or should not be developed.

In terms of who should make decisions about new technologies, the overarching mood appears to be that experts and policymakers should make decisions while taking public views into account. There is much talk of information – and the need to know more before decisions are made. Some of this appears to come from a 'deficit' framing of the dialogue events (or at least the reports), but it also does appear to draw on a genuine view of the public that while experts need to listen, they are also the ones best placed to make the decisions.

e. Social and ethical issues discussed as inherent to technologies

Besides this particular grouping of technologies, another important finding of this analysis is that the social and ethical issues are discussed in the context of the technologies themselves. The classes produced by the analysis are themed around the technologies rather than the issues – there is no class devoted to 'aspirations' or 'risks' or 'explaining the science', for example, but instead 'aspirations' and 'risks' are found within the classes discussing particular 'types' of technologies. The public discourses then treat the benefits and risks of technologies as fundamental parts of the technologies themselves which cannot be separated out. They are different faces of the same coin.

f. Role of nature

At the heart of most of the discourses is the idea of nature and naturalness. This is not just in discussions around environmental technologies, but also in discussions about stem cells and hybrid embryos, which challenge people's concepts of 'naturalness'. Even in the class relating to drugs, where 'nature' is not a significant word, there was nevertheless a sense of the concept of 'naturalness' in the way in which value judgements were being made between drug and non-drug based interventions – there was a clear preference towards non-drug based solutions to mental health problems, leading to the suggestion that we might be medicalising

social problems, for example. Similarly discussion about the potential of cognition enhancers to help student performance were clear that this was far less acceptable than other interventions such as additional tutoring, regardless of cost and safety.

As I will consider further in the discussion (Chapter 7), others have previously identified a role for the concept of 'nature' or 'naturalness' in public conceptions of technology or risk (see for instance Jasanoff, 2005; Lock, Smallman, Lee, & Rydin, 2014; Wagner et al., 2001). But while this analysis supports these findings, it also shows something new – that the public discourses are drawing on three distinctly different concepts of nature or naturalness itself – sometimes used together, but distinct nevertheless. Although these conceptions have been written about elsewhere (for example Gaskell & Bauer, 2001; Wagner et al., 2001) the distinction between the three appears to be unmade. They do however seem to be significant in revealing how people consider particular new technologies:

(i) Ontological

Firstly, throughout the discourses but particularly in discussions relating to gene-technologies (especially those which mix the genes of different species) nature is conceived in 'ontological' terms – as a state of being. Something is either natural or it is not. This appears to be providing an important boundary between what is and what is not desirable, echoing previous research (Lock et al. 2014) that equated 'natural' with 'desirable' in regards to climate change technologies.

The degree of importance that participants put upon this distinction suggests that they have very certain ideas of naturalness, which they use as a yardstick to gauge the acceptability of a newly-encountered (uncertain) science. On the other hand, as others have argued that the boundary between the natural and unnatural is in reality much less certain and is actually a constructed, negotiated and contested boundary (Jasanoff 2005, p.131; Jasanoff et al. 1998; Cronon 1996; Latour 1993), it is likely that we are also seeing some of this negotiation and construction taking place during the dialogues – in the process of deciding what is acceptable and unacceptable, participants are also deciding what is natural and unnatural.

(ii) Ecological

Secondly, in relation to non-biomedical technologies such as geoengineering and agricultural biotechnology, nature is conceived in ecological terms, as a balanced system within which we cannot necessarily anticipate what will happen when humans intervene. This lack of ability to anticipate what will happen is particularly important, as a view emerges that it makes no sense to develop more technologies to address the unforeseen consequences of other technologies – in the case of geoengineering, for instance.

This 'ecological' conception of nature appears to draw upon the environmental movement's narratives around ecosystems, Gaia and a spiritual sense of 'mother earth' (Nordhaus & Shellenberger 2007), but also to much earlier philosophies such as the Judeo-Christian religious doctrine of man's downfall.

(iii) Deontological

Thirdly, nature is talked about in deontological terms – as a binary rule or law that we must obey or face the consequences. This conception is drawn from the discourses on the less human-related aspects of genetic research, such as GM crops and synthetic biology. It again appears to draw on environmentalist and Judeo-Christian narratives around a 'vengeful nature' and Adam's expulsion from the garden of Eden and is often coupled with talk of transgression and nature as a system – upsetting the system will have consequences because you have broken the laws of nature.

g. Role of industry

Alongside conceptions of naturalness, the role of industry and the private sector is treated with suspicion. While its role in developments such as new medicines and drugs is accepted, it is at the same time talked about as a corrupting influence which scientists may not be able to resist. This appears to tie in with discussions of science as being on a slippery slope and in some way out of control. Controlling or tempering this corrupting influence, keeping the focus of science on the important problems is spoken of as a key role of government.

h. Contingency of science keeps issues open

Throughout the discourses found in the ScienceWise documents, an understanding or acceptance of the contingent nature of science was apparent. The discourses tend not to form simple judgements of particular technologies but instead suggest that more information, consideration of different angles and balancing different needs is necessary. Class A2 – 'reaching potential while minimising risk' illustrates this most clearly, with respondents recognising that technologies are not all good nor all bad – that even those technologies with potential problems have potential upsides too (and vice versa) and that these need to be balanced. Similarly, the discourse in Class A1 around drugs discusses the difficulty of drawing a line between legal and illegal drugs and the way that drugs affect some people more than other. Contingency is expressed slightly differently in Class A3 (precautionary in principle), whereby the view appears to be expressed that as the science isn't settled yet, with more research and information, different decisions are likely to be made. Even Class A5 (where do we draw the moral line?) displays a similarly subtle assessment of the technologies in question, with certain things being acknowledged as more tolerable under particular circumstances – when dealing with life threatening conditions. In Class A4 (slippery slope), associated with discussions around GM, industrial biotechnology and synthetic biology. Again a decision was kept open but the discourse was much more about the need for certainty and safety for reassurance.

This latter point appears to raise a tension with the discourses, between the appreciation of the contingency of science and the desire for safety. If people believe that technologies are different in different circumstances and that risks need to be taken in order to progress, then why are they also asking for technologies to be proven safe before they proceed? On one hand this can be explained by the human ability to hold (and express) conflicting viewpoints (Festinger 1962). On the other hand, it is possibly an expression of a similar idea and not as conflicted as it might at first appear. In the absence of any other brakes on technological development, demanding assurances of safety could be the equivalent move to kicking the ball into the long grass, holding up 'play' sufficiently long for science and society to regroup, reflect and perhaps make a different move. Importantly, this contingent view of science also appears to keep matters open – or at least require

decisions to be revisited as and when more information or different moves become apparent.

B. Analysis of expert documents (Corpus B)

Overall, the 12 texts contained 17791 unique words, which were lemmatised to 13889 words, of which 12876 were active words. The corpus contained 14335 text segments and 9304 segments were classified in the analysis (64.91%). The dendrogram below (figure 3) shows the relationship between the classes and their interpretive label

The analysis of the 12 expert reports produced five classes, reflecting five distinct discourses. The full wordlists contributing to these discourses is given in appendix 3, but the ten most significant words are given in the table below.

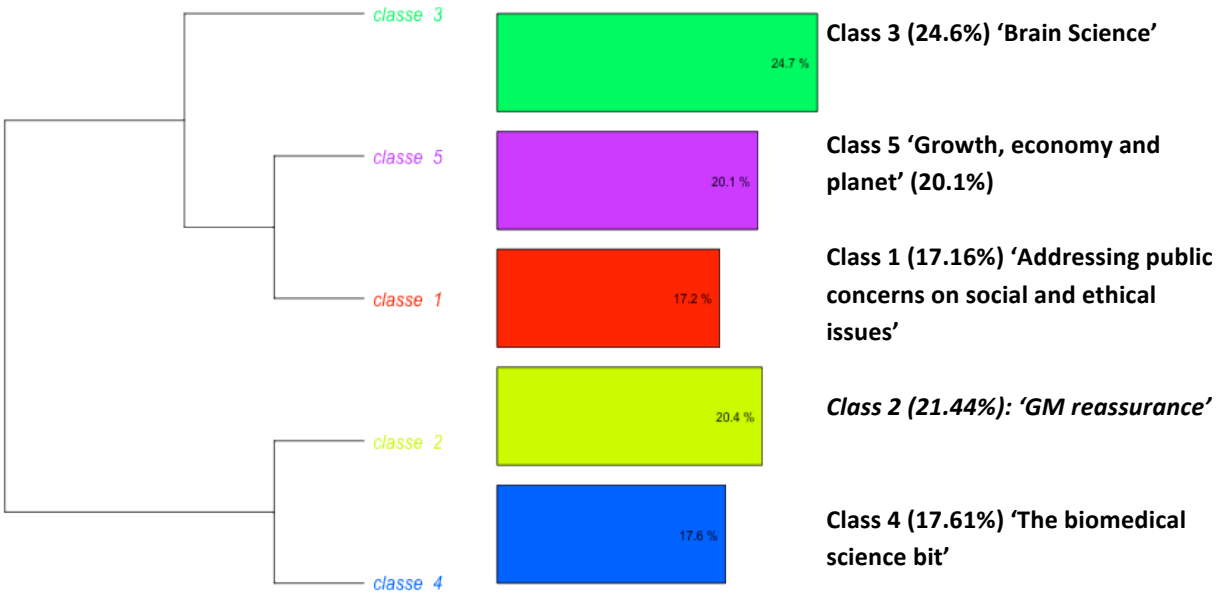
Table 2: Words contributing to the classes produced by IRAMUTEQ analysis of expert reports.

Class	10 most significant words	Chi squared	Associated documents
Class B1 (17.16%)	public issue nanotechnologies ethical dialogue science geoengineering scientific debate concern	1159.96 693.2 659.79 633.17 572.18 530.83 429.33 390.07 326.23 304.6	Geoengineering (2009) Nanosciences (2004) UK DNA Database (2009) Nanodialogues response (2007) Synthetic biology Roadmap (2012)
Class B2 (21.44%)	crop gm plant herbicide gene flow	3478.51 3102.02 1513.05 787.86 734.59 716.42	GM Science Review (2003)

	breed	536.03	
	resistance	522.04	
	food	521.69	
	variety	506.63	
Class B3 (24.69%)	drug	2683.52	Brain Science (2008)
	substance	638.49	
	mental	594.41	
	misuse	472.08	
	treatment	442.73	
	cognition	426.5	
	person	420.96	
	harm	381.47	
	child	363.82	
	disorder	348.13	
Class B4 (17.61%)	cell	3587.48	Hybrids and Chimera (2007)
	human	2695.4	
	embryo	2143.8	
	stem	1764.82	Animals containing human material (2011)
	animal	1255.71	
	mouse	832.73	
	tissue	686.62	Stem Cells (2008)
	hybrid	650.85	
	create	596.86	
	embryonic	569.82	
Class B5 (20.1%)	chemical	1249.69	Nanosciences (2004)
	nanoparticles	1063.79	
	manufacture	685.28	Industrial biotechnology (2005)
	nanotubes	528.29	
	device	517.01	
	industry	515.26	Synthetic biology (2009)
	production	419.55	
	ib	416.46	Synthetic Biology Road Map (2012)
	particle	374.79	
	synthetic	356.03	

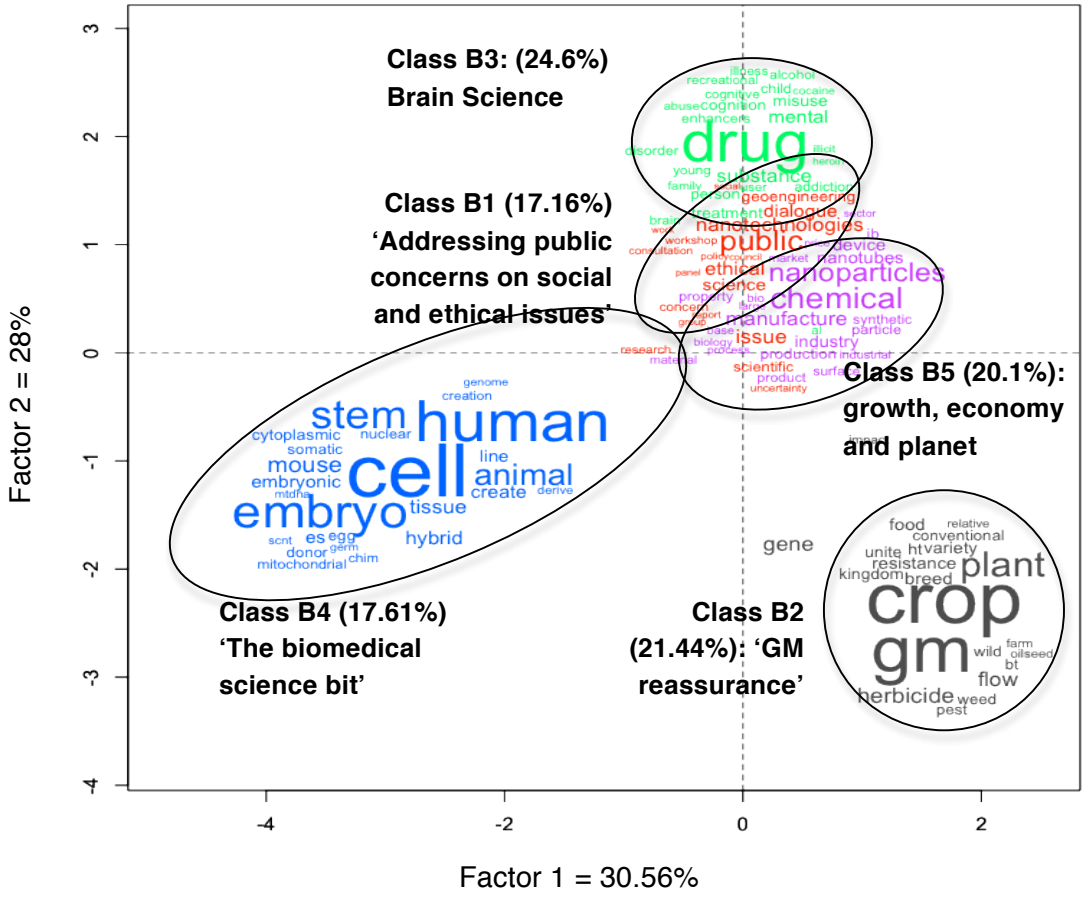
The dendrogram below (figure 3) shows the relationship between the classes and their interpretive label.

Figure 3: Classes produced by IRAMUTEQ analysis of expert reports, with interpretive labels



The figure 4 shows the results of the correspondence factor analysis produced by crossing the words and classes in the contingency table. The 30 most related words for each class are shown. Word size reflects their association with that class (chi-square value) rather than frequency.

Figure 4: Correspondence analysis of classes produced by expert reports, with interpretive label.



Corpus B Initial interpretation: Class descriptions

As with the Public Dialogue reports, in the following section I will describe the five classes that the analysis of expert reports produced and present the most plausible interpretive label. I also present a fictional illustrative paragraph for each class, to help explain its content more vividly. Both the interpretive labels and the illustrative paragraphs have been developed using all of the data produced by the analysis, along with the original text – as detailed in the methodology.

Class B1 (17.16%): 'Addressing public concerns on social and ethical issues'

This class discusses the social and ethical issues arising from the science being considered, particularly in response to the outputs of public dialogue activities. Reports most closely associated with the class are those on Geoengineering, nanosciences, UK DNA database and Synthetic Biology.

Illustrative statement:

> *"Developments in this area bring with them a number of social and ethical issues which were identified by the public in our discussions and which must be addressed if we are to take full advantage of the opportunities offered by this technology."*

This discourse appears to draw heavily from the sections of reports which present the findings of the ScienceWise dialogues, with significant words including 'public' 'dialogue' 'debate' 'workshop' 'consultation' and 'deliberative':

> *"Public concerns about GM were reflected in the report on the review of public concerns, produced as a result of foundation discussion workshops"*
> ***GM Science Review 2003***

> *"The dialogue revealed that most people are supportive of research but with conditions on how and why it is conducted"*
> ***Synthetic Biology Road Map 2012.***

Interestingly, as the two quotes above illustrate, the issues raised by the public engagement exercise tend to be packaged into terms such as 'issues' or 'concerns' and are focused on 'social', 'ethical' and 'regulatory' matters. Social and ethical issues are considered in the same discourse as public attitudes and the focus tends to be on the fact that support for the technologies has been expressed, rather than the details of the conditions under which this support is given.

The discourse also contains a sense of a need (and ability) to resolve any issues and move forward – words like 'address', 'acceptability', 'confidence', 'encourage' and 'resolve' are all significant. The quotes below illustrate further:

> *"The acceptability of geoengineering will be determined as much by social, legal and political issues as by scientific and technological factors. There are serious and complex governance issues that need to be resolved if geoengineering is ever to become an acceptable method for moderating climate change."*
> ***Geoengineering (2009)***

> *"Our attention has been directed at the distinctive ethical issues raised by the use of animals which include human genetic or cellular material. In discussing these, we have addressed a variety of concerns including utilitarian concerns about animal welfare"*
> ***Animals Containing Human Material 2011***

> *"This independent report to government identifies a number of issues that if addressed will make a real difference and put in place the mechanisms to ensure that the UK truly seizes this global opportunity"*
> ***Animals Containing Human Material 2011***

> *"The development of synthetic biology brings with it a key number of ethical and societal implications which must be identified and addressed"*
> ***Synthetic Biology 2009***

This is not the same as a deficit approach (whereby these concerns will disappear as people learn more about the science) but indicates a desire/belief that it is

possible to separate, to deal with and move on from these problems so that the science can be pursued for the public good.

Further to that, the fact that this is a distinct discourse is significant. Social and ethical issues are talked about in different terms to the other aspects of the expert reports. This is in direct contrast with the public reports, whereby discussions of social and ethical issues were found in the same classes as discussions of hopes, applications and risks.

A number of 'people' words are used throughout this discourse, with 'public' 'stakeholder' 'scientist' 'expert' and 'citizen' being significant words.

Class B2 (21.44%): 'GM reassurance'

This is the second largest discourse identified in the analysis. It is drawn from one document alone – the GM science review. The focus of the discourse is on providing reassurance that the risks of GM can be minimised, bringing many benefits.

Illustrative statement:

> *"GM crops will bring huge benefits to the UK. Most of the risks associated with them are either not based on the scientific evidence, are reversible or can be avoided. In fact, many of the possible problems are no worse than the problems associated with current practices anyway."*

Throughout the discourse the vocabulary is relatively technical as it maps out the promising areas of the field, with typical words including resistance, variety, biodiversity, bt [bacillus thuringiensis], glyphosate, transgenes. The only people words contained in the list of significant words is 'farmer' and it also contains only two emotional or sensing words – negative and undesirable. These words are not being used simply to describe possible downsides of GM however. 'Undesirable' is used to describe aspects of current non-GM practice; and while 'negative' aspects of GM are acknowledged in this class, it is within the context of descriptions of how they are being addressed:

"Mutation breeding for instance involves the production of unpredictable and undirected genetic changes and many thousands even millions of ***undesirable*** *plants being discarded in order to identify plants with suitable qualities for further breeding."*

GM Science Review (2003)

"Most of the possible ***negative*** *impacts of gm crops on biodiversity are likely to be reversible."*

GM Science Review (2003)

"There are potential ***negative*** *impacts on non-target organisms but in the case of insect resistance, field studies on commercially grown bt crops have failed to identify any adverse reactions."*

GM Science Review (2003)

The three quotes above illustrate three further features of this discourse. Firstly, the discourse is formed around risk and safety. There is no discussion of social and ethical issues relating to what is right or wrong, nor to the direction the research is taking us – matters that were so important in the public documents. Secondly, there is a tendency to close down the discussion and provide reassurance. Thirdly, the rhetorical device of using the problems with current practice to minimise the perception of problems with GM (if you're worried about GM, then you should be really worried about what's going on already). Both these features are in direct contrast with the public discourses, which focus on uncertainty and the questions that can't be answered by science yet or ever – acknowledging lack of knowledge and the limits of scientific understanding (the known-unknowns and unknown-unknowns). Indeed this class contains none of the 'risk' words found in the public's discourse about GM. Words such as 'unintended' and 'probability', both of which suggest a greater level of control and management, are significant however:

"Therefore for some GM crops and constructs, the probability of a problem arising is lower and the environmental consequences less severe than predicted by the alien species model"

GM Science Review (2003)

"Concerns over whether or not foods derived from GM corps might pose a unique safety issue or might have unintended effects was discussed earlier. It is necessary to put such concerns in context"

GM Science Review (2003)

The word 'safe' is also significant. As well as examples of the word being used in absolute terms (as the public discourses appear to use it), it is also used as a comparative word – arguing that GM should be considered safe as long as it is no more harmful than 'traditional' products:

"Consumption of food is not risk free and requires any novel GM including food to be at least as safe and nutritious as any traditional food it replaces."

GM Science Review (2003)

Class B3: Brain Science

Class B3 (24.60%) is the biggest class and is also associated with one document only – the Academy of Medical Science's report on Brain Science.

Illustrative Statement:

"People already use psychoactive drugs – legally or illegal. New brain drugs like cognition enhancers will help treat mental illnesses and things like Alzheimer's disease but the members of the public we talked to were concerned that they could be abused and lead to new problems."

This report is the wider document that the public DrugsFutures dialogue (discussed above) fed into and the list of significant words is strikingly similar to that of the brain science class in the analysis of public documents. This suggests that there are strong similarities in the discourses within both the public dialogue report and the expert report on this subject.

Like Class A1 above, this class contains descriptions of the views of participants in the DrugsFutures dialogue – with words such as 'participant' and 'engagement'

being significant. Like Class A1, regulation is also talked about in legal terms in this class too – with words such as legal, criminal, law being significant. And people are talked about in relational terms such as 'child', 'adult', 'family', 'parent', 'addict', 'criminal'.

Looking at the original text, it clearly makes reference to the discussions in the DrugsFutures events, suggesting that the public dialogue had some impact on the expert report:

> *"Many participants saw the use of cognition enhancers as valuable in helping young people cope with ADHD, but there were concerns about the impact of a child growing accustomed to using drugs to control mood and whether this heightens their risk of using recreational drugs."*
> ***Brain Science 2008***

> *"Views on acceptable and unacceptable methods of enhancing cognition were complex. Unlike recreational drugs or medicines for mental health, few participants could draw on personal experience of using such substances."*
> ***Brain Science 2008***

There are key differences however: Firstly, the language in this class is also technical as, again, it maps out the field and discusses the most promising areas for research – it contains words such as 'psychoactive', 'receptor', 'neurotransmitter', 'dopamine' and 'epidemiological':

> *"The activity of the nucleus accumbens is influenced by nerve cell neurons that contain the chemical messenger neurotransmitter dopamine."*
> ***GM Science Review (2003)***

Words relating to fairness and equality, that were so important in the public discussions of this subject (whether or not cognition enhancers could give some people an unfair disadvantage or address inbuilt disadvantages), are absent in this class. This class does however include the word 'vulnerability', but it appears to be used interchangeably with 'risk' in this discourse. For instance:

"Identifying the range of risk factors for substance misuse, it becomes possible to formulate strategies for mitigating their effects."
GM Science Review (2003)

"There is also a much deeper understanding of the brain changes that result in chronic drug use and the range of factors associated with vulnerability to drug misuse."
GM Science Review (2003)

Finally, unlike the ambivalence of the ScienceWise discourse (Class A1), this discourse contains slightly more positive words such as 'enhance' and 'promise'. The discourse is talking about making things better for the future:

"For the promise of neuroscience to be realised, the subject must be seen in the wider context of genetics and the behavioural and social sciences."
GM Science Review (2003)

"Drugs called cognition enhancers, which can enhance brain performance in various ways."
GM Science Review (2003)

Class B4: The Biomedical Science Bit

Class B4 (17.61%) 'The biomedical science bit', describes the science behind current developments in biomedical science and how it can be applied in the future. It relates to expert reports on stem cells, animals containing human material and hybrid embryos.

Illustrative statement:

"Research in which human pluripotent stem cells are introduced into animal embryos will clarify the potential of such introduced cells to contribute to addressing questions around the advancement of knowledge into cancer and Parkinson's."

This class is largely technical, containing a significant number of technical terms, such as ‘embryonic’, ‘cytoplasmic’ ‘mitochondrial’ ‘oocyte’ and ‘pluripotent’. In contrast, it contains no emotional or value words (such as positive, benefit, negative, concern, advance, improve).

People are referred to in scientific terms as ‘human’, ‘species’ ‘donor’, ‘recipient’, ‘offspring’, ‘patient’, ‘scientist’ and ‘researcher’.

> *“The only exception is that researchers can apply for a licence to create a hybrid embryo for the purpose of testing human sperm quality.”*
> ***Human Animal Hybrids 2007***

> *“Proof of concept for cell replacement was by transplanting foetal ventral mesencephalic tissue and although there was clinical benefit in some patients there were problems with tissue availability and conclusive demonstration of safety and sustain efficacy.”*
> ***Stem Cells 2008***

The class also contains a number of regulatory words such as ‘legislation’, ‘permit’, ‘licence’, ‘regulate’ and ‘guideline’. These words are used in the context of descriptions of the situation, rather than as recommendations or asks.

> *“Although the creation of true hybrids is permitted in the UK, it is illegal to keep or use hybrid embryos in vitro beyond very early developmental stages.”*
> ***Animals containing human material 2011***

> *“The current legislation on embryos and stem cell research for these permissive countries is outlined”*
> ***Human Animal Hybrids 2007***

Two illnesses that are included in the list of significant words are ‘Parkinson’s’ and ‘Cancer’.

The class contains no words relating to ethical and social issues. ‘Humanised’ is a significant word, which might suggest a discussion of the boundaries between

animals and humans (so important in the public discussions). It is however used in a descriptive/explanatory way to describe the action of creating animal/human hybrids – to explain that they are still not humans.

> *"These approaches create an animal with a genetic sequence that in a specific part resembles the human. The animal's DNA is humanised or made human like."*
> ***Animals containing human material 2010.***

Class B5: Growth, economy and planet

Class B5 'Growth, economy and planet' (20.1%) discusses how new technologies have the potential to transform UK industry, to create jobs and to solve social problems. It is most closely associated with reports relating to nanosciences, synthetic biology, industrial biotechnology and geoengineering.

Illustrative statement:
"Investing in the right aspects of these technologies will allow UK to be competitive in the global market place, grow our economy and help us solve some serious problems ahead, like identifying new sources of energy."

This class represents a positive discourse. The value/emotional words in the list of significant words are largely positive, such as 'advance', 'attractive' and 'opportunity':

> *"Opportunities will arrive through the exploitation of equipment capable of imaging, analysing and fabricating simple materials and devices at the nanoscale."*
> ***Nanosciences 2004***

> *"The market is most attractive when production of biofuels and their feed stocks is competitive with or preferably more cost effective than crude oil derived fuels."*
> ***Industrial Biotechnology 2005.***

This positive discourse is however tempered with some acknowledgement of potential problems. The word 'hazard' is important and this appears to be used in mapping out which approaches might be the most promising/risky and when talking about the need to take a precautionary approach:

> *"These could present a hazard because of their combination of fibrous shape and nanometre dimension"*
> ***Nanosciences 2004***

> *"Field studies may often be essential to quantify ecological exposure to hazards and thus estimate risk"*
> ***GM Science Review 2003***

> *"Until this hazard has been properly evaluated, this risk should be managed by taking steps to avoid large quantities of these nano particles becoming airborne"*
> ***Nanosciences 2004.***

There is also strong mention of environmental benefits with significant words including 'sustainable', 'land' and 'pollution'; although unlike the public, 'nature' or 'natural' were not mentioned:

> *"The ultimate goal of synthetic biology is to develop commercial applications that will benefit society. I.e. to design and build engineered biological systems that process information, manipulate chemicals, fabricate materials and structures that generate energy."*
> ***Synthetic Biology 2009***

> *"In the Industrial biotechnology sector, the shift from a chemical industry based on oil to one based on renewable biological substances will redefine chemical manufacture in the 21st century."*
> ***Industrial Biotechnology 2005***

"The second set of drivers derives from the potential of bio based products in the longer term to deliver outcomes that are sustainable economically, environmentally and socially."
Industrial Biotechnology 2005.

The most significant feature of the discourse is the focus on the economic impact of these technologies. Significant words include industry, market, business, economy, competitive, growth, sale, demand, investment, price, value, pound. People are spoken about as 'consumers', 'workers' and 'engineers'. The class also contains words relating to the size of markets – 'UK', 'European', 'Global' and 'World':

"In the years to come, the UK's success will increasingly be defined by our competitive edge in this and other knowledge intensive industries"
Industrial biotechnology 2005

"It is estimated that 2010 revenues from Industrial Biotechnology in the US alone were $100bn. It is also estimated that £5bn may be added to the European bio economy by 2023 from on-going research activities"
Synthetic Biology Road Map 2012

"Although the world market for nanoparticles is expected to increase during the next few years, to provide perspective, it is worth noting that the global production rate of all chemicals is around 400m tonnes pa."
Nanosciences 2004

Summary of key features of expert discourses

a. Positive discourses

Overall, the expert discourses were positive discourses about the potential of science to tackle the big problems ahead and to generate wealth. Where concerns exist about the technologies, these are seen as issues raised by the public, which can be addressed. In the case of GM in particular, the expert discourse is focused upon providing reassurance that this is a technology to be supported, and a number of rhetorical devices (discussed further later) are employed to assist in this. Even where the public discourse helped shape expert discourses (eg brain science) the expert discourse was more positive than the public one.

b. Technical language and science focus

Technical language is a key feature of the expert discourses and the focus in most classes (except Class B1) is on the science itself. Going back to the original text, the reports typically include a survey of the state of the field, outlining to policymakers what the science/technology in question is capable of.

This is perhaps not surprising given the different authors and apparent purposes of the reports. But this is significant when thinking about the kinds of evidence that policymakers take seriously and why the outputs of public dialogue might be treated differently to that of expert reports by policymakers – what does the language and ontological basis of the expert reports mean for credibility, authority and, ultimately, the perceived value of these reports? I discuss this further in Chapter 7.

Furthermore, the use of scientific terms also appear to be used for what Gieryn (Gieryn 1983) describes as boundary-work – drawing clear lines between what is scientists' business and what is policy/public business.

The technical sections of the expert reports do serve more than rhetorical purposes however. They also provide information about new science and technology, which, from my own experience of working with policymakers is valuable to policymakers as it helps them learn how to engage with the scientific subjects and question in authoritative ways.

Putting it in terms of Collins and Evans's 'types of expertise' (Collins & Evans 2009), the expert reports are using technical language to demonstrate their contributory expertise (and therefore authority to speak), which at the same time is helping policymakers acquire interactional expertise. Questions remain about the appropriateness of this expertise, particularly within the context of considering risk and social impacts, and about the relative value of this to policymakers – issues I will consider further later.

c. Separation of social and ethical issues

Unlike the public discourses, the expert discourses do not cluster around particular technologies in a straightforward manner. Three classes were based around particular technologies (GM, brain science and genetic technologies), but the other two classes were focused on 'perspectives' rather than the sciences or technologies – with one class regarding social and ethical issues relating to these science topics and the other regarding their potential for industrial exploitation.

The way in which the subject matters group could be explained in a number of ways. Firstly, there is a question of timing. GM was seen as the example of things going wrong and the benchmark for improvement in the future. There has been a deliberate and official move to change practice from then on, with expert bodies being encouraged to include an element of public engagement, which feeds into the overall recommendations of the expert. You might therefore expect the later reports to look very different from those on GM – and therefore contain very different discourses. If this is the explanation, it is worth noting that even though these later expert reports include elements of public engagement, they tend to form separate discourses as they are discussed in very different terms, not as part of the wider matter of the development and purpose of the technology. The separate cluster (Class B4) around stem cells and embryology research appears to bring this explanation into doubt however as they were produced very recently (2007 and 2011) yet still are very technically focused.

An alternative explanation is that this particular pattern of discourses could be a reflection of the maturity of the science – and perhaps the interests at stake. GM

and Stem Cell research is very well developed and the potential industrial and medical applications are apparent. This is less so with geoengineering, nanoscience and synthetic biology, where fields of research and companies associated with their exploitation are yet to be fully established. There is time for these less developed technologies to be reflected upon, in still quite abstract ways perhaps.

This division of the discussions of non-genetic technologies into social and ethical issues and industrial benefits is especially interesting. In these instances, the vocabulary used to talk about social and ethical issues is significantly different to the other discourses emerging from the documents. Discussion of the social and ethical issues relating to nanoscience has more vocabulary in common with discussions of social and ethical issues relating to synthetic biology, than it does with discussions of the industrial potential of nanoscience. This perception of the social and ethical issues being separate from the science and technology itself is also evident from the rhetoric used within the discourses (discussed further later) whereby the impression is given that risks and concerns can be managed away from the technologies in question.

Significantly, both these forms of separation is in direct contrast to the public discourses, in which social and ethical issues were discussed in the context of the technologies themselves and the wider potential and the risks associated them and points to very different perceptions of science overall.

d. Management of risk and closing of debate

Coupled with this separation of social and ethical issues, the expert discourses contain a sense that risk can be managed and uncertainty turned into probability. The implication is that it is possible to address the issues raised by the public and move on with the science. As well as there being a class entirely devoted to providing reassurance on GM, the class devoted to social and ethical issues relating to non-biomedical sciences is full of reassurance words such as ‘address’, ‘confidence’ and ‘encourage’. Further evidence of this is detailed in my analysis of the metaphors and rhetoric later.

e. Regulation is described not prescribed

As in the public discourses, regulation words appear in the expert discourses, but they are used in the context of descriptions of the situation rather than as recommendations or asks. Indeed, reference to current regulation is often made as evidence that sufficient controls are in place for a particular technology.

f. Industry and economics important

A whole class is devoted to the role of science in industry and markets. Industry is discussed as not just a beneficiary of these new science and technologies, but a key reason for pursuing them. This is often framed in a national context – ensuring the UK maintains a competitive edge over other countries. While the public discourse mentioned fairness as being important, the expert discourse gave no such indication, implying that these economic (and other benefits) were shared by everyone.

g. Purpose of assurance/clearing the way

The overarching tone of the discourses expressed in the expert reports is one of providing promise and reassurance that the benefits can be achieved with minimal risk or concern.

C. From Discourses to Sociotechnical Imaginaries

The results and initial interpretation show that for both the public and experts, different technologies are talked about in different ways. It is also clear that there are significant differences between the way experts and the public talk about new and emerging technologies. These differences are likely to be important in helping us to understand why the experts appear to have more influence on policy than the public. Table 3 below summaries these.

Table 3: Summary and comparison of key features of public and expert discourses

Public	**Expert**
People focus	Science focus
Social and ethical issues part of science or technology itself.	Social and ethical issues can be dealt with alone, allowing technology to proceed.
Contingency/need for adaptive management/balance	Reassurance
Industry a diverting influence	Industry main beneficiary of science, which is good for the economy
Uncertainty and unforeseen/unforeseeable consequences	Risk management
Elements of “downfall of man from nature” narrative	Strong “harnessing nature” narrative
Beck & Giddens’s ‘manufactured uncertainty’	Beck & Giddens’s ‘external risk’

But do the discourses described above represent a fundamental difference between the public and experts in perceptions of science, its value, safety and role in our society? From the outset, moving towards an answer to this question was a key aim of my research, as different understandings of the place of science in our society could account for parallel differences in policy impact, particularly if one outlook is more aligned to that of policy.

As I have explained earlier, the concept of 'sociotechnical imaginaries' "collectively imagined forms of social life and social order, reflected in the design and fulfilment of nation-specific scientific and/or technological projects" (Jasanoff & Kim 2009) is useful in understanding whether or not different views are at play.

This section therefore aims to go beyond the initial interpretation of the various discourses identified by the statistical analysis produced by IRAMUTEQ, to carry out some additional analysis of the statistical material produced by IRAMUTEQ and the original texts, to build up a picture of public and expert sociotechnical imaginaries. As I have detailed in the Methodology chapter, this analysis of sociotechnical imaginaries uses a framework to guide the questioning of the source material. I have developed this framework based upon the work of Jasanoff (Jasanoff & Kim 2009; Jasanoff n.d.; Jasanoff & Hurlbut 2014) and Dryzek (Dryzek 2005). The findings are summarised in the table below:

Table 4: Summary of key features of public and expert sociotechnical imaginaries

	Public	**Expert**
Basic entities recognised or constructed	People Animals Nature Government Cures	Science and technology People constructed in relation to this Scale: nanoparticles, cells, patient, ecosystem, Economy and market Nations Time
Assumptions about natural relationships	3 conceptions of nature Distinction between humans and animals Promise of advance/cures from science Role of government in regulating use and direction of science	Progress Subordination of nature by science Competition between countries

Agents and their motives	Industry focused on profit making Scientists want to do science Government's role to counter-balance both these excesses People need more information and should be listened to Experts needed to make decisions	Government focused on economic gains Scientists solving big problems ahead Public concerned about change and new technologies Decisions should be based on expert scientific advice/authority of science
Key metaphors and rhetorical devices	Nature Slippery slope Hyperbolic framing and separation of specific from general to elicit support	Use of technical and scientific language Economic arguments for doing science Time limitations and international competition Hyperbolic framing Managing/closing risk Discounting uncertainty "Social and ethical issues" Normalising problems of new technologies

Public sociotechnical imaginary

Overall, the public imaginary is positive but precautionary:

1. Basic entities whose existence is recognised or constructed

The overall ontology of the discourses identified in the public dialogue reports is about people, with typical ontological words including 'person', 'public', 'woman' or 'adult'. People are also referred to as 'patients', 'experts', 'scientists' and 'policymakers'.

Other entities constructed as being distinct from people, are nature and animals, science, expertise, the economy and government. Cures are also important concepts.

The boundary between humans and non-humans is important. This boundary is seen as fixed and refers to the difference between humans and other living things (i.e. different species) and the difference between man-made processes and 'natural' processes. In this way, human life is very clearly distinguished from animal or other life on the planet, although all are seen as part of a system in balance. It is questionable whether humans have the right to interfere with this system.

This boundary also acts as a guide to what is acceptable and what isn't – it is seen as a line that should not be crossed. This is important for questions of governance as it appeals not to legal barriers but to the laws of nature, making particular areas of science that might breach these natural boundaries a matter of morality rather than regulation.

2. Assumptions about natural relationships

As I have described, nature is an important concept in the public discourses and is conceived in three different ways – as a system (ecological), as a state of being (ontological) and as a law that mustn't be broken (deontological). The natural state of the world then is as a balanced system, which man-made processes cannot interfere with without serious and often unforeseen consequences.

Alongside the discussions about mankind violating nature, science is also seen as offering progress and human advancement, particularly when talking about scientific advances relating to biomedicine. This is particularly in relation to its potential to cure diseases, discussed further in the section on rhetoric below.

Knowledge and information are seen as important to making decisions around science, although there is recognition that some things can't be known or predicted. Experts are seen as the people who should be making decisions about these areas nevertheless. The public should also be listened to, but they also need to be equipped with sufficient information.

Control and regulation are important themes in the public discourses. In particular, the role of government is seen as being to control and regulate the use and direction of science and to temper the distorting effect of the private sector.

Throughout the discourses found in the ScienceWise documents, an understanding or acceptance of the contingent nature of science was apparent. The discourses tend not to form simple judgements of particular technologies but instead suggest that more information, consideration of different angles and balancing different needs is necessary.

3. Agents and their motives

The role of industry and the private sector is clearly discussed as being to make profit. Their role in funding innovation or creating jobs is never explicitly acknowledged but their potential to influence or divert research focus is.

Government is understood as a theoretical counterbalance to this influence – the role of government is seen as to control the direction and use of science towards the public interest, although the view expressed was that government is not very effective at this as it is driven by hidden agendas rather than the public interest.

Scientists are seen to be focused upon doing science, rather than considering the wider implications of their work. This is not seen as a positive attribute with people wanting to see a broader definition of 'good science' to take account of normative

and social senses of the word ‘good’; and arguments that there should be a duty on scientists to consider the social and ethical issues relating to their work.

Throughout all of the classes, people (or the public) were seen as recipients of information about science and of the products of science. Indeed in Class A2, the term ‘patient’ was used and in Class 5 ‘consumer’, rather than any other more generic term. Distinctions between ‘patients’ and ‘professionals’, ‘public’ and ‘experts’ are also made. A role for non-experts in shaping the path of science is also discussed in relation to geoengineering, nanoscience and synthetic biology.

Science is discussed in terms that suggest it has a momentum of its own. Terms like ‘slippery slope’ convey something over which we have little control – something that is moving in an inevitable direction.

Nature is also given agency – its ability to wreak revenge is evoked as a reason why we should not engage with certain activities that transgress what is natural.

The reports do therefore show an awareness of power – on the part of policymakers in controlling; on the part of scientists in creating new issues; and nature in providing boundaries and laws. An awareness of the power being exerted by experts – and indeed the power of the dialogue events (which I will discuss later) is not apparent.

4. Key metaphors and other rhetorical devices

A number of important metaphors and rhetorical devices are used within the public discourse.

The slippery slope metaphor is used in discussions around GM and industrial biotechnology, to signify science moving out of control, along a particular direction possibly chosen by others.

A common metaphor throughout the classes is the idea of balance – the need to balance good against bad. For example:

"Overall, there was a sense that synthetic biology was both exciting and scary"

BBSRC Synthetic Biology dialogue, 2009.

"The biggest challenge to this area will be the tension between public and private interests"

Stem Cell dialogue 2007

Two particular rhetorical devices are repeated throughout the classes:

a. Hyperbolic Framing

In discussions of biomedical science, a rhetorical device is evident, which I have called 'hyperbolic framing'. In this device, extreme conditions are used to test and exemplify the circumstances under which the technologies of concern would be acceptable. For instance, a well-known and frightening or incurable disease such as cancer or Parkinson's is used as examples of things that stem cells could help. These examples are then usually followed by a report of approval or a change in perception of the technologies on the part of the public:

"There was a tremendous potential to overcome serious diseases and injuries through the promise of biomedical science, with people highlighting hope for treatments including spinal injuries, neurodegenerative diseases and leukaemia."

BBSRC Synthetic Biology 2009

"The potential of finding cheap and effective ways of tackling malaria and other transmissible diseases in developing countries was also seen as very positive."

BBSRC Synthetic Biology 2009

"The use of stem cells to better understand cancers and develop new drugs treatments was particularly supported."

Stem Cell dialogue 2007

"Nearly four fifths agree with using human embryos in research if it may help to understand some diseases, for example Parkinson's or Motor Neurone disease.

Hybrids and Chimeras 2006

Interestingly, the quotes that best illustrate this rhetorical device are all from the voice of the author, suggesting that the criteria for acceptability that this rhetorical device appears to elicit were produced in the interpretation of the discussions by the report authors. I will discuss this further in Chapter 7, in the context of how policymakers 'read' the input of the public.

b. Abstracting

In contrast to the rhetorical device above (but sometimes used along with it), the second device evident uses the converse – arguing that people don't have a problem with the area of science/technology in principle, it's the particular applications that they are concerned about – and therefore the research should go ahead.

"Reservations and fears tended to be about specific technologies and policies and some of these faded when more information was given."

Science Horizons 2007.

"In general, the discussion of specific medical applications for serious diseases was characterised by a debate on the risks and benefits of particular treatments rather than the wider implications per se."

BBSRC Synthetic Biology Dialogue 2009.

"While overall animals containing human material research was seen as acceptable in principle, some things were seen to be towards or beyond the boundaries of acceptability"

Animals Containing Human Material 2010.

Again, this rhetoric appears to be drawn from the report authors' voice, rather than the quotes of the participants. It is therefore not clear the extent to which it has been introduced by the authors/organisers in the framing of the dialogue. As with

hyperbolic framing however, it does lay out clear criteria by which scientists have public permission to continue their work – it's the applications that we need to worry about, not the science itself. In both cases, it appears that the purpose of the rhetoric is to find a way forward, for the science to continue without any public objections.

The public sociotechnical imaginary – contingent progress

Drawing this together, the sociotechnical imaginary built by the public discourses is one of 'contingent progress'.

For the public, science has the potential to solve many of our biggest problems, especially to find cures for life-threatening diseases. But it also has the potential to produce other, new and unforeseen problems – particularly when it interferes with the natural balance of the world. Science needs to be carefully controlled by the government to make sure it produces social goods and doesn't get diverted by industry into simply making a profit, that it doesn't get out of hand, compromise nature or challenge what it is to be human. The views of the public need to be taken account of during this process, but decisions need to be made by experts.

Expert Sociotechnical Imaginary

1. Basic entities whose existence is recognised or constructed

The ontological focus of the expert documents appears to be around the science or technology itself – words like nanoparticles, mitochondria, and cell are common. When people are discussed, it is in relation to that science and technology – as 'stakeholders' in relation to public concerns, or as 'donors' in relation to stem cells, for example.

Within this however there are interesting variations in scale. For instance, about stem cells and animal-human hybrids is focused at the cellular level, with significant words including 'cell', 'nucleus' and 'mitochondria. The discussion associated with GM technologies works on the landscape level with words including 'environment', 'ecosystem' and 'landscape', while talk of economic concerns talks about both 'nanoparticles' or 'nanotubes' but also national scale entities such as 'UK' and 'Europe'.

The economy and markets are also important ontological terms in the expert discourses, as are time and temporality – a sense of urgency. Such a sense of time is almost completely absent from the public discourses – only one time-related word (urgency) appears in the lists of significant words from the public discourses and this word is used specifically when talking about climate change.

2. Assumptions about natural relationships

a. Progress

As in the discourse identified in the public dialogue documents, the discourses within the expert reports contain a strong sense of the promise of advancement or cures from science. Unlike the public dialogue discourse however, this is not restricted to discussions about biomedical science nor restricted to delivering cures – this sense of progress is throughout all scientific and technological issues within the expert reports, and the benefits to accrue also include economic benefits, national dominance and efficiency/productivity. In the expert discourse, bringing about these benefits is the purpose of science, and to be assured of doing so, policymakers simply need to let science flourish.

This sense of progress is also present even when discussing potentially risky technologies – for example the promise of the environmental benefits that will come from Industrial Biotechnology are emphasised, despite the fact that potential environmental problems that this technology could bring are being discussed alongside.

b. Subordination of nature by science

While nature in this discourse is explicitly talked of in terms of 'natural state', the discourse indicates that external nature (the natural world) is problematic and subordinate to human problem solving. For instance, the rhetoric discussed below around managing risk suggests the belief that human ingenuity can overcome any problems of the natural world. Similarly, discussions around GM from Class B2 imply that natural varieties or processes are problematic, which GM can improve upon.

Following on from that, and drawing on the rhetoric around managing risk and hazards again, the implication within this discourse is that humans (or science) have the capacity to understand, anticipate and manage risk and hazards. This again reinforces the predominance of humans over the external environment.

c. Competition between countries

Science is often discussed in this discourse as a global race. As discussed above, time is a significant concept within the expert documents, as is UK, Europe and the World. Time is passing and others are getting on with the work.

3. Agents and their motives

The documents are targeted at policymakers in government. In light of that, it is clear that the expert documents see Government as motivated by economic gains, national prestige (hence the need to win the global race) along with the social goods that science promised to deliver. By nature of being the target audience, policymakers are also seen as having decision-making power, although these decisions should be firmly based upon the scientific evidence within the reports.

Scientists, the authors of the documents, appear to motivated by understanding more about the world, with a view to solving the big problems we face – indeed the potential to solve small (or local) problems is never discussed. Indirectly, via the private sector, science will also help build business/the economy. Importantly, the scientists are cast in the role of 'experts' who should be advising policymakers and the voices upon which decisions are made.

The public are discussed in sections considering social and ethical issues. These are issues that will be dealt with and as such, the public is conceptualised as being somewhat irrationally or unnecessarily concerned about new technologies.

Science itself is spoken about as a source of good – developing cures and solutions for the big problems ahead and driving the economy and future UK competitiveness.

Power is clearly being exerted within these expert documents. As I explain below, there are a number of very effective rhetorical devices in use that both establish the authority of the expert report authors and demarcate their business from policy business, but also undermine the validity and importance of any concerns that might come into conflict with science's authority and right to operate. But as Bachrach and Baratz (Bachrach & Baratz 1963) have argued, power has two faces – the power to make decisions and power to decide which decisions can be made. By raising new scientific issues, putting them onto the agenda and describing the shape of the issue, the expert reports appear to be exerting both faces of power. So while the reports explicitly acknowledge the role of the policymakers in making decisions affecting science (and indeed give them that power in being the recipients of these reports), they are at the same time creating and maintaining power of their own.

4. Key metaphors and other rhetorical devices

a. The use of scientific language

As discussed above, the expert reports typically use large amounts of technical language and include a survey of the state of the field, giving a brief outline to policymakers of the nuts and bolts of the science. The use of technical language appears to be serving powerful rhetorical functions (as well as substantive ones) in

displaying competence and credibility and therefore winning the confidence of the audience (Hilgartner 2000), but also creating an exclusivity about the knowledge, drawing clear boundaries between what scientists know and what everyone else knows and therefore between what is scientists' business and what is policy work.

b. Economic arguments

Throughout the reports, and in those about biotechnology in particular, economic arguments are used as evidence of the need for policy to make decisions to support the science and technology being discussed. Arguments are made that these technologies will create wealth and jobs, as well as allow the UK to be more competitive in the world:

> *"Now the world's seventh largest chemicals producer UK sales alone in this industry exceed £60 billion with exports worth £43 billion. This is one of our most high value manufacturing sectors employing thousands of people and has a trade surplus."*
> ***Industrial Biotechnology 2009***

> *"This would be equivalent to between 7 and 16% of total chemical industry sales. While UK ib manufacturing opportunities may remain comparatively modest for the foreseeable future a strong position in this knowledge intensive area would allow UK based companies to increase their share of the much larger global market"*
> ***Industrial biotechnology 2009***

> *"They completed an assessment of global applications and forecast sales revenues over the coming five year period. They conclude that the value of the global synbio market will grow at a substantial rate."*
> ***Synthetic Biology Roadmap 2012***

c. Time and temporality

Tying in with the economic arguments, time is also an important rhetorical concept – the sense that decisions need to be made now. Time is often combined with economic arguments and is used to create a sense of urgency and competition, the

idea of longevity – that decisions made now will affect our future, and as a way of making obstacles to progress (such as ethical concerns) temporary.

d. Hyperbolic framing

As with the public, extreme examples of benefits to be accrued or problems to be solved are used throughout – curing cancer and Alzheimer's, climate change, the looming energy crisis and the need to feed a growing world population are all important framing devices.

> *"The greatest changes we will see in the 21st century may be brought to us through developments in our understanding of the brain. These advancements may offer revolutionary treatments for the brain and could see the end of neurodegenerative disorders such as Parkinson's and Alzheimer's."*
> ***Brain Science 2008***

> *"In the field of energy, synthetic biology is being used to develop far more efficient biofuels. These developments have the potential to alleviate current problems with biofuels. For example, competition for land use between energy and food crops."*
> ***Royal Academy of Engineering, Synthetic Biology 2009***

> *"Crops with enhanced tolerance of different stresses enables more flexibility within agriculture and leads to more productivity in problem soils or situations where this may be particularly important – in developing countries where poor soils are widespread."*
> ***GM Science review 2003.***

Superlatives are used throughout too, asserting the importance of science in solving these pressing concerns – science won't just play a part, but is fundamental or vital to solving these problems:

> *"Studies, particularly in mice, have played a fundamental role in research over the past 50 years to understand the complex processes underpinning cancer"*
> ***Animals containing human material 2011***

"A transition towards renewable bio-based feedstocks is vital for the production of chemicals, materials, fuels and energy, to lessen dependence of fossil fuels and achieve climate goals."

Industrial biotechnology 2005.

f. Bundling and closing public concerns

There is also a tendency to bundle complex public concerns, which are arguably often about matters that are created by and inherently part of the technologies being discussed, into 'social and ethical issues' which are then considered collectively.

"Public concerns about GM were reflected in the report on the review of public concerns, produced as a result of foundation discussion workshops"

GM Science review 2003

This rhetoric is reinforced by the presence of a cluster in the IRAMUTEQ analysis devoted to social and ethical issues, indicating that the vocabulary around the issues is distinct from that of the rest of the reports.

These issues are also closed down and treated as something that can be dealt with or solved. The scientists have public permission to act, they just have to address these issues. In this way, public concerns, which the public discuss as inherent properties of the technologies, are interpreted as 'conditions' on how the research should go ahead and epiphenomena that can be dealt with apart from the science.

"The development of synthetic biology brings with it a key number of ethical and societal implications which must be identified and addressed."

Royal Academy of Engineering Synthetic Biology 2009.

"The dialogue revealed that most people are supportive of research but with conditions on how and why it is conducted."

Synthetic Biology Road Map 2012.

"This independent report to government identifies a number of issues that if addressed will make a real difference and put in place the mechanisms to ensure that the UK truly seizes this global opportunity."
Animals Containing Human Material 2011.

"If geoengineering is to play a role in reducing climate change an active and international programme of public and civil society dialogue will be required to identify and address concerns about potential environmental social and economic impacts and unintended consequences."
Geoengineering 2009

This tendency to separate out and then close down or solve social and ethical concerns is of obvious use to scientists. The message is compelling – if they are given the responses and opportunity to address these matters, science can proceed in a manner that is satisfactory to everyone. There is nothing to worry about here.

Obstacles to progress (such as social and ethical concerns) are presented as temporary. Objectors are not saying no, but just not yet:

"A further review following such studies in about a decade would be appropriate to reconsider the prospects for such approaches at that time, in the light of advances in relevant technologies and the likelihood of some more permanent geoengineering contribution possibly being needed"
Geoengineering 2009

"There are others who reason that this approach understates the distinct differences between GM and non GM and that because the technology is relatively new, we know too little. The uncertainty is too great and there are too many gaps in knowledge to pursue it safely at the current time."
GM Science Review 2003.

In the case of GM in particular, two further rhetorical devices are used to reassure and close down discussions about uncertainty:

g. Normalisation of problems

The problems associated with GM technologies are normalised by building comparisons with the problems with 'acceptable' technologies. While the new technologies might have problems/issues associated with them, they aren't important when you compare them to the problems we are dealing with already. That this technique seems to be particularly well used when talking about biotechnology, might reflect an awareness of the value put by the public on 'naturalness' – comparing new technologies to old ones highlights the 'unnaturalness' in techniques we already accept and therefore might seem to put GM on a level footing of acceptability:

> *"Mutation breeding for instance involves the production of unpredictable and undirected genetic changes and many thousands even millions of undesirable plants being discarded in order to identify plants with suitable qualities for further breeding"*
> ***GM Science Review 2003***

> *"Concerns over whether or not foods derived from GM corps might pose a unique safety issue or might have unintended effects was discussed earlier. It is necessary to put such concerns in context"*
> ***GM Science Review 2003***

> *"Might GM crops change agricultural practice in the UK? If so, what might be the likely consequences? It is widely acknowledged that modern non-GM agriculture has already had negative impacts on biodiversity and the wider environment in the UK."*
> ***GM Science Review 2003***

h. Discounting uncertainty

Further to that, there is a tendency to discount uncertainty. The impression is given that we can and do know all of the risks associated with a new technology and it is possible to address them:

"Most of the possible negative impacts of gm crops on biodiversity are likely to be reversible"

GM Science review 2003

"There are potential negative impacts on non-target organisms but in the case of insect resistance, field studies on commercially grown bt crops have failed to identify any adverse reactions."

GM Science Review 2003

The Expert sociotechnical imaginary: Science driving progress

Together, these features build up a picture of an imaginary based around 'science driving progress'. In this imaginary, with sufficient resources and freedom, science has the ability to solve the world's problems. Any problems or risks arising can be managed and dealt with, by more knowledge and information. But in most cases, the risks associated with scientific and technological developments are no worse than those offered by nature anyway. The public are both potential consumers of new technologies, but are also barriers to progress and in need of reassurance that their concerns can be addressed. The state is a provider of many of the resources needed to do science, while industry is a beneficiary – going on to turn the scientific discoveries into wealth, jobs and economic growth.

Chapter 5 – Analysis of policy documents

In the previous chapter (Chapter 4), I looked at the content of the reports of public dialogues that are presented to policymakers, and the analogous reports from expert committees, with a view to understanding more about the impact of public engagement on policy and the possible reasons why this has been limited. I identified a series of public and expert discourses, which build up into two different socio-technical imaginaries – a public imaginary of 'Contingent Progress' and an expert imaginary of 'Scientific Progress'.

In this chapter I take a similar approach – analysing the discourses and sociotechnical imaginaries expressed within Corpus C, comprising the policy documents on analogous topics to those included in the public and expert analysis. This is with a view to (in Chapter 6) comparing them to the public and expert imaginaries already identified, and considering what similarities or differences in sociotechnical imaginaries and discourses mean for the impact of public dialogue on policy.

Corpus C is made up of policy documents that relate to the issues considered in the public dialogue and expert reports. Typically these are 'government responses' to the expert submissions, but also include select committee investigations, to which the public and expert reports were submitted for evidence, as the public and expert reports fed into various stages of the policymaking process. These documents do not span precisely the same timeframe as the public and expert reports, as there is a time-lag in policymakers producing their responses. A full list of the documents included in the corpus is given in appendix 1.

Results of Iramuteq analysis: Corpus C

Overall the 11 texts comprising Corpus C contained 5909 unique words, lemmatised to 4470 words, of which 3785 were active words. The corpus contained 2589 text segments and 1561 segments were classified in the analysis (60.29%). The analysis produced four classes, reflecting four distinct discourses. The full wordlists

contributing to these classes are given in Appendix (iv), but the top 10 words and their Chi-squared values, along with the documents associated with these classes are given in the table below:

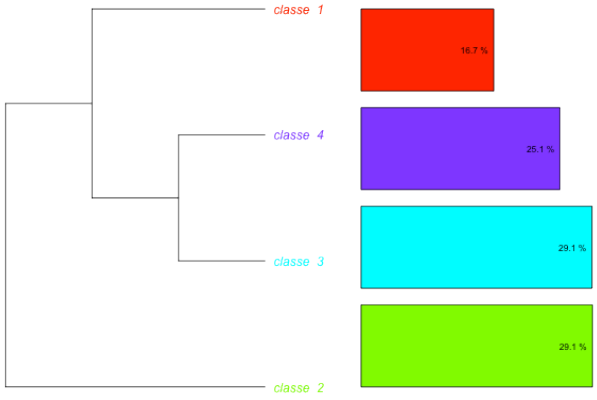
Table 5: Words contributing to the classes produced by IRAMUTEQ analysis of UK Government policy response documents.

Class	**10 most significant words**	**Chi squared**	**Associated documents**
Class C1 (16.72%)	gm crop herbicide conventional grow gene maize plant farmer acre	947.01 821.23 147.18 138.38 118.06 116.27 100.91 99.34 97.73 95.8	Genetically Modified Foods – Frequently Asked Questions (Defra 2004) The GM Dialogue – Government Response (2004)
Class C2 (29.15%)	embryo human hybrid chimera animal creation hfea act draft cytoplasmic	714.23 497.58 434.78 301.77 291.69 291.25 202.38 174.9 135.13 130.76	House of Commons Science and Technology Committee: Government proposals for the regulation of hybrid and chimera embryos. Fifth Report of Session 2006–07 Government Response to the Report from the Joint Committee on the Human Tissue and Embryos (Draft) Bill (2007)
Class C3 (29.08%)	commission nanotechnologies information member royal	77.59 72.06 59.25 51.61 50.15	Government Response to the House of Lords Science and Technology Committee Inquiry into Regenerative Medicine (2013) Government Response to the House of Commons, Science and

	public section society system regulatory	47.73 38.09 34.78 31.13 29.20	Technology Committee 5th Report of Session 2009-10: The Regulation of Geoengineering UK Government Response to The Royal Commission on Environmental Pollution (RCEP) Report "Novel Materials in the Environment: The Case Of Nanotechnology" (2009) Response to the Royal Society and Royal Academy of Engineering Report 'Nanoscience and nanotechnologies: opportunities and uncertainties' (2005)
Class C4 (25.05%)	ib innovation council fund igt sector business pound industry bbsrc	322.75 129.62 123.61 123.57 115.08 114.78 104.61 97.76 95.09 88.42	Response to 'A Synthetic Biology Road Map for the UK' (Letter from Science Minister, 2012) Government response to the UK Stem Cell Initiative report and recommendations (2007) Government response to the Industrial Biotechnology – Innovation & Growth team report to Government (2009) UK Government Response to The Royal Commission on Environmental Pollution (RCEP) Report "Novel Materials in the Environment: The Case Of Nanotechnology" (2009)

The figure 5 below shows the dendrogram representing the relationship between the classes produced in the descending hierarchical clustering and their interpretive labels.

Figure 5: Classes produced by IRAMUTEQ analysis of UK Government policy response documents, including interpretive labels



Class C1 (16.72%): Safety and choice so that we can get huge benefits from GM

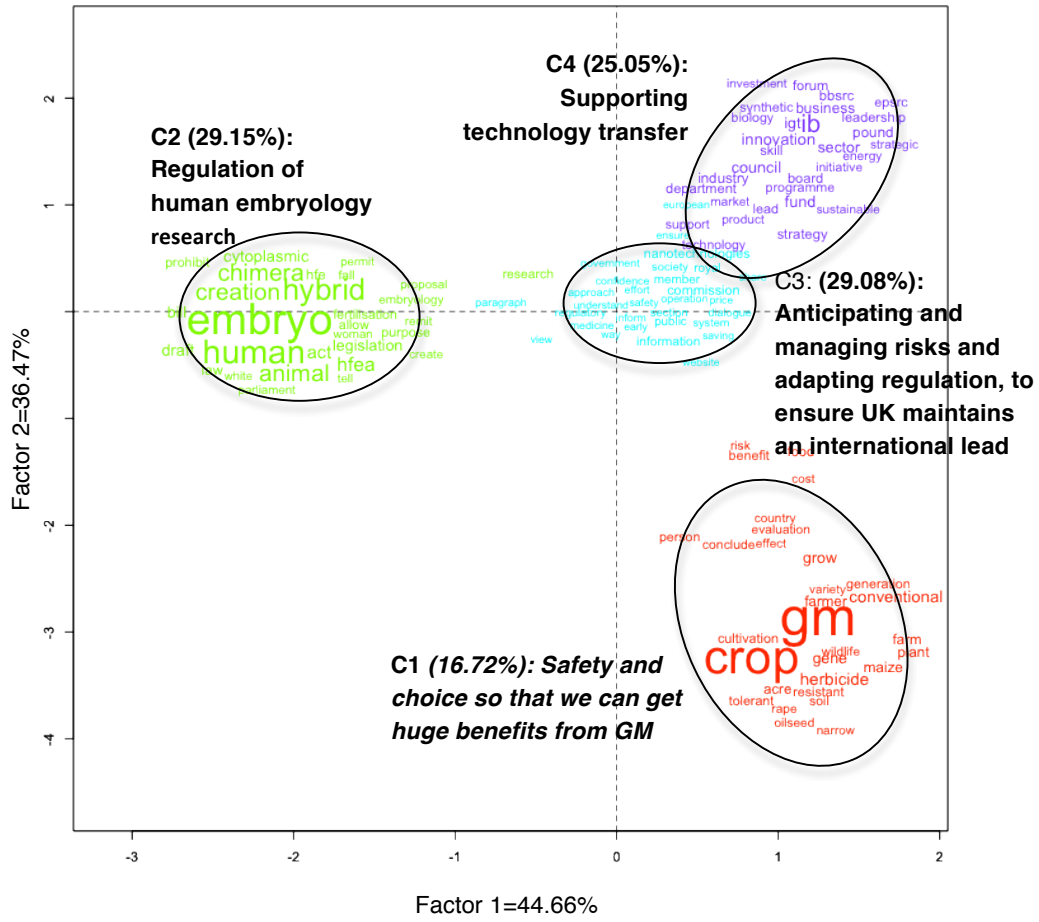
Class C4 (25.05%): Supporting technology transfer

Class C3: (29.08%): Anticipating and managing risks and adapting regulation, to ensure UK maintains an international lead.

Class C2 (29.15%): Regulation of human embryology research

The figure 6 below shows the results of the correspondence factor analysis produced by crossing the words and classes in the contingency table. The 30 most related words for each class are shown. Word size reflects their association with that class (chi-square value) rather than frequency. It shows that the classes C3 and C4 are the most closely related to each other, with some overlap in vocabulary, while the other two classes (C1 and C2) are distinct and discrete.

Figure 6: Correspondence Analysis for classes produced by UK Government Policy response documents



Initial Interpretation: Class descriptions

As in the previous chapter, in the following section I will describe the four classes that the analysis of Corpus C produced and present the most plausible interpretive label for each. I also present a fictional illustrative paragraph for each class, to help explain its content more vividly. Both the interpretive labels and the illustrative paragraphs have been developed using all of the data produced by the analysis, along with the original text – as detailed in the methodology.

Class C1 (16.72%): Safety and choice so that we can get huge benefits from GM

This is the smallest of the four classes identified. The discourse is focused on the government's plans for regulating GM. It draws from the two documents relating to GM foods – the Government response to the GM Nation debate and Defra's Frequently Asked Questions document.

Illustrative Statement:

> *"GM crops could offer real benefits to consumers and farmers in the future and our comprehensive research has found no reason to think they pose any risks to human health, nor are any less safe than conventional crops. We do need to monitor this for unforeseen problems though and consider each on a case-by-case basis but much will depend on whether consumers choose gm foods and on the ability of the regulatory system to continue to manage any risks effectively*."

Throughout, the discourse is about balancing different interests in order to allow the technology to develop – the interests of organic and non organic farmers and consumers; the concerns of the public vs. scientific evidence of safety; evidence of safety vs. possible unforeseen risks; costs vs. benefits:

> *"This precautionary and evidence based approach strikes the right balance between managing the risks and harnessing the potential benefits of GM crops"*
> ***Government Response the GM dialogue 2004***

The discourse is 'agriculture' focused – 'farmer', 'crop', 'plant', 'agriculture' and 'farmland' are all significant words. The discourse also ranges in scale from 'gene' to 'country'. The public are variably referred to as 'consumers' or 'people'. The choice of these words appears to depend upon the issue in hand, with 'people' tending to be used when describing the ethical concerns of the public and 'consumers' used when discussing more preference based concerns or potential benefits:

> *"The debate has confirmed that people's attitudes towards GM crops are shaped by a complex range of issues."*
> ***Government Response the GM dialogue 2004***

> *"We take public concerns very seriously and we recognise the need to address people's legitimate anxieties around GM crops."*
> ***Government Response the GM dialogue 2004***

> *"Looking to the longer term, future developments in GM crops have the potential to offer more wide-ranging benefits to both farmers and consumers."*
> ***GM FAQ 2004***

> *"Consumers want to continue to be able to choose conventional and organic products if GM corps are grown commercially in the UK."*
> ***Government Response the GM dialogue 2004***

While the discourse acknowledges that the public has concerns about GM (although 'concern' is not a significant word to this class) there is no discussion of these as ethical issues. Indeed the only evocation of ethical matters in the text segments most associated with this class is an argument that it would be unethical not to pursue GM research:

> *"The Nuffield Council on Bioethics in its recent report on the use of GM crops in developing countries concluded that there is an ethical obligation to explore these potential benefits responsibly in order to contribute to the reduction of poverty and to improve food security and profitable agriculture in developing countries."*
> **Government Response the GM dialogue 2004**

Instead, public concerns around GM are discussed as safety issues, relating to human health and the environment, as well as matters of choice. These concerns are seen as matters to be addressed and resolved – and managing these concerns is seen is one of the key risks of GM technologies. An interesting turn is also put on the idea of the right to choice – that it's not just about the right to choose not to consume GM crops but also the right to choose to be able to consume them too:

> *"The science review sought to address all the key science related concerns, especially those which are most frequently raised about GM good and crops. It concluded that there is no evidence to suggest that current GM foods pose a greater risk to human health than their conventional counterparts."*
> ***Government Response the GM dialogue 2004***

> *"The balance of any costs and benefits will depend on a range of factors and there will inevitably be trade offs. Much will depend on consumer attitude towards GM food and crops and on the ability of the regulatory system to continue to manage any risks effectively."*
> ***Government Response the GM dialogue 2004***

> *"If farmers and consumers do not see the benefits of GM crops and GM foods then they will not grow or buy them."*
> ***Government Response the GM dialogue 2004***

> *"It is also important to bear in mind that freedom of choice works both ways. Not allowing GM crops to be grown in the UK would deny farmers access to the benefits of the technology which is available to farmers in other countries."*
> ***Government Response the GM dialogue 2004***

> *"Consumers want to continue to be able to choose conventional and organic products if GM crops are grown commercially in the UK and farmers must be able to maintain different production methods so that they can respond to consumer demand."*
> ***Government Response the GM dialogue 2004***

Reassurance – both on the safety of GM and the strength of evidence drawn upon to reach this conclusion – is important in this discourse. Expert bodies such as ACRE are often mentioned as sources of evidence, for instance. At the same time, the discourse couples strong statements about the safety of GM (particularly in relation to traditional crops and foods), with a clear understanding that there could be unforeseen consequences that need to be monitored, and the contingency of the technology which means it needs to be monitored on a case by case basis. 'Risk' is a key word in the discourse, although the discourse is clear that any possible risks can be quantified and managed away. The discourse also uses the technique found in the expert reports, of normalising risk by comparing the risk of GM to the risk of non-GM:

> *"The government advisory committee on releases to the environment (ACRE) has said that if GM herbicide tolerant crops transfer genes to other crops or wild relatives, this poses a very low environmental risk"*
> ***GM FAQ 2004***

> "It [an advisory body] found that worldwide there have been no verifiable ill effects reported from the consumption of products from GM crops over seven years and there is no evidence to suggest that current GM foods pose a greater risk to human health than their conventional counterparts."
> **Government Response the GM dialogue 2004**

> "The science review concluded that this was a distant future possibility for the UK if different varieties of the same crop with different GM traits were proposed for commercial cultivation in the EU. The risks and any possible mitigation measures would be considered as part of the approval process.
> **Government Response the GM dialogue 2004**

Environmental words are significant in this discourse, including 'environment', 'wildlife', 'biodiversity' and 'ecology'. Neither 'natural' nor 'nature' were significant words. A previous moratorium on growing GM crops is also highlighted – almost as a demonstration of how far the government will go to safeguard the environment/ to show that this is not a foregone conclusion. Interestingly, the quotes nevertheless

demonstrate a governance rather than a strong government approach – a voluntary agreement was reached with industry:

> *"When English Nature and others raised concerns that the introduction of GM herbicide tolerant crops could further exacerbate the decline in farmland wildlife, we reached a voluntary agreement with industry to call a halt to commercial growing"*
> ***Government Response the GM dialogue 2004***

> *"We put precaution into practice by commissioning a four year programme of GM crop trials, the farm scale evaluations – the largest anywhere in the world. Our voluntary agreement made clear that there would be no commercial cultivation of GM crops in the UK until we had assessed the results of the trails"*
> ***Government Response the GM dialogue 2004***

Throughout the discourse, making sure the benefits of GM are gained is important. But where 'benefit' is a significant word, the sense of what these benefits are, is not concrete. Current benefits are recognised as limited, but those that could come in the future are the most important:

> "The central conclusion of the study is that existing GM crops could offer some cost and convenient advantages to UK farmers"
> **GM FAQ 2004**

> "The strategy unit's study on the costs and benefits of GM crops concluded that any economic benefit from the crops presently available is likely to be limited in the short term but that future developments in GM crops could potentially offer more significant benefits"
> **Government Response the GM dialogue 2004**

> "Looking to the longer term, future developments in GM crops have the potential to offer more wide-ranging benefits both to farmer and to consumers"
> **GM FAQ 2004**

"More importantly, we should not turn our backs on the potentially significant benefits which future generations of GM crops could offer" **Government Response the GM dialogue 2004**

Class C2 (29.15%): Regulation of human embryology research

This class relates to the way in which advances in human genetics should be regulated. It is drawn from reports of the UK government's response to the joint committee report of the Human Tissues and Embryos Draft Bill (2007) and from the House of Commons Select Committee Report on government proposals for the regulation of hybrid and chimera embryos (2006).

Illustrative statement:

"The government should open the door to research using human animal chimera or hybrid embryos, as it is likely to bring significant health benefits in the future. There is little opposition, besides that based on opposition to research on human embryos in general. Legal advice is needed to consider the humanness of embryos, so that it is clear whether such matters should be regulated by HFEA or another agency, and the regulation needs to provide a clear framework within which research can take place."

The discourse uses a range of ontological and technical terms, relating to embryo research. Significant words include 'embryo', 'human', 'hybrid', 'chimera', 'animal', 'women', 'egg', 'sperm' and 'cell'. Specifically, the discourse considers whether the current legislation is sufficient or whether new rules are needed. Regulatory words include 'law', 'licence', 'parliament', 'regulation', 'authority' and 'power.

Overall, the discourse is supportive of science, with words such as 'allow' and 'permit' being significant, and (the Select Committee report in particular) looks for a way to allow it to happen:

"We believe that in general the creation of all types of human animal chimera or hybrid embryos should be allowed for research purposes if appropriately regulated."

House of Commons Select Committee Report on Hybrid and Chimera Embryos 2006.

"We find the government proposals in the white paper unnecessarily prohibitive and recommend the government ensure that its draft bill reflects the liberal view it claims to be taking in opening the door to research using human animal chimera or hybrid embryos."

House of Commons Select Committee Report on Hybrid and Chimera Embryos 2006.

The vocabulary in this discourse is not as enthusiastically supportive as the words found in other discourses identified however. Importantly the list of significant words also includes 'prohibit' and 'ban', suggesting that there are some aspects of science that are off limits, although the details of the text suggest that the reports question whether that should be the case:

"We have conducted this inquiry in response to the publication of government proposals to prohibit the creation of human animal chimera or hybrid embryos for research for the time being."

House of Commons Report on Hybrid and Chimera Embryos 2006.

"There is clearly some confusion surrounding the Government's decision to omit from the draft bill the current provision which prohibits the genetic modification of embryos for research purposes"

Government Response to report on Human Tissue and Embryos (draft) Bill 2007

Overall, the role of the government is to regulate these activities. Specifically, the purpose of the regulation is to provide rules under which research can take place:

"The new legislative structure should permit the creation of animal human hybrid and chimera embryos for research purposes subject to regulation and should aim to reduce the risk of litigation on borderline cases."

House of Commons Report on Hybrid and Chimera Embryos 2006.

Beyond this, while the discourse acknowledges the ethical issues relating to the activities under consideration – and to the public dialogue that has fed into the evidence base – ethical issues are problematized and/or dealt with as legal matters. Neither 'moral' nor 'ethical' are significant words in this discourse, although 'law' is. For example the question of the humanness or otherwise of hybrid embryos – an issue that was very important in the public discourses – is looked at as a legal question that will define who regulates:

> "HFEA receives revisited legal opinion on whether cytoplasmic hybrid embryos should be regarded as human for the purposes of the HFE act and whether such creations would be prohibited or licensable under the act."
> ***House of Commons Report on Hybrid and Chimera Embryos 2006.***

The public dialogue itself is also problematized, with the representativeness of the views expressed brought into question. Further, the text calls for 'experts' and 'scientists' to be identified who have scientific objections, suggesting that objections on scientific grounds had higher status than moral and ethical objections:

> *"We have seen no conclusive evidence to indicate the true state of public opinion on the creation of animal human chimera and hybrid embryos for research."*
> ***House of Commons Report on Hybrid and Chimera Embryos 2006.***

> *"Establishing where there is specific opposition to the creation of human animal chimera or hybrid embryos for research purposes is important if an accurate assessment is to be made of whether there is significant opposition to this research from those who like the government otherwise support human embryo research."*
> ***House of Commons Report on Hybrid and Chimera Embryos 2006.***

Class C3 (29.08%): Anticipating and managing risks and adapting regulation, to ensure UK maintains an international lead.

Class C3 is most closely associated with the government responses to reports on nanoscience, geoengineering and regenerative medicine, discussing how the risks associated with these technologies can be anticipated and managed and how public concerns can be understood and addressed, in order to be world leaders in these fields.

Illustrative Statement:

> *"The government will ensure a coordinated approach to developing this technology, which will be reviewed at 5 and 10 year intervals. This approach will bring together a wide range of stakeholders and the public, so that we can anticipate, understand and manage potential risks, address public concerns and ensure the responsible development of these fields while maintaining our international competitiveness."*

The discourse represented by this class is focused around anticipating and regulating the risks and problems that might stop the successful development of these technologies.

Uncertainties or unknowns about the technologies are recognised, but they are seen very much as knowable – it is a problem of lack of information rather than the unpredictability of these technologies. More research, collaboration and information sharing is seen as the solution. While the approach to managing technologies might need to change as more is known (for instance, the review points are seen as important in the government's strategy), these factors are considered to be knowable – words such as 'understand', 'information' and 'sharing' are important:

> "In particular, the government shares the Royal Commission's understanding that there is no evidence of actual harm resulting from the use of nanotechnologies, but accepts that this is a possibility and that there is a need to develop our understanding further."
>
> ***UK Government response to RCEP report on nanoscience 2009***

"MHRAS internal nanotechnology working group which has been in existence since June 2003 comprises regulatory scientific and technical specialists who meet on a regular basis to carry out horizon scanning share information and raise internal awareness of issues that may arise from nanotechnologies"
Government response to the Royal Society Report on Nanosciences 2005

"… and nanotechnologies as the basis for a continuing science and society dialogue that will seek to ensure that we have a regulatory system which will address public concerns and which allows the development of nanotechnologies in a responsible and innovative way."
Government response to the Royal Society Report on Nanosciences 2005

Furthermore, problems associated with these new technologies are seen very much in terms of risk, rather than ethical problems such as moral hazards (i.e. relating to the kind of world we want and the appropriateness of these technologies). These risks are seen as manageable and matters that can be separated from the technologies themselves – the role of government is to manage these risks whilst allowing the technologies to develop. The term 'responsible development' is used to describe research that has addressed these issues:

"Nanotechnologies have already been identified as a key area in a number of contexts. For example, the Defra science forward look identifies the development of nanotechnologies as a key driver in determining the future evidence base that Defra requires to deal with potential risks to the environment"
Government Response to the Royal Society Report on nanoscience 2005

"The government will continue to ensure an integrated and co ordinated approach to nanotechnology through bringing together a wide range of stakeholders with a focus on understanding and managing potential risks and ensuring the responsible development of nanotechnologies."
UK Government response to RCEP report on nanoscience 2009

The outputs of public dialogue activities are talked about in this discourse, with specific reference made to debates such as the Royal Society's public dialogue on nanosciences. In the first instance, these dialogues are seen as a way to map out the social and ethical dimensions of the technologies, so that experts can understand which issues need to be 'addressed', allowing the technologies to develop 'responsibly'.

> *"The public dialogue involved workshops in Birmingham, Cardiff and Cornwall where around ninety members of the public heard about potential geoengineering ideas and had a chance to discuss their ethical, social and legal implications."*
>
> ***Government response to Geoengineering Report 2009***

> *"Policymakers will want to hear about and then respond to public concerns related to ethical social health safety and environmental issues. To help meet this aim, the government is already supporting a number of activities such as Sciencewise."*
>
> ***Government Response to Royal Society Report on Nanosciences 2005***

> *"The government's aim for public dialogue around nanotechnologies is to elicit and understand people's aspirations and concerns around the development of these technologies through the dialogue process scientists and the public can jointly explore existing and potential opportunities"*
>
> ***Government Response to the Royal Society Report on Nanosciences 2005.***

Interestingly, the potential benefits coming from nanosciences and geoengineering are not described or discussed in this discourse – the only specific mentions of possible benefits relate to the need to maintain international competitiveness and to monitor possible medical uses for their effects on human health and of new materials on the environment. Future benefits do however appear to be assumed – the main thrust of this discourse is about enabling these technologies to develop. At the same time, there is recognition that the precise applications and outcomes of research are unknown – much of this discourse is about the need to monitor future

uses in order to take account of them. In many cases, this involves collaborating to share and create more information that might help anticipate risks:

> *"Instead, government will explore alternative ways of obtaining early information about new materials and products, through existing structures and stakeholder networks and will keep this horizon scanning function in mind during the forthcoming development of the UK's strategy for nanotechnologies."*
> ***UK Government Response to RCEP Report on Nanoscience 2009***

> *"The Royal Commission recommended that responsible organisations set up structured systems to keep a watching brief on the development of novel materials and to enhance the sharing of information and the opportunities to work together to identify and manage emerging problems"*
> ***UK Government Response to RCEP Report on Nanoscience 2009***

> *"We recommend that regulatory bodies and their respective advisory committees include future applications of nanotechnologies in their horizon scanning programmes to ensure any regulatory gaps are identified at an appropriate stage."*
> ***Government Response to Royal Society Report on Nanoscience 2004***

> *"Government will explore alternative ways of obtaining early information about new materials and products through existing structures and stakeholder networks and will keep this horizon scanning function in mind during the forthcoming development of the UK's strategy for nanotechnologies"*
> ***UK Government Response to RCEP Report on Nanoscience 2009***

Class C4 (25.05%): Supporting technology transfer

The discourse in this class is focused around structural and financial support being put in place to help the translation of basic research into businesses. It is most strongly related to government responses to reports on industrial biotechnology, the UK stem cell initiative, nanosciences and synthetic biology.

Illustrative statement:

> *"The government recognises the importance of the UK's science base in providing the new ideas and innovations for translation into applications. The government will provide funding for such research over the next decade and develop a strategy to support businesses in exploiting this."*

The focus of this discourse is around money, business and industry, with words such as 'pound', 'industry', 'technology', 'skill', 'company' and 'work' being significant. The only people word is 'engineer'. A typical text segment is:

> *"Government and industry can work to create an encouraging and enabling political and economic framework to catalyse the growth of the market for IB produced products, processes and technologies."*
> ***Government response to the Industrial Biotechnology – Innovation & Growth team report to Government (2009)***

The vocabulary is positive, with words such as support, lead, invest, train and opportunity being significant. There are no negative or critical words associated with the class. In particular, the active words appear to be used to describe the active role of the government in pushing this agenda forward. These active words also tend to be powerful in nature – for instance, 'drive', 'lead', 'accelerate', 'build', 'launch' and 'strengthen'. The discourse also has significant number of 'new public management' words, such as 'strategy', 'forum', 'programme', 'strategic', 'deliver', 'priority', 'plan' and 'facilitate', indicating that the role of the government is to 'enable' the desired future (rather than legislate or regulate):

> *"The implementation plans for the Industrial Biotechnology IGT will directly drive the success of industrial biotechnology in the UK. The utilisation of the technology strategy board's knowledge transfer networks coupled with the continuation of industry led activity is the minimum requirements for implementation of the IB IGT recommendations."*
> ***Government response to the Industrial Biotechnology – Innovation & Growth team report to Government (2009)***

> "Government's role will be to continue to create the climate in which the research initiatives described above may flourish. Work has already begun – in May 2012, the government boosted innovation to stimulate growth in synthetic biology by investing some £6million."
>
> **Response to 'A Synthetic Biology Road Map for the UK' (Letter from Science Minister, 2012)**

Within this discourse, science appears to be seen as a solution, a producer of technologies and driver of growth, with words such as 'technology', 'product', 'solution', 'economics' and 'growth' being significant. Science or application related words are not common – the only words in the significant list are 'bio', 'energy' and 'chemical':

> "The Government accepts the importance of the UK's science base in providing the new ideas and innovations for translation into industrial biotechnology applications."
>
> **Government response to the Industrial Biotechnology – Innovation & Growth team report to Government (2009)**

> "Synthetic Biology could produce solutions to many of humanity's most pressing issues and at the same time presents significant growth opportunities."
>
> **Response to 'A Synthetic Biology Road Map for the UK' (Letter from Science Minister, 2012)**

Summary of key themes emerging from policy discourses (Corpus C)

a. Focus on supporting science

Overall the focus of all the policy discourses is on enabling science and innovation, in order to grow the economy and maintain national competitiveness. Specifically, they look at the government's role in regulating and providing support for the various areas of science. Within this, the role of regulation is in balancing interests, providing infrastructure and coordination and ensuring no harm is done.

b. Benefits of science assumed, not specified

Beyond economic benefits, the purpose to which the science being discussed is generally not specified in these policy discourses. Applications are implied rather than described. One of the texts contributing to class C3 acknowledges this – pointing out that the potential applications of some new technologies are unknown and need to be monitored. Even without clear applications however, science is seen as an automatic and unquestionable good. The implication is that doing more science will undoubtedly develop more social benefits, as that is what science 'makes'.

c. Uncertainty, risk and unforeseen consequences acknowledged

The policy discourses raise the possibility of uncertainty and unforeseen consequences and the need to monitor and look out for these, and to adapt the regulation to cope with these new consequences, is described. This uncertainty is however seen as a reason to seek more information or knowledge (i.e. to do more research), rather than to put on the brakes. For policymakers, the unknowns were knowable (but as yet unknown) rather than unpredictable futures.

d. Social and ethical issues as epiphenomena and questions of risk or legality

Connected to the previous point, throughout the policy discourses, social and ethical issues relating to science and technology are acknowledged, but are not discussed beyond that. Instead, they are sought to be 'addressed' or balanced, while still allowing the research to take place. Social and ethical issues are seen as

epiphenomena that can be dealt with separately from the science itself. They are also seen as 'public' matters – concerns raised in public dialogues in particular.

The policy discourses also talk about the problems associated with new science and technologies as matters of risk or regulation. As with uncertainties, these are seen as matters that can be quantified, managed or resolved with more information, more research or better regulation. Such a view of science and its associated problems appears to provide a practical way forward that allows the science to happen while still minimising the problems, but at the same time, perhaps without intending to do so, they close down potentially important matters of ethics and morality – matters that are important to the public.

Class C2, which discusses the legislation around animal human hybrid embryos is a particularly interesting example of this. The policy discourse recognises that the question of whether hybrid embryos are animal or human is an important one. But for them this is a matter to be settled in order to work out who would regulate them – if they are human embryos then the HFEA is responsible, if animals, then the Home Office. For the policymakers, a clear, settled answer is the important thing and so the law is turned to in order to settle this very moral matter decisively. As I will discuss further later, turning social and ethical issues into risk or legal matters keeps the issue in the expert domain and allows it to 'slot' more readily into existing ways of decision making or into categories of evidence that policymakers know how to process.

e. Reliance on 'expert' advice

As well as the tendency to turn social and ethical issues into 'expert' matters of risk and legality, the policy discourses also appear to draw very heavily on expert advice, with scientific organisations being mentioned and quoted and scientific language being used throughout.

f. Public dialogue mentioned but problematized

Public dialogue events are mentioned in the policy discourses. In particular, they are discussed as ways of identifying public issues to be addressed. They are however

problematized, with questions raised about their representativeness and calls for similar views to be sought from 'experts' in order to verify their validity.

From Discourses to Sociotechnical Imaginaries

As with the public and the expert corpuses, I have looked at these policy discourses together to understand the underlying sociotechnical imaginaries at play:

1. Basic entities recognised or constructed

In terms of the basic entities recognised, the focus of the policy discourses is split between people, technology, government and the economy.

People are variably referred to in terms of their relationship to the technologies in question – farmers and consumers in the case of GM; patients, men and women in the case of embryology research; the public in the case of nanoscience and synthetic biology; and as engineers, workers or professionals in discussions about technology transfer and funding. Perhaps surprisingly for a corpus that includes parliamentary documents, there are no references to citizens or voters.

Scientific and technological concepts are also discussed – words such as nanoparticles, embryo, chimera and gene are significant.

Government is discussed in terms of ministers, regulation, bill, committee.

The economy is also an important matter for these discourses, with concepts such as markets, business sector, pounds, investment being key. Tying in with the idea of government and the economy, words relating to countries and nations – the UK, Europe, international are also important.

In terms of boundaries, when talking about embryo research, the boundary between human and animal is very important for the policy discourse – but this is seen as a legal rather than an ontological boundary.

2. Assumptions about natural relationships

a. Science drives progress and solves problems

The policy discourses contain a strong sense of the promise of advancement or cures from science. Science and technology is seen as the provider of solutions – for healthcare, for sustainability and for the economy. The precise nature of the solutions or benefits offered by such developments is unspoken – indeed their unknown nature is mentioned – the implication being that more science will inevitably bring social goods as this is the purpose of science.

b. Risks and uncertainties are knowable

Coupled with this however is the acknowledgement that uncertainties and risks surround some of these new developments. These risks and uncertainties are seen as knowable or manageable with more information and are epiphenomena.

c. Social and ethical concerns can be addressed

Concerns about social and ethical issues are matters that have been created by the public and matters, which can also be addressed with more information or legal clarity.

3. Agents and their motives

Science is seen as producer of goods and solutions. More science therefore brings more social goods.

The public are discussed as a group who have concerns and objections not shared by the scientific community – public dialogue is a way of finding out what these concerns are, so that experts can decide which ones are valid and address them.

The source of most advice on the matters being considered are 'experts' – specifically the scientific members of august bodies such as the learned societies. They have the right to talk on these subjects and verify/challenge public concerns.

The law is also an important source of advice and seen in the policy discourses as the way to settle social and ethical issues. Legal decisions are often used as a proxy for discussion of moral and social issues.

Industry is an important partner in developing these new technologies and translating them into businesses, jobs and economic growth to keep the UK internationally competitive.

Above all this however, is the role of Government in hearing these different interests and standpoints, balancing interests and providing rules to ensure that science causes no harm and is able to proceed effectively.

4. Key metaphors and other rhetorical devices

The sense of progress and the potential future benefits to come from science is a key theme running throughout the policy discourse. The future therefore is a key rhetorical device in the policy discourse – it is not about what science is doing now, but what it can do in the future. As I have already mentioned, this is not necessarily based upon any specific benefits in the pipeline, but the idea of science as a producer of solutions in the future.

Alongside that runs the idea of the need for the UK economy to compete in a global market. Throughout the discourse the role of science and innovation in driving the UK economy is important, as is the suggestion that this will keep us ahead of the game – giving us an international lead, for instance. This ties in somewhat with the expert rhetoric of time and urgency.

The advice of others is also evoked throughout the policy discourses, providing third party endorsement to policy proposals or allowing particular issues to be raised by 'others' – for example, social and ethical issues are raised by the public. Expert advice appears to have the most currency and is also used to neutralise more problematic discussions – legal expertise is drawn upon to settle the ontological questions at the heart of the hybrid embryo legislation, and scientific expertise guides judgements about the potential risks of environmental technologies, for example.

The Policy sociotechnical imaginary: Science driving economic progress

Together, these features build up a picture of an imaginary of 'science driving economic progress'. In this imaginary, with sufficient resources and freedom, science has the ability to solve the world's problems. Any problems or risks arising can be managed and dealt with by more knowledge and information. Social and ethical issues raised by the public can be addressed by anticipating and managing risk or by the law. Industry is a partner in developing these new technologies and converting them into jobs and wealth and the role of government is to ensure that the partnerships and infrastructures are in place to ensure this happens in a way in which the different interests are balanced.

Chapter 6: Comparison of public, expert and policy sociotechnical imaginaries

In the last two chapters I have described how I have identified various discourses in the public, expert and policy documents that build up into a public sociotechnical imaginary of 'Contingent progress', an expert imaginary of 'Scientific progress' and a policy imaginary of 'Science driving economic progress'.

In this chapter, I compare these three imaginaries and consider what the similarities and differences in sociotechnical imaginaries and discourses mean in terms of the impact of public dialogue on policy. Are there any traces of the public or expert discourses in policy documents? How do policymakers perceive public dialogue and what role do they see for the public in decision-making? What does the policy sociotechnical imaginary look like and what role do policymakers see for science in government and society? Instead of the traditional approach to evaluating impact by examining how particular thoughts move through the paperwork, I am seeking to understand impact in terms of how the high-level ideas and visions, and general approaches to the subjects in hand, are reflected and expressed in the different corpuses.

At this point I would like to put forward a series of initial hypotheses that aim to provide an explanation for the level of impact of public dialogue on policy that is evident. In the context of these hypotheses, I compare the three sociotechnical imaginaries and revise the hypotheses before analysing the interviews. In this way, I aim to shed light on whether or not these hypotheses are reasonable and whether there are further explanations that help understand the impact of public dialogue on policy, how evidence is used and balanced in policy, how public dialogue fits in, as well as to get a clearer picture of the sociotechnical imaginaries at play.

- H1a: Public dialogue has had very little impact on policy
- H2a: The policy sociotechnical imaginary is more aligned with the expert sociotechnical imaginary than with the public imaginary
- H3a: Policy discourses draw more strongly on expert advice

Comparing Sociotechnical Imaginaries

The key features of the public, expert and policy sociotechnical imaginaries is given in the table below:

Table 6: Key features of the public, expert and policy sociotechnical imaginaries derived from the text analysis.

	Public	**Expert**	**Policy**
Basic entities recognised or constructed	People Animals Nature Government Cures	Science and technology People constructed in relation to this Scale: nanoparticles, cells, patient, ecosystem, Economy and market Nations Time	People constructed as citizens and consumers Science and technology Economies and market Law Countries/nations – UK, Europe,
Assumptions about natural relationships	3 conceptions of nature Distinction between humans and animals Promise of advance/cures from science	Progress Subordination of nature by science Competition between countries Risks manageable	Progress Role of government in enabling science, balancing interests and looking after economy Expert and non-experts

	Role of government in regulating use and direction of science	Uncertainties knowable	Risks manageable Uncertainties knowable Competition between countries
Agents and their motives	Industry focused on profit making Scientists want to do science Government's role to counter-balance both these excesses People need more information and should be listened to Experts needed to make decisions	Government focused on economic gains Scientists solving big problems ahead Public concerned about change and new technologies Decisions should be based on expert scientific advice/authority of science	Government manages economy and enables things Law settles matters Industry a partner in converting science to wealth Science is producing social goods – benefits assumed not specified Public has concerns about things and need to be reassured 'Experts' & scientists have the right to talk on these subjects and verify/challenge public concerns

Key metaphors and rhetorical devices	Nature Slippery slope Hyperbolic framing and abstracting to elicit support	Use of technical and scientific language Economic arguments for doing science Time limitations and international competition Hyperbolic framing Managing/closing risk Discounting uncertainty Separation of social and ethical issues Normalising problems of new technologies	Economic arguments for doing science International competition and urgency Social and ethical issues converted to risk = public matters Third party advice and endorsement

It is possible to see some overlap between the public and the policy discourses described in chapters 4 and 5 – the sense of uncertainty and the need to monitor outcomes in particular. But comparing the public, expert and policy sociotechnical imaginaries above, it is apparent that the policy imaginary is much closer to the expert imaginary than the public imaginary. While the expert imaginary is perhaps more centred around the science and technology and the policy imaginary taking more account of people and regulation, this can be accounted for by considering the different functions and audiences of each set of documents. The core understandings and imaginaries of the way that science is and ought to be within our society are however strikingly similar: the (unquestioning) understanding that

science will solve problems and deliver social goods; that science is a driver of the economy and of international competitiveness; the perspective that social and ethical issues are matters of risk and understanding, which stand aside from the technologies themselves and that can be quantified and resolved by more education or more research; the role of science to support and serve industry, which in turn supports and drives the economy.

This is in contrast to the public imaginary, in which the science and technology are seen as producing goods and solutions, but also as producing problems too; where industry is a necessary but distorting influence that needs to be managed; and a sense that science can get out of hand, compromise nature or challenge what it is to be human.

This suggests that what we are looking at is an 'elite' imaginary of 'Scientific Progress', held by policymakers and scientific experts, and a 'counter-imaginary' of 'Contingent Progress', expressed by the public in public dialogues. While these two imaginaries are not a million miles away from each other (they are more similar than the "promethean elite meets precautionary public" description that Dryzek et al. (2008) has characterised around GM, for instance) the differences are significant – particularly when thinking about the impact of public dialogue. As I will discuss later, this is not least because the way we see and understand science shapes the way we believe it needs to be managed and controlled. The shape of regulation is therefore likely to reflect the shape of the sociotechnical imaginary held by those designing regulation (Jasanoff & Kim 2009; Hurlbut 2015).

What does this tell us about the impact of public dialogue?

From the outset, I have been aiming to answer the question of whether public dialogue has had any impact on public policy in the UK. Having identified the public and expert discourses that feed into policymaking, as well as the policy discourses that emerge, is there any evidence that the public discourses have had any impact? And does this analysis provide any evidence to explain this? At this point, I will reflect on the evidence to date, to test my initial hypotheses, with the aim of developing them further, ready to be tested with my interviews with policymakers

H1a: Public dialogue has had very little impact on policy

To begin, by comparing the discourses and high level sociotechnical imaginaries expressed in these discourses, there is evidence that some aspects of the outputs of dialogues are reflected in policy – not least because there are specific mentions of the public concerns being raised in dialogue events and to ScienceWise. The policy discourses also share with the public discourses the recognition of uncertainty around science and the need to anticipate and monitor for unforeseen consequences that might emerge from new sciences and technologies.

However, while the policy discourses also acknowledge the social and ethical issues raised in public dialogue, these issues are not explored or considered much further. Rather than being seen as an integral part of the science and technologies themselves, the social and ethical issues are seen as separate matters that can be dealt with and minimised – which is similar to the way in which expert discourses treat these issues. Further, while the public are seen as the sources of these issues in the policy discourses, this is problematized and the veracity of the public as sources is brought into question. Instead, the authority to deal with these issues is seen as lying still with experts – in the domains of risk management or the law.

Beyond the specific mentions of the outputs of public dialogue, it is difficult to establish whether the other similarities (such as the acknowledgement of uncertainty mentioned above) are the result of the influence of public dialogue or whether they are the result of shared views or the effect of other influences such as lobbying from other sources or alternative pieces of evidence. I explore this later in interviews with policymakers, although, as I have described in the introduction, it is difficult it is to trace particular decisions back to particular pieces of evidence.

In light of this, I would like to amend H1a to:

H1: Public dialogue has had some, but limited impact on policy.

H2a: The policy sociotechnical imaginary is more aligned with the expert sociotechnical imaginary

As I have described above, I have found that the expert and policy sociotechnical imaginaries are closely aligned, creating an 'elite' imaginary of 'scientific progress'.

The outputs of public dialogue in contrast contribute to a 'counter-imaginary' of 'contingent progress'. This counter imaginary could be seen as challenging or undermining the 'elite' imaginary – and be given less currency as a result. In particular, the elite imaginary, with its focus on economic growth and managing risk, provides an efficient way to close down issues around science and technology and to move on. It also provides a clear role for government that is in keeping with the wider political narrative about reducing the role of the state. The public discourse in contrast begins to question whether profit should be at any cost, potentially holding back economic growth, or at least making the UK a less appealing place to do science. It also presents a more challenging and problematic role for government, in balancing interests and ensuring science is used for public good, rather than not causing harm. It also tends to keep issues open, which perhaps presents problems if the policy system needs clarity and closure.

The rhetoric and ontology of the public counter-imaginary might also undermine its power and therefore mean that views based around this imaginary are not taken as seriously as those based around the elite imaginary. As I have already described, the expert discourses use much more technical language, especially compared to the public discourses. Hilgartner (Hilgartner 2000, p.8) who looked at scientific advice through the metaphor of 'performance', argued that scientific advisory bodies use their technical knowledge to display competence and credibility and therefore win the confidence of audiences. Its presence in these reports could therefore be seen as a rhetorical device that instils the experts authoring the reports with authority by reinforcing the privileged and expert nature of their knowledge. At the same time, the public discourses' ontological focus on people rather than technology could be deepening the perceived differences in credibility between the two sets of reports. Cook and colleagues (Cook et al. 2004) talking to GM scientists involved in public engagement activities, reported that the public were seen to be making emotional (rather than rational) assessments of technologies, and to therefore be vulnerable to manipulation by the press, NGOs and politicians. If this view is shared by policymakers, then it might work to undermine the credibility of the public reports as a source of advice, by reinforcing this perception that the public's views on new technologies are irrational and susceptible to change – and therefore not worth building into policy.

Reflecting this, H2a is therefore amended to:

H2: The impact of public dialogue is limited because of differences between elite and public sociotechnical imaginaries

H3a: Policy discourses draw more strongly on expert advice

It is clear from the policy discourses that 'expert' sources are valued in policymaking – and that the outputs of public dialogue are not seen as 'expert' sources. As I have described above, the public discourses are people focused and appear to have less rhetorical power than the expert discourses. Furthermore, the evidence from the text analysis suggests that policymakers sometimes look for 'expert' opinion to verify the public views put forward.

As I have explained in the introduction, expertise can be seen as both relational and substantive. Either understanding could provide an explanation for the preference for expert advice in this instance – the policymakers might not see ScienceWise as the right kind of institution to provide policy advice, that the public have no particular knowledge (besides their lay perspectives on social and ethical issues) of value to policymakers, or policymakers might not consider lay perspectives to offer any valuable insight.

So, from where do policymakers get their advice? How do they decide who to listen to? What kind of knowledge or expertise are they looking for? And how are the views of the public and the outputs of public dialogue in particular seen in this context? I will explore these questions further in my interviews with policymakers. In the meantime, H3a is amended to:

H3: 'Expert' sources are valued in policymaking – and public dialogue is not seen as a source of expertise.

In the following section, I will go on to test and develop these hypotheses in light of the information gathered in my interviews with policymakers.

Interviews with policymakers

As detailed in the methodology chapter, my group of policymakers for interview comprised two former Chief Scientific Advisers (CSAs), four former Government ministers from the two main political parties, three civil servants and one former special adviser. The interviews were semi-structured, based around the same series of questions, but adapted for the particular interviewee's background and the direction that responses took.

As I have explained in the methodology, the interviews were analysed in two ways – firstly, using a framework that was developed around the three hypotheses that emerged from the text analysis; secondly, they were revisited more inductively, to identify any themes and messages that were important but outside the initial coding framework. I present the findings in this order in this chapter – first presenting the data from the interviews that test and develop my three hypotheses and then presenting any additional points that add to the picture of the impact of dialogue on policy and suggest a further fourth conclusion.

Throughout this chapter I use quotes from interviews, but do not attribute the quotes to named individuals. Instead I use the designations above, so that the comments remain anonymous while allowing any differences in opinion related to roles to be apparent. In order to maintain the anonymity of the interviewees, I have not been able to provide the full transcripts. Instead I have used lengthy quotes in order to ensure the comments are understood in context.

Hypothesis 1 – Public dialogue has had some, but limited impact on policy.

Evidence of the impact of public dialogue events on policymakers was variable. Dialogue appears to have had the most impact on civil servants. All three of the civil servants spoken to had experience of ScienceWise public dialogue events and were enthusiastic about them. In contrast, none of the ministers were familiar with ScienceWise nor public dialogue. The views of the former Chief Scientific Advisers

were in-between – they were aware of public dialogue but had not necessarily been involved themselves nor understood how such an activity could be useful to them.

Civil Servants

The civil servants (some of whom had worked for the ministers interviewed) were the most familiar with dialogue and Sciencewise and all three had been actively involved with at least one event. They understood that the aim was to involve public perspectives in the policymaking process. The impact on policy of policymakers' experience with public dialogue was difficult to quantify or account for however. In many instances, interviewees reported that the public hadn't expressed anything that they (policymakers) hadn't considered already, but that the process was useful as a sense check or grounding, or that it simply felt like the right thing to do:

Interviewer	Do you get involved with any of the public engagement or public dialogue activities?
Civil Servant	I've been involved in one, which was on data... It was done as part of the Royal Society 'Science as an Open Enterprise' report and some of the administrative data taskforce work. Basically a dialogue was done on how the public felt about their data being used for policy reasons. And it was really great actually… the cohort that was involved in the dialogue started with a kind of, the whole concept of open data and data sharing is a bit of a, its not of a high interest prima face until you start talking about it. And just a little bit of discussion about what it was really got people engaged and by the end of the dialogue they had become, the group had come up with a sort of set of principles around which data sharing was and wasn't ok. So, from a standing start to have been able to do something so sophisticated, I thought was excellent.
Interviewer	Did they tell you anything new that you hadn't given any thought to?
Civil Servant	Erm. Well I was new to the policy area, so a lot of that was new.

	But in hindsight, I was part of an expert round table [details removed for confidentiality] that came up with the same, well similar concepts in terms of contextual, the importance of context to data sharing rules and regs. There were differences and a different level of sophistication, but everyone's a member of the public, so it's kind of, the public dialogue thing, it's quite hard to think of the public as a generic mass actually. It's not really, I wonder if that's not helpful either.
Interviewer	So what happened to the guidelines or principles that they drew up then?
Civil Servant	They are in the report and I have personally shared that report with quite a number of people across government. Whether they have read it or not, I have no idea. But it certainly, it sits with me, as someone, one of the people in government who cares about these things, as a rather important piece of evidence that I was part of and saw how it was done and I had confidence in it as an exercise. I knew the limitations of it as an exercise, but for quite an abstract area like data, it's just useful to have something that is grounded in reality. What has always struck me about public dialogue stuff, it feels ready-made quite minister friendly because by definition it can't be pointy headed and techy because it's non-experts usually. It's lay people. And that is a useful thing.
Interviewer	What is the purpose of it from a policymaker's perspective?
Civil Servant	Public dialogue? Erm. Well I think it's to, I think it's, I think there are a number of purposes aren't there. It's partially to generate ideas. It's partly to quality or sense check ideas, it's to, coming back to the delivery ball, the dialogue can help understand how you can land [policy], you know. It's this co-creation point which is I think extremely of its time.
Civil Servant	But the public dialogue was quite affirming for the research councils because their policy was pretty much presumption of openness but

	you need to make judgements about privacy about commercial security about confidence about when you release incomplete datasets, all of these questions was already there and the public actually, a very small number of members of the public involved with the dialogue, reinforced those views and suggested they were sensible views. The nature of the research matters, that privacy matters, but that sometimes you might trade some of that off.

Interviewer	Have you come across any of the Sciencewise dialogues?
Civil Servant	Yes, some of them. I was heavily involved in, not the big GM Nation thing quite a few years ago, but recently I was involved in quite a bit of that. Synthetic biology I've been involved with, ones on that as well. I think Sciencewise is generally a good thing because it gets government trying to think in different ways trying to engage with the public in different ways and that's gotta be a good thing. Whether it's right or whether it's doing everything it should be, I don't know. But having a group of people who are trying to encourage some different ways of working on that has got to be a good thing.
Interviewer	Did it influence any of the sorts of directions you were thinking?
Civil Servant	[Pause] the report was delivered shortly before I left. But I'm not [inaudible] since. I'll be honest. When I remember reading the report from that dialogue, I remember thinking I think I would have guessed all of that. What did we learn? I don't know. I don't know whether there's been an assessment to what Sciencewise the impact it's actually had. It's a good thing. I've always enjoyed engaging with, it makes me think differently. It makes me think a bit more openly and that's gotta be a good thing.
Interviewer	Did you go to any of the meetings?
Civil Servant	Yeah. I was sitting on a steering group for a little while in the run

	up to it. And that was good. And the techniques they were using to engage a very small sub-section of the public on synthetic biology, it was good. It was good to get people engaged and all that. But then I remember getting what I think was the final report that had conclusions about what became extracted from this process about what the public feels about synthetic biology. And it was useful to see, but it would have been what I guessed. People have got some hopes, they've got some concerns, they're generally more positive in health care, they don't really want the leaked stuff changing the environment, they want to see that it's regulated properly. They think scientists, I think there was one interesting point actually, they wanted scientists to be guided a bit more by what they should be doing in this space rather than a free for all. That was kind of interesting. That was one point that made me stop and think.
Interviewer	The fact it wasn't interesting, are you saying things you'd thought about or weren't things that were in your powers?
Civil Servant	No no no they were in my power but I guess apart from that last point, none of it was stuff that I hadn't already assumed. So I guess in some ways there is value in it in confirming what we thought because we are members of the public after all. So there was value in it bringing some kind of level of rigour to confirming most of what we thought the public were at and throwing up a couple of additional interesting things that we needed to take on board.

One interviewee was however specific about the insight that the public can bring to discussions about science and technology, pointing out that the addition of the public dialogue element to the Royal Society/Royal Academy of Engineering report on nanotechnologies had actually increased the value of the report to policymakers by presenting a more nuanced view of the technologies that moved beyond simply cheerleading for science:

Interviewer Were you involved with nanoscience when there were the various debates around that?

Civil Servant Yes. I did a bit of the work on policy at the point at which the Royal Society report was being published. And of course that Royal Society work was quite interesting because it was the first, and I think it's not happened again, the first time the royal society took some account of public views as part of their deliberations on a subject. So that report was quite a nuanced report that talked about potential risks in quite a transparent way, talked about potential benefits of the technology and also raised issues around public views about the technology. And because of that, the report was quite influential I think. And it was also in contrast with GM, this was all happening at the point at which there was no regulatory framework in place, so there was scope in order to develop things in the light of that, the regulatory framework.

Interviewer Why do you think the public stuff made it more influential?

Civil Servant Because it gave a nuanced view I guess and brought that together with the scientific analysis around the costs and the benefits and the risks. I think that work was pretty good at taking both the benefits and the risks seriously. So I'd contrast it with the work the RS did on Fracking recently, where I think a lot of commentators would say it was a bit of a cheerleader type report that focuses on the benefits and doesn't talk much about the risks and almost abrogates any responsibility for understanding what the societal views are and taking them into account.

The potential for reinforcing prejudices or bias in policymakers' views was highlighted by one civil servant however:

Civil Servant	But the GM area is interesting because there was a large body of already carried out public dialogue work on GM. My sense was that was acknowledged in the policy process but not particularly drawn upon nor used particularly effectively. In a sense it was used in that the broad conclusion was, this is generalised, but an anti GM conclusion and this was essentially valued very highly by those ministers who were anti GM and not valued at all, or criticised as being flawed by those who were keen to promote GM as a technology. It didn't really help in that sense, it just reinforced people's prejudices.

Chief Scientific Advisers

The former CSAs interviewed were less familiar with ScienceWise and public dialogue than the civil servants. They did however appear instinctively to feel that is was a good thing. One was clear of the benefits that could come in terms of behaviour change and bringing science and society closer together, but had never been involved nor advocated for such a dialogue; the other had been involved and was clear that the purpose is about sense checking and evidence building:

CSA	I'm not sure how you bring in the average person on the street. I'm not sure. It's an interesting question. To what, I mean this sounds a bit snobbish I know, to what degree does the average person on the ground know what the issues are? I believe, and you might want to check, I believe the Royal Society had a small project, a policy project, asking almost your exact question. Now what you would have to do is to have some sort of um, what they call citizens juries, local meetings and um you can do two things. I mean I'm not a social researcher. I could imagine you could

	construct some really good survey questions, being very careful not to be leading, because you can always get any answer you want by phrasing the question, but you could combine doing some really good surveys with some, I'll call them focus groups, where you bring 20 or 30 people together, you might ask them the same questions you might have on the survey, then spend half a day discussing the issues and then see if they came up with the same answers afterwards. But we haven't done that. Not for any of the assessments I've been part of. Should we? It would be an interesting idea. Costs money, but maybe not outrageously so, so maybe.
Interviewer	Why do you think it's important to do?
CSA	I think it is, well I suppose actually at the end of the day, what does society care about? What is their concern? … Understanding what people care about is rather important because... I gave a talk in Scotland yesterday, I give a couple of weekly forums, and someone was saying what's one of the most important things? And it's behaviour change... Big behaviour change. If we want change, the public have to buy into these issues. The more they own the issues they'll do three things potentially. 1. Modify their behaviour to waste less food, waste less energy. 2. Send a message to government these are important issues to them. Dammit we want action 3. Send a message to the private sector, we want environmentally and socially sustainable products. So an informed public can send multiple messages. And then also, once we understand the issues, the scientists working can then think through, OK so to address their issue these are the sorts of research questions we need to be asking.

Interviewer	You know that there has been a move to try to involve the public in decisions around science. Have you been involved with any of these?

CSA	We did a, it's not so much science, well I suppose it is. We did a consultation when I was at DFT on road user charging. So we did a Saturday morning workshop in Reading where we just got the lay people to turn up to a school I think.
Interviewer	Was it a useful exercise?
CSA	It was useful in what it showed was that the package of policies as it was, was incomplete because it was only about charging motorists. It wasn't about funding public transport to replace, sorry to offer choices on how to make a journey.
Interviewer	Presumably you could have worked that out without a public consultation?
CSA	Yes but it actually gave us the social science evidence. Through a set of focus groups. And they went all around the country and got very similar answers, as you might expect.

Significantly, this last interviewee was talking about some focus groups that were commissioned by the social researchers within that particular government department. This is distinct from a ScienceWise public engagement exercise which, beside methodological differences, would have operated at arms length from the policymakers and evidence teams. This appears to be an important distinction to make when considering impact.

This difference in the levels of familiarity and engagement with ScienceWise and public dialogue activities in general suggests that the policy influence of such activities functions at a civil service level. While the outputs might feed into the 'evidence mix' presented to ministers, there is little evidence that ministers are aware of this or directly engaged with public dialogue. The quotes above also suggest that the issues discussed in public dialogues function at a sub-ministerial level – that the discussions reflect decisions made by officials rather than decisions made by ministers. This is an important point that I will discuss later, in the context

of the policy models being described by interviewees and what that means for public dialogue.

Furthermore, the outputs of public discussion appear to have more impact when the policymakers themselves have attended and participated – none could recall reports, only experience of being at the events. This is supported by the quote from a civil servant below:

Civil Servant	I don't know how much exposure ministers would have had to formal public dialogues and the whole stuff around GM like citizens juries. I think they got that in a digested format from their advisers, so I don't think that they would… and this is a problem in a sense that if my argument is that the value you get from these public debates is the nuance, then actually that nuance is lost once a policy official has converted a 50 page report into two sentences, which is the reality.

Former Ministers

Former Ministers (and the special adviser) interviewed were unfamiliar with the idea of public dialogue and ScienceWise. None had been involved with a ScienceWise dialogue and all seemed to understand it to be a public education exercise. As I will discuss later however, this does not mean that they were not enthusiastic about involving the public in decision-making:

Interviewer	And I don't know if you've come across this, but there's a part of government called Sciencewise that is trying to enable public debate?
Former Minister	[Shakes head]
Interviewer	You haven't come across this?

Former Minister	Well obviously that's something within the civil service, within the department that's obviously what we give a lot of thought to. The team talks we'd have about how to do this would be decided between the senior civil servants and the ministers. The chief scientist, he was present at all decision-making meetings absolutely because that matters to me that we have the evidence base right. But you would also have a director of communications whose job it is to try to advise on how to communicate this. And we had a very good head of news who is still there and we had to think very carefully how do you bring across to the public a very difficult message.

Interviewer	Were you involved in ScienceWise?
Former Minister	Sciencewise? Is that the public education stuff?
Interviewer	Yes, sort of. It's public dialogue.
Former Minister	Yes, well we funded [first name removed] what's her name down in Bristol. I was very keen on that. Yes.
Interviewer	But you weren't involved in any of the events they ran?
Former Minister	I may have been but I don't recall it as a huge thing. But we did do a lot on the public education science engagement thing.

Interviewer	Sciencewise was in your bit wasn't it?
Former Minister	Yes. I found that, and I was trying to encourage more of this, so the 'Science, So What?' campaign, all of the encouragement of STEM

	subjects, women in science and engineering, were about one core idea, which is that motivating the people who are working in science and engineering, to feel that they had a voice, which needed to be listened to collectively and to try and provide a platform for that. Both in terms of to encourage them to engage in the debate on these topics – not…now how can I put this… Sometimes I felt in the scientific community… there's a feeling that this is all pointless. I'll just get on with my science and those idiots, you know. And I feel that's wrong. That's too depressing if you sort of give up like that. You have to say, if you're a scientist or engineer, you've made a choice to work in that area because you believe it is important. It's your life's works. And so surely you feel that engaging with people who don't get it is something you should do. Because if you don't, who's going to? And therefore if the scientific community doesn't make its voice heard, no-one's going to do it for them.

Special Adviser	So, was I involved in any public debate type of thing? Not really, no. It was probably more the media person who did that kind of thing, it was much more engagement with representative groups than the public.

Overall, the interviews with policymakers appear to support H1 – that public dialogue has had some, but very limited impact on policy. The interviews have also indicated that the impact is largely focused at a civil-servant level but that, even then, the civil servants interviewed were unable to articulate very clearly what the impact had been – beyond a sense-check and feeling that it was the right thing to do.

The policymakers did however appear to value public input –recognising that they had interesting and useful perspectives. This rules out one possible hypothesis for the lack of impact – the public don't have anything useful to say:

Civil Servant	[in this department] ultimately the people who make decisions are ministers. And their decisions aren't just based on science. I mean, in the UK generally our ministers try to make decisions in line with the science. That's often the way the UK governments of all colours want to go and that's a good thing. It's not like that in a lot of other countries. But they shouldn't just take it on the basis of that. They weigh up public feelings of course, they weigh up what's going on in parliament they weigh up what's going on in the media, they weigh up what's going on legally, they weigh up the science, the economics. I don't think they'd want to make a decision that was totally out of kilter with the science, that probably wouldn't work, but undoubtedly there would be instances where they have to respond to the public's wishes. They are elected, that's what they are there to do. So we don't live in a technologically driven decision making state. That probably wouldn't be a good thing. There are times when it might seem like a good thing but it wouldn't be a good thing. People's views and opinions are what really matter and so ministers are the place where you bring all of these considerations together and try and work out ways. As officials, it's our job to try and present them with all the evidence and the legal, the science, the economics, the policy, the views about stakeholders and public and then try and arrive at some advice as to what decision they want to make on that basis.

Civil Servant	But something like GM. I've heard experts say, look hey, we can say through all our regulatory systems that they're safe and therefore people should just accept that and move on. Well. Rightly or wrongly that's not how the world is working on this kind of issue. Like you were saying at the start, quite a lot of the ScienceWise stuff was focused on nature and people sort of relationship to it. So stuff like GM obviously, at least in Europe are taking an approach to listen to the science and make a decision. That's not working for the public rightly or wrongly. So you do

	need to adapt and take a different approach. Otherwise we are never going to break through that logjam. So a deeper understanding of why people are reacting in the way we do, or is it geopolitical forces at work here, it probably is to some extent, then you need to be alive to that and adapt. But unless the public don't care about the issue I don't think you can just close down an issue from the public and move on from it from there. I think it's always going to be more complicated.

One of the former ministers interviewed explained the importance of the public in pushing issues onto the policy agenda, using the particular example of European Fisheries policy:

Former Minister	Now we had been struggling to articulate this [the problem with fisheries policy] within the European Union for some time and to find likeminded countries who would come with us on a journey where we could actually come to a point of ending the policy of throwing away good fish, good protein. And denuding our marine biodiversity. It was a preposterous situation, but nobody frankly, very few people were interested beyond the academics and the policymakers. All of a sudden, it comes out in the public domain because of some high profile television documentaries. Next thing, we have campaigns running with celebrity chefs and so on. And all credit to it, because sometimes that is quite helpful for a policymaker. Finally you can stand up and say hey, we are now going to move on this because it is suddenly a live issue.

Possible explanations for this limited impact

Besides the fact that there appears to be a low level of understanding of the purpose and potential of public dialogue, particularly amongst ministers and CSAs, I have put forward two further hypotheses to explain the limited impact of public dialogue:

Hypothesis 2: The impact of public dialogue is limited because of differences between elite and public sociotechnical imaginaries

Hypothesis 2, from the text analysis, proposed that public dialogue had little impact on policy because it presented a sociotechnical imaginary that is counter to the 'elite' imaginary held by experts and policymakers.

To begin, is my description of an elite imaginary held by policymakers reflected in the way in which policymakers talked about science during the interviews? In analysing the interviews with policymakers, I argue that it is reflected. Furthermore, the interviews also provide some insight to the way in which this imaginary precludes the accommodation of public perspectives.

1. The interviews supported my characterisation of an elite imaginary

a. Economic focus

The importance of the economy, which is at the heart of the proposed 'elite' imaginary of 'scientific progress' does appear to be reflected in the interviews with policymakers. In particular, the interviews with former ministers who had had responsibility for the science budget illustrated this especially well when talking about their roles, and the role of investment in science, within government:

Former Minister	The important thing is that you're in cabinet and that you're able therefore to make the case for science. And you remember at the end of 2008 the financial crash was just really starting to bite and so it was very topical – the rebalancing of the economy, initiatives to address the crash and questions around investment in science. There were regular COBRA committees about policies for stemming the financial downturn and some of those were to do with the

	promotion of innovation in areas which were seen to have a really quite a quick win…. What I found as Science Minister, was that you are presented with the need to defend the science budget, the science ring-fence in particular. And your ability to do that is largely to do with convincing the Treasury the merits of the case. It's partly within that departmental budget, but it's also on a stand alone basis and you have to be able to make your case. Now one of the problems at that time was that we didn't have any data that the Treasury would regard as coherent and convincing on the impact that science investment would make. Therefore you were always relying on either, well it's a statement of the bleeding obvious, or you were giving some anecdotal examples and people were able to do that, but there was no financial analysis or regular collection of data.

Former Minister	I think it was essentially that you made the best case for investment in research and investment in higher education if you aligned them with the most economically productive parts of the economy, which didn't mean that everything then became applied science, far from it. But understanding where these activities stood, their critical relationship with the development of skills, their critical relationship with innovation policy and their CR with future innovation and productivity and products needed to be seen as a whole, so you were really taking a lot of higher and further education and saying you have many, many different important and different activities but a core rationale is your relationship with innovation growth and the economy.

Given this deliberate alignment of science and economic objectives, it is possible to understand that a public perspective that challenges this in any way – even by simply questioning the motives of industry – would be difficult to accommodate and could in fact result in such views being excluded.

Interestingly, one of the former ministers goes on explain how the scientific community had been encouraged to think about their research in these economic terms, and how a situation of mutual self-interest had been created in this way – a situation in which a public that questions the correctness of this relationship – and indeed sees a different role for government in regulating rather than facilitating the relationship, would be problematic:

Former Minister	There is, there was at the time this philosophical argument about well why should we have to do this [talk about the benefits of research]? Isn't it obvious? And I think that a lot of the politics around science come from the basis that people in the science community think that this is so obvious. Why do we have to go through these hoops? And I think that fundamentally they're right. It should be that obvious. The problem is that's not how politics actually works in government. And therefore it's self-interest for the scientific community to provide the evidence to back up its assertion and not to see it as an attack on the fundamental public good that investment in blue sky research has. I got into quite a big political hoo-haa at the time in saying to people it's not that I'm questioning fundamental research is a public good, what I'm saying is that you need to move beyond the assertion that good things come from it. We have to show the data and it's a reasonable requirement for us to do that. And if we do do it, it will put future science ministers in a much stronger position to argue the case.

b. Social and Ethical issues as epiphenomena

The finding that the policy discourses and elite imaginary see a distinct division between the science and the social and ethical issues was also supported by the interviews. For instance the following quote from a civil servant, in which the 'social' part of GM is very clearly being seen as separate from the 'science' itself:

Civil Servant	You could argue that a lot of the anti GM lobby is much more about mechanisation and over technologicalisation of agriculture and capitalism and the food chain and lots of things that have absolutely nothing to do with GM and the science.

One of the former CSAs puts it even more sharply when he compares attitudes to data security of the public (which he later characterises as not rational because they are not consistently applied to every technology) to his own view that data technologies in themselves aren't problematic, we just need to identify and manage the problems that might come from them:

Former CSA	Obviously the debate in the House right now, or probably in the Lords by now, on information security and data security is an example. People don't see it like that. They see it as snooping. Actually, it's about knowing what the bad guys are doing in advance of them doing it so we can stop them.

One former CSA also reinforced the view that social and ethical issues can be separated from the science in arguing that academics' outlooks on the world should not and do not affect their science. They were explaining the role of the CSA in a political setting, which they refer to as 'belief based systems':

Former CSA	I think that academia is in a position where it ought to be able to strengthen its ability to do that [give impartial advice] because the one thing we ought to be able to be is agnostic as to where the answer is. And a lot of policy think tanks have been hijacked by belief based systems so they are partial. And the one thing I think academics should hang onto like grim death is their ability to be agnostic with regard to any pre-conceived idea of what is right or wrong.

Such an outlook would present two further problems for a more nuanced public perspective that sees the benefits and problems of science and technology as two sides of the same coin. Firstly, if the expectation is that social and ethical issues are separate from the technology, then the views of the public would be heard as such – reports from dialogue would be seen to be providing lists of things to be dealt with or the conditions under which research could proceed. This was evident from the text analysis, but is also expressed by one of the former CSA's in response to a question about why listening to the public is important, whereby he explains that the public would be able to say what they are concerned about but not really formulate any questions or comments about the science:

Interviewer	Why do you think it's [listening to the public] important to do?
Former CSA	I think it is, well I suppose actually at the end of the day, what does society care about? What is their concern? … On climate change, are you concerned, why are you concerned and what are the issues you are concerned about? It would probably have to be at a fairly macro level and it might come to is there evidence that it's changing? Well what I really care about, will it affect food security, will I get more drought, and what will that do, will it give me more floods? So you know, what is the issue when they think about climate change, that hits them in the mind. So they wouldn't come up with specific science questions, they could talk about the issues they care about.

Secondly, regulation and policymaking structures are likely to be shaped by such an understanding too. As a result, the public imaginaries and discourses are unlikely to be reflected in the policy responses as there are simply not the structures to accommodate such complexity. One of the civil servants expressed this possibility:

Civil Servant	Having been involved with a few public dialogues around different topics, one of the general conclusions that we draw from them is, and in a sense this isn't a very helpful conclusion, is that the public can often see both sides of the argument about things. And they see the nuance and the challenge of balancing the two sides and

that's what comes out of the public dialogue across a whole range of subjects. In a sense, it's often the, you can argue that it's objectively the right, if there's a right answer about these things – it's neither the benefits are absolutely fantastic you need to do this, nor the risks are dreadful you can't possibly do this. The answer is obviously, is often we need to proceed with caution. And that's what comes out of public dialogue most of the time. And it seems to be a difficult ball game for the policymakers to square.

Because I think the minute you give a hint that you take a… you know, let's take fracking as an example. The minute the government acknowledges that there are risks, then that gives very strong ammunition to lobby groups that are trying to stop something and I would guess it works the other way, but it's easier to think of it in terms of the risk. So I think proceed with caution is quite a difficult line to ride because you've got almost always two powerful lobbies, one of which is saying you need to do this – often an industry lobby or whatever, and then you've often got activists lobby that may be informed by all sorts of things in addition to the risks, trying to stop something happening. And almost with proceed with caution, you end up batted from both sides and it's almost easier for government to say 'oh we're just going to go with this' and ignore one side or another of the debate. So I think that's sometimes why. The most recent at RCUK I was involved in a dialogue on open research data, which is a completely different area but has exactly the same characteristics where on one side you have the open data activists who are painting this nirvana that will be created by opening up all of the data that we can, and on the other extreme you've got the privacy campaigners who say that this is the [end of the] world as we know it, the end of civilization as we know it and the public dialogue that we did said 'yeah the data should be open, but there are lots of reasons why you might close it, so you need to make a judgement.' And that's not very sloganable. Whereas the other two are more…

In particular, one civil servant, who was able to reflect on their experience in government dealing with GM foods, described this situation precisely when he says that regulation often cannot accommodate the social concerns of the public:

Civil Servant	I'm looking back on what they said, you could say that the public dialogue in the sense of public opinion had a very strong effect on policy where it could. But where you had this European framework that was very strictly linked to the scientific evidence, then the government was playing with a very straight bat and voting where the direction of the scientific evidence was pointing.

Conversely, a civil servant explained how more nuanced perspectives can be taken into account if the discussion takes place before regulation has been designed:

Civil Servant	So that report was quite a nuanced report that talked about potential risks in quite a transparent way, talked about potential benefits of the technology and also raised issues around public views about the technology. And because of that, the report was quite influential I think. And it was also in contrast with GM, this was all happening at the point at which there was no regulatory framework in place, so there was scope in order to develop things in the light of that, the regulatory framework.

c. Risks and uncertainties can be known, quantified and managed (by experts)

The sense that uncertainty can be quantified and managed, that was so strong in the policy and expert discourses, also came through in the interviews. For example, one of the former CSAs, who was explaining that one of the challenges of the CSA was to convince policymakers that science always operated within the area of uncertainty and unknowns:

Former CSA	Again my own discipline of [removed] is one of sceptical disbelief of anything you observe. And even when you think you've completed it it is still a hypothesis. You never say this is the truth. It is always a hypothesis that is moving towards being able to interpret better what you are seeing by you never get to a situation where you are not prepared anything and everything about what you believe to be true. Which is sort of how you manage uncertainty because you've got to live the basic tenet that everything is uncertain. That does not stop you making a decision however. And I think that's where politicians have difficulty. They want, they believe they want certainty in order to make decisions. Wrong. What you need is sufficiently, sufficient understanding of the impact of the uncertainties on the consequences of your decision so that as you go forward you can… it is more likely that certain things you want to happen are going to happen, rather than less likely. And there is a lot of writing by that professor from Cambridge who has done a lot of work on public understanding of uncertainty. He has a very unusual name. He's just been knighted actually in the honours. He's on the today programme, the Radio 4 discussion programme meetings late at night or early in the morning. I've worked with him. [name removed] did a review of what he called black swan events. He said, how we look after black swan events and one of the things this guy said, wow it's really smart. And it was very nice to hear him say that because this was his subject. He said, basically we need an imagination lab, because once you've imagined it, it is not a black swan event. The black swan event is one that you did not actually know anything about before you have evidence to show it has happened. Ahh, that's interesting he said because once you've imagined it then you can start thinking about what if this ridiculous thing that nobody had imagined happening before happens. Then you get into the semantics about how you communicate uncertainty in the extreme.

One of the former Ministers interviewed also echoed this point about the ability to know unknowns, talking about the potential for more information to resolve potential uncertainties or conflicts:

Interviewer	How do you know when the evidence is incomplete?
Former Minister	Ermm. The..sometimes it's very obvious because it's scientifically disputed that the evidence is there. And a clear one of this I would say from a year ago would be the conflicting scientific views over neonicotinoids, where some were saying the widespread global empirical evidence clearly suggests that the precautionary approaches has to be taken. But there was conflicting evidence and this is sometimes the unintended consequences that says that well one, it's not actually conclusive and there needs to be more data and I think that is still the case today.

These interviews appear to confirm hypothesis 2, that the impact of public dialogue is limited because of differences between elite and public sociotechnical imaginaries. As I will discuss further later, these differences act in two ways. Firstly the elite imaginary acts as an indicator of the direction of travel that policymakers believe should be taken, thereby distinguishing which views can and cannot be taken into account. But at the same time, it also acts as lens through which the public's views are seen – the tendency to hear public views as acceptability criteria rather than alternative imaginaries, for instance.

Secondly, the public sociotechnical imaginary, in which government acts as a counter-measure to the excesses of the market or of uncontrolled scientific developments, and in which the risks of technologies are inseparable from the benefits, also struggles to be accommodated within an elite imaginary dominated by the need to support the market and economy and to manage and minimise risk.

Hypothesis 3: 'Expert' sources valued in policymaking – and public dialogue is not seen as a source of expertise.

The text analysis highlighted how the policy discourse drew heavily from the expert discourses, and that the outputs of public dialogue were not seen as 'expert sources'. As well as holding up this hypothesis, the interviews also shed more light about policymakers' understanding of expertise, which indicates that this preference for 'expert advice' is not entirely driven by shared imaginaries, but that there is also a desire to access substantive expertise and knowledge.

To begin, it was clear that expertise was extremely important for policymaking. Every policymaker interviewed referred to experts of various kinds. The quote below from a former CSA illustrates this well, emphasising the breadth of expertise drawn upon:

Former CSA	Science and evidence, good science and good evidence is a necessary condition for informed policy formulation. It is necessary, but not sufficient. And that is to say that there are other factors beyond even the natural sciences. So what is the evidence they [policymakers] should need? Well they need natural science evidence, evidence from the economics, statistical information, social science information, if it's an animal health issue, obviously veterinary information and even some operational research and obviously some statistics, I mean things on trends etc. So my job therefore was to make sure the best evidence is being used, but not being silly enough to believe it gave you the answer. All I would ever ask from a policymaker, whether that be an official or a minister, is simply that they don't selectively use information or distort the information.

a. Substantive Expertise

Expertise was described in substantive terms – people are asked to be involved in policymaking because they know something about the issue under consideration. For example, the former CSAs and Ministers told stories about how their

backgrounds in science (contributory expertise in Collins and Evans's classification of expertise (Collins & Evans 2009)) helped them understand the issues they were dealing with, but also to make judgements about other areas of science (referred expertise in Collins and Evans's framework), which was a significant skill sought in their appointments.

Former Minister	Previously I did 15 years in [name of industry removed] before I went into politics and when [the Prime Minister] was appointing me, he said, I want you to do this job because you have worked in farming and I know that you will understand the [name removed] industry and also that you've worked at a European level and that you're a linguist so that when it comes to all these meetings in Brussels, actually you will be able to represent the UK well because you understand how it works. The [specific name removed] policy is very very technical. You almost need a lexicon to deal with all the jargon that comes with it, but you know I grew up with that.

Former Minister	So [the Prime Minister] said why don't you come and do this. Because of your background you're a practitioner and your own experience, someone with a PhD, done research, built companies based on [relevant subject removed]. You speak with some authority.

Former CSA	So [Government CSA] asked me to do a review. Because I'm a physicist he thought that I'd get all the wave mechanics and the rest of it. So I sat down and read through all of this stuff. I can't say I understood it all but I got the general picture and I said well this is ok as far as it goes but you seem to have stopped thinking about the impact of waves, other than what appears to arrive south of Ireland. And I said, we are actually talking about an ocean that will sustain waves where the wavelength is the width of the Atlantic… …So I said, why aren't we thinking about the Atlantic on this and they said, gosh it's far too difficult to do. So I went away and dug

	around and found an oceanographer in Liverpool University, who had been doing studies of the impact of long wavelength oceanographic phenomena on coasts. So I said, would you be interested in helping us to understand it? …. So he went away and did some calculations and came back to a meeting which I remember, because the guys who had been doing this work, who had done things to some extent along the brief they'd been given. And this guy came in and said, well what I've discovered is Morecombe back silts up…. And everyone said, oh my god. That changes things doesn't it? So that was an intervention from my sort of basic physics of how do waves work, because I'm an optics person I know that you have to understand all of the wavelengths not just those that you think are interesting for the little phenomena you are worried about. Especially if you are talking about long timescales. So there was some basic understandings of how things work that allowed me to ask a question that they hadn't asked in the way they'd set up the study in the first place which changed the outcome and everyone went away and said, oh, well now then, let's think about that.

Interviewer	Do you think that your scientific expertise was one of the main skills you drew on?
Former CSA	Yes, I mean I had the privilege over my career of working in whole bunch of different science and engineering disciplines, so although I started life as a physicist, because of the different work I did in defence I got engaged with electronics, with IT, sensors, with atmospheric effects, space technology, and a whole raft of different things. There was almost nothing I hadn't seen in some shape or form outside the bio and medical area. That's where I felt vulnerable. But in [government departments with physical science foci] that was ok. Actually, when I got into [named department] proper there were bits of [the department] that had policy obligations with regard to some medical aspects because they are the body that licences and in particular, this is a sensitive subject,

	which is to do with the use of non-human primates in research. I won't say any more about that because I think it's too delicate for this conversation, but that took me out of my depth and I said so. And that's the other thing you learn to be able to do is to say look, here's an area I believe I am expert, here's an area I believe I know enough to be able to say something sensible, here's an area I don't have enough knowledge. I'll offer what will be some intelligent commentary, but recognise this is not my area of expertise.

Former CSA	We had a lady sat at our sage meetings who had done her PhD on that volcano. Not any volcano. That volcano. She knew exactly what was going on in great detail.

Ministers also reported how keen they were to hear 'from the horse's mouth' i.e. from people who were engaged with the research or working at the coal face, although in many cases these were people who also shared their views and which might be contrary to the views of advice coming from officials.

Former Minister	So the chief vet would be very important in all of that. I thought he was excellent and actually I have to say, the veterinary scientists were probably in the end the ones who had most influence on me. Because they are on the sharp end between understanding epidemiology of the disease in the wildlife and in the domestic herd. And interfacing with the farmers and the integrity of their profession globally about how do we deal with tuberculosis. It's a serious disease you can't ignore it and what should we advise the decision makers to do in this situation. And they were very good and I spoke to more than one vet through all this and vets in Ireland, vets in Australia because they're trained to try and tackle disease aren't they? You know they're not trying to make money out of raising cattle.

Former Minister	I always found that when it came to the most difficult decisions and the most controversial decisions or ones which frankly I disagreed with, then there was no substitute for actually bringing in the people who had written the briefing documents.

Former Minister	You would get the advice that came in from officials, but you would have a lot of contact, I mean we would go and spend quite a bit of time with some of the Cambridge firms to understand how their model actually operated.

b. Expertise as a role/relational

Alongside this idea of substantive expertise however, policymakers also referred to expertise as a role – that people working in the relevant institutions held the right expertise and therefore their institutional affiliation is a sufficient proxy for any further examination of credentials:

Interviewer	When you were looking for evidence (not necessarily just in this case) where did you look and how did you know where to look?
Former CSA	Partly by knowing enough about what was going on in various universities, by going to the research councils with whom I have a good relationship, so I just rang people up and said are you funding work in xyz and if so, where. And so they sent me some links to projects they had funded in various universities, ring up the universities and it turned out that if I said that I was the CSA, there was a sort of, yeah we'll tell you anything we want to know.

Former CSA	So one of the challenges I had and problems when I did this [named] assessment, the one I mentioned earlier where I had the bureau of 60 people, was how did we select the 6 NGO groups or the 6 consumer groups or the 6 private sector groups. So should they self select? That's obviously the right answer, but how do you set up a

	process across the world, where all of the private sector can agree on who their six representatives are, or the NGOs across the world. So in the end, to be honest, much of it was pre-selected by me and a few others, not just me, based on who had been to the consultation processes. So we had a bit of a consultation, so we had Greenpeace, we had Oxfam, so we did listen to people, but we did not go to self-selection, which is the ideal one in my opinion.

Interviewer	When the emergencies happen, where do you get advice and evidence from? Who helps you with that?
Former Minister	They put a lot of resource into evidence gathering and there are a high proportion of scientists in the department. So I've referred to they contract with organisations like the Met Office in terms of weather. In respect of plant or animal disease, it has animal and plant health laboratories that work to a capacity to deal with rapidly escalating disease. It has state of the art laboratories in Yorkshire at FERA and animal health laboratories in Worcestershire.

Civil Servant	We've been trying to come up with, in the last year, a new way of assessing quality based upon some fundamental questions about the design of the process – who has done it? Who has funded it? How have they reached their conclusions? The sort of peer review process it has gone through?

Civil Servant	In an organisation like government where the quantity of things that go past a minister's desk or an official's desk is such that that it reduces the opportunity to go back and read those really sort of academic papers, so you are relying as you go up on trusted parties. Whether that's learned societies, or whoever else, or groups, to sort of synthesise that evidence. So to go back to your core question, where does evidence come from? Well it's commissioned reports, it's statistics, it's ONS, it's scientific papers, it's the media erm.

c. Networks

Networks and contacts also appear to be key ways in which experts are identified. The two former CSAs and the special adviser interviewed in particular referred to their contacts in science on numerous occasions and used it as an illustration of the kind of skills they brought to their roles:

Former CSA	One of [the permanent secretary's] questions, one of the early questions, she said – I've just had a phone call. You're now working for me as chief scientific adviser. It's nine o'clock at night. Sorry to phone you at night. But it's nine o'clock, the Secretary of State has just called me and he wants a briefing tomorrow morning at one o'clock on Bovine TB. He doesn't know very much about the subject, what are you going to tell him. I said, well I hate to say it, I've never even heard of Bovine TB, so he knows a hell of a lot more than I do! [Laughter] It's clearly an animal disease of cows and it's obviously TB [laughing] but that is literally all I know. But that's not a problem. I've got a science advisory council that's got three animal health experts on it. I'll phone them immediately to see what they understand to be the big issues on it and what do we know about the issue. I'll get them to give me names outside of my science advisory council, so I'll quickly go through what's the disease, what are the issues and what are the policy issues at stake, so that by tomorrow morning can tell him how bad the disease is, what are the potential and how serious is it, whatever view and what are the potential approaches when it looks at it from a policy point of view. So I'll make sure that I feel that I've got, I'll wake up the people and make sure that I've got a good briefing for him by tomorrow morning. If I don't know the answers to any of his questions by tomorrow morning then I will tell him I will make a note of each question I can't answer I'll then work with this community and the large community and get back to him 24 hours later.

Former CSA	And the volcanic ash story was similar in so far as again, I knew the right people in the right place. I can find two stories out of that. One was this ash cloud was appearing and we hadn't got any sensors. We'd got satellites that were delivering certain types of information, but basically we needed an aircraft that could safely fly somewhere near this stuff and get some sensors on it. Now I used to be a professor at [named] University.... So I happened to know the guy who ran the whole of the aeronautics operation [at that university] so I rang him up and said what's happened to this aircraft. He said it's grounded. Its instrumentation is being changed. So I said so if we said here are the instruments we want on the aircraft and we want in airborne in 48 hours, what could you do about it? He said, yeah, we could do that. So I said, and what about the airworthiness certificates? And he said, well I'm the only person now who has the CAA licence to say this aircraft is airworthy but if that's you wanted to do, that's what I'll do. And that's what we did. I knew the right people, I knew where to go, I knew where the aircraft was and it was flying within 48 hours and we got data which allowed us to say Hmm. And it's got no sulphur in it, that means it's no medical hazard.

Civil Servant	In terms of gathering of evidence – what keeps coming up – it always comes down to people. It's always people providing the evidence and it's always human networks.

Former Minister	And another key person, if you're mapping it, was [name removed] who was Chair of Research Councils UK. By coincidence, another [city name removed] connection. So I had known him when he was doing his original demography/epidemiology at [city name removed] …we had mutual friends who I played cricket with. It is a funny world.

Interviewer	The people, the stakeholders you were involving, were they people that you had worked with before?

Former Special Adviser	Mostly. Mostly my network yeah. But then others. You know that it's a small circle and if you wanted to get into the network, all you had to do go to a handful of drinks receptions or policy events in Westminster and suddenly you're a face. And you're a name and you know the people and you can just get back and have a conversation.

Interviewer	How did you decide who to hear information from?
Former Special Adviser	To be honest, it was largely contacts and networks. And yeah. That kind of thing. But it wasn't so it wasn't always contacts in terms of oh I knew you from ages ago, come and tell me this. Because there would be so many people coming that it would be like, ok that seems like an important person to see.

Interviewer	How were people picked to go on those [advisory] groups?
Civil Servants	Erm. That's an interesting question. Largely through personal contacts I guess. So the CSA would know people who were experts in particular fields and he'd consult with them and they might be involved themselves, they might make recommendations for other people who were involved, so quite a sort of word of mouth.

One former minister went on to explain how their networks, and the networks of the expert he worked with, allowed them to manage controversy around a particular policy:

Former Minister	And I said we are going to need somebody to review [a field of science] in the UK. So this was before there had been any public fuss. And so by the time the announcement was made, I was able to announce that [name removed] was going to do the review. I was at the advantage of knowing him because he was the vice chancellor of [name removed] university. So [a senior civil servant] suggested him,

	gave me a ring and said what do you think about [name removed] and I went Hurray! And he did a fantastic job although there was a terrible period of time of criticism from the community and we ended up getting [former Royal Society President] to hold a dinner at the Royal Society in which I said, look, this is where we are. We've got [name] doing a report. You all trust him so call the dogs off because all you're doing is damaging British Science's reputation around the world. You can't shift anything here…. and it all died down then.

d. Public dialogue not seen as sources of expertise – but 'stakeholders' are.

In terms of how the public are conceived by policymakers, while civil servants and politicians saw them as a useful source of perspective, or at least as sense-checks, the Chief Scientists questioned whether the public were able to make sense of the issues at stake:

Former Minister	My feeling is that the general public out there is pretty smart. They can figure these things out. They need to be given the information.

Former CSA	I'm not sure how you bring in the average person on the street. I'm not sure. It's an interesting question. To what, I mean this sounds a bit snobbish I know, to what degree does the average person on the ground know what the issues are?

Former CSA	The reason for saying this is that there's no rationale in the public response to some of these things. It's not rational…
Interviewer	Does it matter if the public aren't rational though?
Former CSA	No. If the public aren't rational it doesn't matter, but if you expect them to be you end up in difficult places. It doesn't matter. Oh no, I'm not looking for rationality I'm just saying you need to work in a context where you understand what you're observing. Your model may be wrong if you think it's rational.

On the other hand involving stakeholders – organised groups of the public or organisations that represent the perspectives of the public (or particular parts of the public) – in decisions was seen as important. While this wasn't seen as unproblematic, there were two compelling reasons given why it was an effective approach. Firstly, this was to ensure that a range of views had been considered. This reason was particularly important in controversial areas (such as bovine TB), where there was a risk of a judicial review, in which evidence of having consulted with a range of stakeholders would be vital. Secondly, involving stakeholders was important in order to 'bring people along' with decisions. Building a consensus isn't necessarily the important issue here, rather than being accountable and sharing the decision process and rationale:

Civil Servant	We rely on getting a sense of what the public think is through groups who may represent groups of the public – NGOs, Charities, companies, or whoever. But that's not necessarily where the public are. And the Labour administration really kind of pushed the idea of consultations and that was a good thing. But did we really reach the public with that? Were the public really going to read a consultation on Defra's new water quality policy? Then there's got to better ways of doing it.

Former Minister	Well I think we were exceptionally good at what that horrible old term of stakeholder engagement. We did tend to not only in terms of regular meetings with the most important partner organisations in different portfolio areas, but also in terms of those sort of the real partnership working where you would develop policies with a group of people. In that situation, not everybody gets everything that they want all of the time, that's the nature of it, but I think we were good at developing policy alongside people rather than just piling it on top.

Former minister	The agriculture industry was beside itself with the slaughter of 23,000 cattle a year, the bill is rising, rising to over £100m a year to deal with that, and so there was a lot of pressure to make a decision but the civil servants were good because I said I'm not ready to make this

	decision. I don't feel I've exhausted every possibility and until I have I'm not going to make it. And I also want to hear from everybody who's got a locus on this before I reach that decision. It's going to be judicially reviewed because it's so controversial so I want to get this process absolutely right because the worse thing to do would be to make the decision and then to have made a mistake by not knowing a key fact, or making an error in how we made the decision. And to Defra civil servants credit, they really did the process extremely thoroughly and they we pushed back the timescale for making the decision and I met I think it was 23 different stakeholders on a full spectrum of, from don't you dare touch a badger through to the only thing to do is to cull the badgers. The full spectrum. And that was very important.

Civil Servant	How do you judge whether you've got enough around a particular intervention? It is a judgement call. I mean for that this is where you bring in engagement with stakeholders, engagement with the public, engagement with academics as to whether they feel that the proposals government is putting forward for what to do, based upon what we know, part of the evidence, whether we think the proposals are right, especially on hugely contentious issues where people are really polarised, we are never going to reach consensus, arm. Well, really if a government is doing its job right, laying out the facts about what is the situation and why we think an intervention will work. If we get enough people to agree with that and people can see clearly and transparently our train of thought our logic behind it then that's probably quite a positive place to be for rolling out a new policy.

When the public do need to be accessed directly, the ministers and civil servants described how this was via the politicians' and departmental mailbags and advice surgeries. Understanding public perspectives was thought to be built into the fundamental business of being a politician:

Interviewer	How do you know what the public is thinking?
Former Minister	Well it's interesting because of course they write to us. And the letter writing department within Defra of course keeps a close tally on the issues people write to us about. There were fewer letters about the badgers than there were about the forestry saga, so actually it's one way of measuring.

Civil Servant	But I think most successful politicians have the views of the public ingrained in their psyche. Cos that's, they've had to win public arguments to get elected in the first place. So every decision they make always will be floating around what will the public think because that's what wins and loses elections

Interviewer	How did you know what the public were thinking?
Former Special Adviser	I guess a few things. Firstly, we did get a regular opinion collections of analysis of polls and opinion surveys, so that came through the department. Second, I know it's a bit anecdotal but I was always impressed by the fact that our ministers spend every Friday talking to people. And that shapes a lot of their thinking, so it's kind of public opinion.

Civil Servant	But they are heavily, heavily influenced, ministers, by their personal correspondence. So one minister in particular in the time I was working on GM, I remember him saying that he was getting 50 letters a week about GM and they were all anti. So why should he even think about taking a positive pro-GM view? He was representing the people and they were writing to him. And you know not ignoring the fact that the minister's postbag is not representative, but that's the immediate thing that they are seeing in a very direct way of getting a sense of public opinion.

The interviews therefore not only support hypothesis 3 – that experts sources are valued in policymaking and that public dialogue is not seen as a source of expertise,

but it gives us a more detailed understanding of what is valued in experts. Policymakers appear to value substantive experience in the field and a knowledge of the subject, but this also appears to be evaluated on the basis of roles. In other words, it is having the appropriate job in a relevant institution, rather than expressing any indications of knowledge, that confers the status of expertise upon an individual. While it seems reasonable to suppose that the two are related – that these individuals are in those positions as a result of their knowledge – the interviewees give no indication that knowledge was evaluated or formed part of their assessment of suitability of experts.

Furthermore, in highlighting the importance of networks as sources of expertise, and the involvement of organised groups of the public in such networks and (therefore) in the policymaking process, the interviews put forward another explanation for why dialogue has little influence. The outputs of dialogue is not included in the policymaking process because it is not part of the network of 'stakeholders' from which policy advice is drawn.

Models of policymaking

Further to these three explanations for dialogue's limited impact on policy (conflicting sociotechnical imaginary; not expertise; outside networks) the interviews brought up a further idea that has some explanatory value in this context – that dialogue perhaps targets the wrong issues in the wrong place in policymaking.

While talking about evidence and public dialogue, although not all explicitly said so and few used the same words, the policymakers interviewed described a clear 'model' of how policy works – and a hierarchy of policy issues in particular. While different value judgements were made on this model (the CSAs tended to problematize it, the politicians and civil servants tending to be more matter of fact about it), it was implicitly described by all of the 'types' of policymaker interviewed.

a. Hierarchy of policy exists, from 'meta narratives' to 'specific policies'

To begin, the policymakers described a two (or three) tier structure in which there are 'meta narratives' that describe the overarching framework within which sub-narratives sit. Beneath that, comes the individual 'policies'.

The special adviser interviewed described this hierarchy most concisely:

Former Special Adviser	There are a macro narratives around like, the role of climate change or the role of nuclear, the role of the state and the private sector. And then within those there are a kind of sub narratives like the role of energy efficiency vs. the role of renewables and the role of technologies. And then within those there are specific policies, like what are we going to the do CERT? What are we going to do on fuel poverty?

b. **The meta narratives are set by the political party in power.**

One of the civil servants described meta narratives as 'the parameters' in which policymaking takes place.

Civil Servant	[a former science minister] is really interesting on this... People vote for politicians based on a sort of value framework and a kind of, they vote for a party because they know that party will make decisions in a consistent way. If a party simply started making decisions on the basis of purely evidence every time, as [the former minister] says, it would be way too unpredictable for voters and it would be chaotic. He likens political parties to research agendas – so you have the parameters of the agenda as set, but then you can play around inside those parameters a little bit more. So that's the first thing – the evidence is always in that kind of context.

c. Science won't overturn meta narratives but is powerful at a policy level

The distinction between political/meta-narratives and specific policies is important because it governs the extent to which evidence and public opinion can influence decisions. As the interviewees described, science can put an issue on the political/meta- narrative agenda, but public and political will is needed to allow policymakers to act on the issue. Science is unlikely to overturn a decision at the political/meta narrative level, as a former minister explains:

Former Minister	There were certainly ones where there… I can remember once I said to – and I won't mention what area this was in, which portfolio area – but I said, I need a briefing on all the options to resolve this. And some of the options that came back were frankly beyond the pale... And I instantly red lined those, and said I don't want to see this briefing until those are taken away from it. Go back and reconsider the other options on this part of the spectrum and give me more detail on those.
Interviewer	And why were they beyond the pale?
Former Minister	Politically unacceptable. Politically unacceptable. Policy wise, you could have done it with an ultra-right wing government. Politically, yeah. I just didn't even want to entertain the idea.

At the policy level, decisions will be made by balancing different sources of evidence with the politics of the situation and the delivery objectives. One of the civil servants and a former minister both put this well in describing how evidence, political objectives and delivery need to be aligned in order for policy to be acceptable:

Civil Servant	So, you can have the best most evidence-based policy in the world, but if you can't land it what's the point? The IFG have done a lot of work about this policy window and the stars really need to align quite often in order to get things through.

Former Minister	For example, one of the debates that we had must have been now about 6 years ago was on the langoustine, sorry the Northern Ireland nephrops fishery of langoustine. So the shellfisheries off Northern Ireland, and which also goes onto parts of NW Scotland as well. And the science at that point was saying one thing conclusively, that it was at such a point of overfishing that you'd have to shut the fisheries. Where do the politics come into that? Politics come into that because there are communities there which entirely rely on that fishery. And if you shut them down there are no communities anymore. And you're not going to suddenly give them a lump sum to sit and twiddle their thumbs. So that's where politics interferes with pure scientific based decision making. Policy of course is always a combination of the two.

It is at this policy level however, that scientific (and other) evidence and the public can put issues on the agenda and form the basis of a decision, provided it fits within the political narrative and politics:

Former Special Adviser	For example, water, south east incredibly water stressed. A lot of evidence showing we had less water per capita than Cyprus, huge pressure and the Thames gateway was putting enormous pressure on, so there was a big scientific argument in that favour … So therefore we needed to look at regulation so that people couldn't pave over their driveways or look at building regulations to make sure that homes were more sustainable both in terms of water absorption and usage. And then we had to fight the economic case with the other government departments who were coming from a different perspective.

d. There is a hierarchy of evidence

In this evidence mix, there also appears to be something of hierarchy of evidence – as well as science, economics evidence is very important, but even more so is legal advice. The earlier quote from a former minister about the need to consult

stakeholders in light of a risk of a judicial review illustrates this well, along with the following explanation from a civil servant:

Civil Servant	The economic advice would be quite up front in a way when it was put to ministers, for example. They would be interested in the costs and benefits of policy options. The science is almost used as the gatekeeper to get the policy options into play and then it's the economics and legal advice and things like that… Ministers don't like breaking the law…I think it's true that if they've got scientific advice that says do x and they've got legal advice that said if you do x then you've got a 50% chance of a legal challenge, then they wouldn't do it. Law would sort of trump the science, which is probably quite right.

Furthermore, ministers collectively (across departments and across government) make decisions at the political/meta narrative level, while policy could be developed by ministers or civil servants.

Former Minister	Any significant decisions, certainly, when I was a minister, were always round tabled and they would certainly be round tabled at ministerial level amongst all of the minsters and sometimes it would be round tabled at a senior board level as well at Defra.

Former Special Adviser	But don't forget. I was aiding and advising decision making. In addition the officials would be doing a lot of input and consultation and all of that, and that will be the primary source of information to the minister. They would get meetings with officials, briefings with officials, meetings with stakeholders themselves. What I especially did was just lubricate and supplement that add to it, sometimes guide and shape it.

e. But science presides in an emergency

Interviewees described how this situation changes during an emergency or crisis. Here the rules about politics appear to dissolve and much more focus is put on evidence. This is especially so when safety is at stake.

Civil Servant	And never waste a good crisis falls out of that. So usually when bad things happen, that's a trigger point for movement on a particular area. And you have to be ready for that as well.
Interviewer	Presumably the science was only part of the story [on volcanic ash clouds]. How do you think when it came to ministers looking at the science, how did they do that?
Former CSA	The science dominated because basically the CAA, who were given the responsibility of saying this thing can be where we can fly safely because they had the international authority to say where it was safe to fly, so [the Secretary of State] kept his hands off it. He knew that was the right place to be.

This implicit model is important when thinking about how the outputs of public dialogue can feed into policymaking, since it is often argued (by for instance Irwin, Jensen, & Jones, 2012b; Macnaghten et al., 2005; Stirling, 2007; Wynne, 2006) that an important purpose of public dialogue is to discuss the general direction of travel or shape of the world, rather than to comment on the details of particular policies and that dialogue should be discussing science and technology at an upstream phase. These direction of travel, upstream issues would appear to fall into the category of political or meta-narrative decisions and therefore be difficult to change on evidence alone and would definitely be those issues considered by ministers rather than civil servants.

In this chapter then, I have tested the hypotheses emerging from the text analysis that explain the impact of public dialogue on policy, using interviews with policymakers. Specifically I have tried to move beyond describing the tension between public and policy perspectives. In describing and analysing policymakers

views on public dialogue and other sources of evidence and expertise that are expressed in these interviews, I have aimed to develop a more detailed understanding and begin to theorise the institutional response to the outputs of public dialogue. In the next chapter I will consider this further and reflect more fully on what this means for public dialogue as a practice.

Chapter 7- Discussion and Conclusions

In this research, I set out to understand more about how public opinions and discourses influence the course of science and technological development. Specifically, I wanted to know whether the move in the UK to involving the public in decisions around science through a series of public dialogue events, has had any success in strengthening the public voice in decision-making around technoscientific issues. In particular, I was interested in the substance of the discussions within these dialogue events, not only to try to understand these questions further, but also to shed light on how we as a society learn to live with technoscientific developments and on how expertise and evidence is understood, valued and used in policy.

In this chapter I draw together the results presented in the earlier chapters and set it in the context of previous work in the field, to answer these questions and draw conclusions about the extent to which public dialogue has and could impact on public policy. I also reflect on the methodology used in this research. Finally, I raise a number of further issues for public dialogue which would be worthy of further research and set out some suggestions for how practice can be improved on the basis of this research.

Overall, I conclude that the public talk about new and emerging science and technologies in a way that is very different from the way in which experts and policymakers discuss the same subjects. In particular, the public see the social and ethical issues and concerns arising from technologies as inherent to the technologies themselves, while the experts and policymakers see them as external epiphenomena. I argue that these different ways of talking about science and technology are both a result of and a reflection of two different socio-technical imaginaries that I have identified – a dominant 'elite' imaginary of 'scientific progress', which is shared by policymakers and scientists, and a counter-imaginary of 'contingent progress' which emerges from the public discourses. Since these imaginaries both shape and describe how science and the role of the state is seen, the public imaginary and discourses are seen as oppositional, but are also difficult to accommodate within the 'machinery' of policymaking and so have limited influence. Furthermore, public dialogue exercises are not seen as a source of

expertise, nor are they part of the networks that influence policy, further limiting their potential to influence policy.

Using a computer assisted text analysis system to looking across the outputs of public dialogues however shows that the dialogues do generate some interesting discussions and that the public do have contributions to make to public policy around science and technologies. To increase impact, thought needs to be given to the type of decisions that dialogues seek to influence, to engage policymakers in discussions about the sociotechnical imaginaries that are shaping their perceptions of policy and the public, and to ways in which public dialogue can be brought into policymaking networks and coalitions.

So what has been the impact of public dialogue?

1. Dialogue offers insight into public perceptions

To begin, it is clear that the dialogue events have been successful in exploring public perspectives and provide a rich source of insight into how the public talk about and come to know new science and technologies.

By looking at the content of the reports of public dialogue events over the last 10 years, I have identified a series of public discourses around new and emerging science and technologies (Class A1: Drugs: cure or cause for medical or social problems?; Class A4 Challenging our way of life; Class A2 Reaching potential whilst minimising risk; Class A3 Precautionary in principle; Class A5 Messing with nature – where do we draw the line?). By comparing these discourses to those that were produced by the analogous analysis of 'expert' documents, I have identified a number of features unique to the public discourses:

a. The public express an optimism towards science that is tempered by a sense of contingency;
b. The public discourses cluster around particular groups of technologies, rather than being 'generic' for all science and technology, or specific to each technology;
c. Social and ethical implications of new scientific developments are considered to be inherent parts of the developments;

d. The focus of public discourses is on people rather than technologies;
e. Nature plays a key role in shaping conceptions of the acceptability of technologies and in the way they should be regulated;
f. The public see an active role for government in controlling the direction of research.

Others have previously identified individual aspects of the analysis I describe, but the statistical methodology I have adopted has enabled me to look at subjects side-by-side and to focus on what was said rather than any institutional framing or normative assumptions about the dialogue process, thus bringing new insight to the material. Comparing public and expert discourses has also allowed patterns to be identified that others have not recognised. For example, MacNaughten and Chilvers (Macnaghten & Chilvers 2014) have carried out a similar analysis of public dialogue reports, but focusing exclusively on ScienceWise dialogues from a marginally different timeframe and carrying out the analysis by hand. They identified five cross-cutting themes which they argued were strongly affiliated to which of three 'models' of public engagement had been employed. While there was some overlap between the themes they identified and some of the issues arising in my discourses (for instance, they identified the speed and direction of research as a key public concern), their groupings did not map onto my discourses, suggesting that the groupings that I have identified are not a manifestation of the type of dialogue being undertaken but reflect different discourses that are taking place regardless of the style of dialogue being undertaken. Supporting that point, Chess and Purcell's review of empirical evidence of the success of different participatory techniques concludes that "factors other than the mechanism for the participatory process undoubtedly account for variation in public participation success (Chess & Purcell 1999).

a. Contingent optimism

Firstly, the public discourses conveyed a sense of progress and optimism about science, especially biomedical science, but this was coupled with a strong sense of contingency. The public understood that there are good sides and bad sides to every technology. How they felt about a particular science and technology therefore depended upon how it was being used and the special circumstances of each case,

rather than an inherent quality of the technology. The direction that the technology was taking society and the morality of the research (particularly in relation to human embryo research) were also important in guiding discussions. As such then, the public discourses did not tend to form simple judgements of technologies, but instead to suggest that more information, consideration of different angles or perspectives and a balancing of different interests and needs was necessary.

This is somewhat in contrast to the expert and policy discourses, which were more positive and aiming to enable the science to happen. While the expert discourses highlighted possible benefits to come from these technologies – particularly in providing cures to terrible diseases and growing the economy. The policy discourses tended to assume any benefits beyond economic ones as given. Policy discourses rarely discussed the application of particular technologies – more science was by its nature seen to be a good thing. Concerns or risks were acknowledged as public concerns, but were treated as obstacles that need to be addressed or overcome (I will discuss this further later).

b. Clusters around technologies

Secondly, the public discourses group around particular technologies. Specifically, I found distinct discourses around drugs (Class A1); technologies with biomedical applications such as stem cells, nanoscience and synthetic biology (Class A2); non-biomedical technologies such as geoengineering, the UK DNA database, energy and non-medical applications of nanoscience (Class A3); technologies that work with the genetic building blocks of life, such as synthetic biology and GM (Class A4); and those which involve combining human and animal material, such as hybrid embryos (Class A5).

This pattern of classes suggests that people talk about different 'types' of technologies in different ways. This is reinforced by the analysis and interpretation of these classes. In particular, depending on the technology being discussed, people appear to express different levels of optimism/sense of progress, different types of concern, and different conceptions of nature and see different kinds of regulation as necessary.

While none of the discourses were outrightly hostile to the technologies in question and all expressed a sense of balance and contingency – that it all depended upon the use, circumstances and future information – the discourses around biomedical applications of stem cells, synthetic biology and nanoscience were the most positive. Other technologies generated a greater sense of scepticism, questioning whether they were really moving us forward. Discussions around drugs, for instance, questioned whether they were masking rather than addressing the real problems; questions around environmental technologies asked whether they had the potential to make things worse.

The types of concerns expressed also appear to be tied to the types of technologies. For biomedical sciences, the concerns related to the involvement of the private sector and whether this would distort the focus of research into more profit making developments and whether this might make treatments beyond the reach of some. On more environmental technologies such as nanoscience and geoengineering, the concerns were around hazards, and moral hazards in particular – whether or not the technologies were taking us down a path we wanted; GM and synthetic biology raised concerns around safety, the environment and the sense of science (and the future it gives us) being out of control; and on human embryology research, concerns focused on morality and whether it is right to carry out this research.

The conception of nature evoked also varies according to the technology discussed, and perhaps drawing on that, so does the type of regulation being considered or asked for. For instance, in discourses around human embryology such as human-animal hybrid embryos nature is seen ontologically – as a state of being – and regulation seen as a moral matter; in discourses around non-biomedical technologies such as geoengineering and nanotechnology, nature is seen in ecological terms – as a balanced system within which we can't predict the effects of man's influence, with regulation seen as a matter of government policy and control; and in discussions of genetic research such as GM crops or synthetic biology, nature is spoken of in deontological terms – as a binary rule or law that we must obey or face the consequences, and nature itself is seen as the regulator – bringing revenge on those who break the natural laws.

Others have argued previously that people don't have attitudes to technology in general but have specific attitudes to particular technologies – for instance Evans and Durant (Evans & Durant 1995b)(Evans & Durant 1995a) discussed how people feel differently towards medical and other sciences; Bauer and Gaskell have described the difference in people's attitudes towards 'green' and 'red' biotechnologies (Gaskell et al. 2001). But by looking at public discussions of various technologies collectively, this analysis has shown that people don't just have different attitudes to different technologies, but they also talk about technologies in different ways. It is not just that they feel different levels of support for different technologies, but they also identify different issues of concern. Importantly, these different attitudes and ways of talking appear to cluster or group in a particular way. This is also perhaps a more nuanced and detailed interpretation of the ScienceWise outputs than that of Chilvers and Macnaughten (2014) who concluded that there were five spheres of public concern expressed in public dialogue reports: the purpose of science; trust; inclusion; speed and direction of innovation; and equity. It is reasonable to argue that these themes were present throughout the discussions, but the way and degree to which they were expressed varied according to which cluster of topics was being discussed – equity and inclusion seemed to be more important in clusters around biomedical sciences while speed and direction in discussions of environmental technologies, for instance.

The way in which the public discourses 'cluster' around groups of technologies appears to be consistent with previous work that found that the public created and used a mental dichotomy or schema to help them assess new technologies. For instance, my previous work with Simon Lock (Lock et al. 2014) looking at how the public come to understand climate change technologies, found participants in focus groups using nuclear and wind power as the two 'yardsticks' by which to size up new technologies like carbon capture and storage, with views and concerns about the new technology following those associated with the existing technology that the new one was judged to be most 'like' (Lock et al. 2014). It also supports the argument that the public use cognitive 'heuristics' to judge new technologies, drawing on their previous experience of other technologies to create historic analogies to guide their decision making around new technologies (Scheufele & Lewenstein 2005; Currall et al. 2006; Upham & Roberts 2011; Slovic 2010).

Importantly, these clusters of technologies suggests that there is little basis for the concerns frequently expressed by the scientific community (for instance in the introduction to the House of Lords 2000 Science and Society report) that we are seeing a crisis in public confidence in science and that public anxiety over GM represents and outright rejection of technology. GM is a particular technology, that acts in particular ways and is discussed in a particular way. Other technologies are discussed much more enthusiastically, so direct parallels cannot be assumed. However, discussions of synthetic biology do appear in the same discourse as discussions of GM, which suggests that this could be an area of concern in the future.

c. Risks and ethical concerns inherent to technologies

The clustering of public discourses around technologies also means that when the public discussed the technologies, talk of uses, risks, benefits and regulation were all tied up in the same discussion, rather than forming separate classes. This creates a clear distinction between the public and the expert and policy discourses, with the public seeing the social and ethical issues as inherent parts of the technologies themselves, while the expert and policy discourses treat these issues as epiphenomena that can be separated from the technologies and dealt with. Indeed, these different ways of seeing the relationship between science and social and ethical issues – and therefore science's role in progress – is at the heart of the differences between the public and the elite sociotechnical imaginaries.

In the public imaginary, progress (which is particularly evident in biosciences' ability to produce cures) is tempered by a perception of the contingency of science and an understanding that the risks and social and ethical issues arsing cannot be disentangled from the science or technology itself. Balance is also an important metaphor used through the public discourse – technologies like synthetic biology are seen to be both exciting and scary and that good governance is about balancing these benefits and concerns. For the public then, while science represents progress, it has also caused some problems too. And these problems are inherent in the technologies themselves.

In contrast, the ‘elite’ imaginary sees science as a force for progress which is not simply focused on ‘cures’ but which can bring about wider changes and address the really big problems ahead – including national dominance and increased productivity. Social and ethical issues are to do with public perceptions or insufficient scientific knowledge. They are either not worth worrying about, because the technologies of concern are no worse than the current technologies in use, or these concerns can be dealt with by information or more research. The problems can be managed away, allowing the science or technology in question to fulfil its potential.

A clear illustration of these different perspectives in action was found in the policy discourse around human-animal hybrid embryos (Class C2). For the public (Class A4), this was a very moral matter. And at the heart of deciding whether or not it was research that should go ahead was a question of whether these embryos are human or animal. Rather than being a categorical or ontological question that needed to be settled however, the public discourse suggested that the act of raising and considering the question was important in helping people come to terms with this technology.

The policy discourse however recognised this concern raised in the public dialogue events, but were keen for it to be settled as swiftly as possible, in order to decide which body should regulate this research – if they are human embryos, then the HFEA would be responsible but if they are animal embryos, then it would be the Home Office. In order to resolve this practical question of regulatory responsibility then, this question, which was a very moral matter for the public, was turned into a legal matter upon which a judge could rule.

These two different discourses and approaches appear to have strong overlaps with Beck and Gidden’s two notions of risk (Beck 1992; Giddens 1994). In the first notion, risk is ‘no more than a part of an essential calculus’ (Beck 1998). It is seen as a statistical operation which promises to ‘make the unforeseeable foreseeable’ (Beck 1998). This matches very strongly with the rhetoric within the expert and policy discourses, which seek to quantify and deal with risks ahead.

Beck argues however, that as nature has become permeated by industrialisation, we are now in a new phase of 'manufactured uncertainty', where 'the production of risks is the consequence of scientific and political efforts to control or minimise them' (Beck 1998). This conception of 'manufactured uncertainty' appears to have strong echoes of the public discourse.

Hilgartner (2000) and Latour (Latour, 1987, Chapter 1) have pointed out that scientific texts use the rhetorical technique of anticipating reader's objections and trying to demolish them in advance. It is possible that this is shaping the experts' tendency to provide reassurance and close down debates around risk. Rather than representing an underlying belief that this science can do this, it reflects perhaps, a belief that policymakers want to be reassured and to be presented with certainties. Cook's work looking at scientists' attitudes to the GM debate (Cook 2004) found a similar tendency to perceive decisions around introduction of GM technology as entirely safety oriented and based on a rational choice model, however. He describes how the scientists' focus was almost exclusively on a cost benefit analysis of assessable safety issues relating the health and the environment, with no reference to unforeseen risk. Since these views were expressed outside a policy setting, they suggest that this tendency to separate and manage risk is not simply meeting expectations. It is also of obvious use to scientists and policymakers. The message is compelling – given the responses and opportunity to address these matters, it is possible that science can proceed in a manner that is satisfactory to everyone. There is nothing to worry about here.

This understanding is however problematic. It cuts off scientific practice from public wishes – the opposite of the aim of public dialogue and the more recent move to responsible research and innovation. This tendency to close down concerns is also likely to be problematic in the longer term because of the impossibility of the task – as Beck has argued, the social and ethical concerns around new scientific and technological developments are inherently bound up with these technologies – they cannot be separated out as they are a product of those technologies.

Nevertheless, these different understandings have significant implications for public dialogue's impact on policy, which I will discuss further below.

d. Focus on people

In the public discourses, in each of the classes people (rather than the technologies) were the focus. This contrasts with the science/technology focus of the expert discourses and the much broader spread of the policy discourse across people, technology, government and the economy.

Arguably these different foci simply reflect the different roles taken by each of the groups in the discussion. But the 'people' focus that the public discourses adopt, while unsurprising, does raise some questions about the credibility of this evidence.

Hilgartner (Hilgartner 2000, p.8), who looked at scientific advice through the metaphor of 'performance', argued that scientific advisory bodies use their technical knowledge to display competence and credibility and therefore win the confidence of audiences. Its presence in these reports could therefore be seen as a rhetorical device that instils the experts authoring the reports with authority by reinforcing the privileged and expert nature of their knowledge.

At the same time, the public discourses' focus on people rather than technology could be deepening the perceived differences in credibility between the two sets of reports. Cook (2004), talking to GM scientists involved in public engagement activities, reported that the public were seen to be making emotional (rather than rational) assessments of technologies, and to therefore be being vulnerable to manipulation by the press, NGOs and politicians. Not only is the scientific focus and language of the expert reports giving real and rhetorical power to the expert discourses, but the public discourses alongside run the risk of looking emotional rather than rational – and therefore vulnerable to manipulation by the press, NGOs and politicians (Cook 2004). This perception was reinforced by some of the documents in the policy analysis – the report on human animal hybrid embryos for instance made a distinction between religious and scientific objections to the technologies. Comments made by policymakers in interviews also reinforced this – one of the former CSAs kept referring to value-based judgements as 'faith based', arguing that is was the role of academics to rise above that and make rational choices, for instance.

Unwittingly then, by focusing on people and social and ethical issues, the public discourses might be reinforcing the perception that that the public's views on new technologies are irrational and susceptible to change – and therefore not worth building into policy. This is a point worth further consideration when thinking about how dialogue can have more impact on policy.

e. Role of Nature

Nature is a key concept in shaping views about technologies – and not just in discussions about environmental technologies. I have described above and in Chapter 5, how the public discourses express three different concepts of nature, and these concepts appear to at least influence how people think about regulating particular science and technologies, as well as the limits that should be put upon these areas of research.

This role of nature in the public discourse is in contrast to the 'elite' discourses which do not engage with the concept of nature in the same way – for the experts, 'natural' is a technical term to refer to non-GM strains of plant or animal and in many instances is a term used to refer to a less favourable situation. In the policy corpus 'natural' or 'nature' does not appear in any of the discourses at all.

Others have previously identified a role for the concept of 'nature' or 'naturalness' in the public's conceptions of technologies and risk. For instance Corner et al (Corner et al. 2012) found that a key factor driving public perceptions of the acceptability of different geoengineering procedures was the extent to which a technology was perceived as supporting or imitating natural processes. Lock, Smallman and Rydin (2014) found that a sense of 'naturalness' equated with a sense of 'good' when considering climate change technologies; Jasanoff (2005) describes how 'modern' and 'unnatural' became closely linked during the UK's BSE crisis, with this connection later fuelling negative perceptions of GM; Wagner et al (Wagner et al. 2001) found that expressions relating to 'tampering with nature' dominated focus group discussions about the dangers or hazards associated with GM, concluding that "the public debate on biotechnology is in fact deeply influenced by polarised views of nature". Furthermore, they identified two perceptions of nature – spiritual, where nature is seen as an animistic or spiritual force – and un-spiritual, which the

authors describe as quasi-scientific, seeing nature as a complex and uncontrollable force. Importantly, these understandings of nature are described as 'polarised' and 'parallel but diverging representations' one or other of which people use as a frame to argue about GM. In other words, people hold one understanding or another of nature, which shapes their views of GM. The discourse analysis does not suggest that this has happened in this case. Instead, the conceptions I have identified are much less value frames and more understandings that people are able to switch between according to the technology under consideration.

So while earlier works have described different and competing conceptions of nature, some of which map onto one of the three conceptions identified here, the precise nature of each conception, their coexistence and association with different technologies is new. This finding, I argue, has come out of the methodology I have chosen to use. While the individual concept of nature have been identified by case studies, it is only by looking across the subject matter and seeing the three concepts discussed side-by-side, that the distinctions and the extent of the conceptual differences becomes apparent.

f. Active role for government vs. industry

The public discourses also assign a particular role and agency to government – of controlling the direction of research and the influence of industry, to ensure social goods. Industry is however only mentioned in the discourses about biomedical developments and GM (classes A2 and A4). When it is discussed, it is seen as primarily motivated by the need to make a profit. This isn't necessarily considered to be a bad thing, but it is seen as something that needs to be controlled as it could be a distorting influence that takes research down the wrong path and puts the price of drugs and technologies out of reach for some. The role of government is seen as a counterbalance to this.

This is in contrast to the expert and policy discourses, in which whole classes are devoted to the importance of industry – both in supporting science but also as beneficiaries of science. In fact, as I will discuss further later, this economic perspective appears to be the key driver for the elite discourses. Importantly, the role of government is also seen very differently in these elite narratives – in the

expert reports, the main role for the state appears to be in providing the funding and infrastructure for research and innovation. Existing regulation is described and while areas for further research are highlighted, no areas for further regulation are discussed. The policy documents, unsurprisingly are much more focused on the role of the state in regulating science, but again, the tendency is to describe existing regulation and reflect on whether this was sufficient or not, the sub-text being that the role of the state is to provide support, ensure no harm is being done and then move out of the way.

This policymakers' perception – that it is not their role to actively be involved in the direction of research – has also been found by others. For instance, Macnaghten and Chilvers (2014) recently interviewed senior staff in UK-based science organisations and found that neither the purpose nor the directionality of science and technological development were seen to be major issues for reflection. "The good purpose of science was automatically assumed and presented as self-evident." (Macnaghten & Chilvers 2014). It is also the basis of the "Haldane Principle" at the heart of UK science policy, whereby the state provides the funding and scientists decide how best to spend it. It does however present a particular problem for public dialogues looking to influence policy as on one hand there would appear to be no levers to enact this particular public request, while on the other hand, as I and others (for example Evans & Durant, 1995b; Gaskell et al., 2001; Macnaghten & Chilvers, 2014) have shown, the direction and purpose of scientific developments are key to their public acceptability, and trust in government hinges on its ability to act in the public interest. This presents a potential flashpoint in the future.

2. Rhetorical problems within dialogue

Having acknowledged the insight gained from dialogue, this research however, has revealed two functional/rhetorical problems within the dialogue processes examined.

In Chapter 4 I have described two rhetorical devices – 'hyperbolic framing', whereby extreme conditions are used to exemplify the use of a new technology and to test

public attitudes; and 'abstracting', whereby report authors argue that people aren't worried about the technology in principle but have concerns about particular applications. While these devices appear to be used in order to help bring abstract aspects of science and technology to life, especially when involving the public in 'upstream' discussions, together, both these devices appear to give the public very little room to disagree or object to a technology. Objections to the principle of a technology are neutralised by arguing that the public accept particular applications. Similarly objections to particular applications are neutralised by arguing that the public accept the technology in principle. This (unwittingly) creates a situation whereby nothing can be objectionable and there is no option except to conclude that there an apparent acceptance of the technology being discussed.

Furthermore, the process of making a technology real enough to be discussed in the dialogue, which usually draws upon the expert imaginaries (which are themselves normative), also fixes the participants' understandings. Descriptions of the potential of a particular science, given in a dialogue to help the public make sense of an abstract concept, by the end of the dialogue have become a description of the purpose of a particular science. Conversations about potential uses of technologies are then transformed into discussions of conditions for use of a particular technology and very little room is left for any concerns to have status as anything beyond epiphenomena.

This tendency to frame the discussion in terms of the dominant imaginary and to create difficulties for the public in expressing any objections or departures from that imaginary has implications for this research. In particular, it suggests that differences between the public and elite imaginaries are likely to be underplayed in the dialogue events and subsequent reports – the rhetorical devices involved acting to mask differences. This would counterbalance any tendency to emphasise difference inherent in the IRAMUTEQ methodology.

It also raises important questions about the purpose of dialogue – and whether it ever can be valuable in broadening the perspectives from which scientific decisions draw, bringing the process of co-production into the open, making science more socially robust or democratising science. Thorpe and Gregory (Thorpe & Gregory 2010) have argued that contrary to the motivations around democratisation of

science that have been driving forces behind making public engagement a legitimate (and increasingly perceived as necessary) activity, public dialogue programmes potentially operate as forms of control and 'co-optation' that effectively promote and shape the public as markets for new technological products. Looking at the discourses within the public dialogues here, they also appear to be playing a role in fixing the meanings of yet to be real technologies – not just for the public, but for the scientist and policymakers involved too. In a dialogue, stem cells move from being invisible cells in a dish in a lab, to cures for cancer or spinal injuries, for example. Furthermore, I would argue that the public have little choice but to support the scientific narrative of progress being presented to them. At best the dialogues are providing an opportunity for the public to outline the conditions for acceptance of technologies that are going to be developed.

This is both a conceptual and methodological issue, but one that it will be important for new developments – such as the European move to Responsible Research and Innovation, which focuses on aligning the outcomes of research with the values of society. If upstream engagement is the important focus for public dialogue, then ways need to be found to create a space where the realities of science are discussed – where the banality of the majority of applications of science are admitted and where we can move away from the 'cycle of promise' (Brown et al. 2003).

3. Little evidence that public discourse has influenced policy

As I have described in Chapter 6, the analysis of discourses suggests that some account is taken of the outputs of public dialogue in policymaking – not least because there are specific mentions of the public concerns being raised in dialogue events and to the Sciencewise programme. In particular, public dialogue appears to be seen as a useful way to identify potential social and ethical issues for policymakers and experts alike. The policy discourses also share with the public discourses the recognition of uncertainty around science and the need to anticipate and monitor for unforeseen consequences that might emerge from new sciences and technologies.

But, by comparing the discourses and sociotechnical imaginaries within the public dialogue, expert and policy documents, it is clear that the overarching viewpoint of the public is not reflected in the policy documents. In fact I have described two 'competing' sociotechnical imaginaries – an elite imaginary shared by the scientists and policymakers, in which science is key to generating financial wealth and where social and ethical issues as epiphenomena that can be managed away; and a public counter-imaginary that takes a more sceptical view of the role of industry and understands the up and downsides of science as two sides of the same coin.

The policy documents and interviews with policymakers also show a clear preference for 'expert' advice. Expert sources are frequently mentioned in the texts and interviews; when the public perspectives are taken into consideration, the issues raised are converted into 'expert' matters by looking at social and ethical issues as questions of risk or legality; 'Expert' verification of public perspectives is also frequently sought. This is not to say that public concerns are not of interest to policymakers, but the public are usually accessed via 'stakeholder' groups – NGOs or consumer groups, who arguably act as 'expert publics'.

Whether this preference for 'expert' publics is a matter of expertise or networks will be discussed further later, but from the interviews with policymakers, it appears that at least part of this is due to public dialogue events not being on policymakers' radar. Indeed politicians, in particular, appeared to be confused about the purpose of public dialogue. This was perhaps surprising given that at least one had had overarching responsibility for the ScienceWise programme. Those who were familiar with it saw its purpose as being to educate the public and bring them round to the scientific way of thinking, which, as I will discuss later, may be a fair reflection of the reason why such programmes are supported at a political level, even if they aren't the reasons given by others.

In contrast, dialogue did appear to have had some impact on the civil servants interviewed, all of whom had been involved with at least one ScienceWise activity. Nevertheless, they were still unable to articulate the impact that these dialogues had had in any concrete way – at best it reinforced what they had been thinking already.

This conclusion is largely in-keeping with the findings of other evaluations of the UK's public dialogue activities, with others finding little evidence for significant impact. Macnaghten and Chilvers (2014) interviewed civil servants about their institutions' response to ScienceWise outputs in particular. They concluded that "Public engagement activities were seen to have had marginal impact on core business…most respondents saw a limited role for active public involvement in organisational decision-making." ScienceWise itself has undergone two recent evaluations. The first (Warburton 2011), which covered the time period considered in this thesis, was more enthusiastic than Macnaghten and Chilvers, claiming that there was evidence that ScienceWise public dialogue projects had influenced policy decisions and plans, improved policy and decision making and helped policymakers gain new perspectives and insights. But the examples given to illustrate these impacts do not indicate that they found much more impact than this research has found – they generally highlight how the issues and concerns raised in the dialogues were mentioned in the policy reports and how policy makers were more committed to involving the public in future policy discussions as a result of their initial involvement with ScienceWise. The more recent evaluation (Risk and Policy Analysts 2015) quantified the impact of the dialogues and concluded that 50% of the dialogues looked at had influenced the development of new decision making processes (i.e. had resulted in commitments to involve the public in discussions in the future); 50% had resulted in increased knowledge for commissioning bodies about the nature of conflicts; 35% had fed directly into policy. The evaluators did point out however that in these 35% of dialogues that had influenced policy, the public findings had agreed with the commission body or expert viewpoint and "that it was unclear what impacts may have resulted in the event that there were significant disagreements".

At best then, public dialogue is useful to policymakers in supporting expert viewpoints or identifying future areas of conflict or concern. Given the importance that has been put on the move to public dialogue in the UK over the last 15 or more years – developed in response to a perceived 'crisis in public confidence in the government's use of science' (House of Lords Science and Technology Select 2000) and quickly establishing itself as the only response to such a perceived crisis – such impacts appear to be incredibly modest.

4. Reasons why public dialogue has had limited impact.

As I explained in the introduction, others have concluded that dialogue has had limited impact because of the lack of reflexivity of policymaking institutions and their dominance by technocratic viewpoints (Wynne 2006; Macnaghten & Chilvers 2014; Stirling 2007). There has also been a tendency to focus on evaluating the process of dialogue, as a proxy to more substantive matters about impact – for instance, MacNaghten and Chilvers's work (Macnaghten & Chilvers 2014), looking at the institutional effect of ScienceWise, focused on how different types of dialogue processes link to policymaking. Recent work by Emery et al (2014) proposes a range of criteria to increase the policy impact of public engagement, all of which are process matters. In this research, I have gone beyond pointing to institutional structures for explanation, to begin to explain why such institutional structures and arrangements exist and cannot accommodate public perspectives.

From the outset, I have been clear that while the process of dialogue must be relevant in answering the question of why the impact of dialogue has been so limited, it cannot tell the whole story. The substance of the discussions, the way it is seen and understood by policymakers and how this 'evidence' fits in and competes with other sources of evidence must be important.

With this as the starting point, in the next section I will draw on my analysis and interviews, as well as STS and political science literature, to try to explain some of this lack of impact. I will argue that the output of public dialogue has had limited impact because it presents a vision for the future of science and society (sociotechnical imaginary) that is significantly different to that of the 'elites' and which is misinterpreted by elite audiences as opposition. Partly as a consequence of this, the nature of the public discourses and the perceived status of public dialogues, the outputs of public dialogue are not seen as sufficiently robust evidence to base policymaking upon. Furthermore, the way in which public dialogue activities are commissioned and managed means that they are outside the policy networks or advocacy coalitions that constitute influence in policy.

a. Different visions for the future of science – competing sociotechnical imaginaries

I have already described how the public dialogue reports have expressed a sociotechnical imaginary that I have labelled 'Contingent Progress', which is subtly but significantly different to the 'Scientific Progress' imaginary of the expert and policy documents. I have also argued that in light of this, there appears to be a public 'counter- imaginary' that is competing with the dominant 'elite' imaginary.

John Dryzek, in his work on looking at the outputs of consensus conferences on GM foods in six different countries (Dryzek et al. 2008), characterises the situation he has observed as "Promethean Elites Encounter Precautionary Publics". He claims that deliberative publics always express worldviews of a 'precautionary' character, views which are consistent with Inglehart's (Inglehart 1990) postmaterialism, in which quality of life, freedom and participation take precedence over quantity of material goods, security and social order. Policy 'elites', constrained by their priority to ensure economic competitiveness in a globalizing world, are, in contrast, 'promethean' – having faith in the capacity of humans to manipulate complex systems for their own advantage and valuing material prosperity and economic efficiency as instrumental to further problem solving. These two 'worldviews' are generally at odds and irreconcilable with one another, as large costs would be incurred if a state departed from promethean facilitation of technological innovation, diffusion and adoption, he argues. Put most simply, the public and elites value different things and therefore have different views of the future and science's role in it, particularly whether or not science and innovation is a force of progress or a source of problems.

My analysis suggests that the public and expert imaginaries do not split into 'Precautionary' and 'Promethean' quite as neatly as Dryzek has found in the case of GM foods. Dryzek's 'Promethean' outlook appears to go further than the 'science driven progress' elite imaginary identified here. In particular, in Dryzek's promethean worldview "Ecosystems impose no real constraints on human activity – in particular on economic growth" (Dryzek et al. 2008). Such an extreme position was not evident in the expert discourses – even in the most robustly pro-science discourse (Class B5 – Growth, economy and the planet), economic and scientific development was not discussed with disregard to the wider environment – indeed solving

environmental problems was seen as one of the key objectives of science for the future.

Similarly, while the public discourse around GM foods identified in Class A4 was very similar to the 'precautionary' worldview that Dryzek ascribes to his public, the overarching public imaginary was less so. The public imaginary shares with the expert imaginary a sense of scientific progress and there are instances, particularly around biomedical sciences, where the public discourses show evidence of enthusiasm for some risk-taking and a fear of stagnation and loss of impetus as a result of over-precaution. Furthermore the economic value of science is also recognised, albeit tinged with a concern that this could be a diverting force.

Moreover, the differences that I have identified between the public and expert sociotechnical imaginaries are more subtle and profound than simply a clash of values. The differences in imaginaries stem from very different perceptions of science, how it works and how it can be used.

In particular, the public understanding that the role of government is in tempering the influence of industry, gives an important clue to why public discourses have limited impact on policy. It is possible that the counter-imaginary is at odds with the objectives of the policymakers and therefore discarded. The House of Lords Science and Society Report (2000) (Chapter 5) hints at this possibility in saying from the start that "to prohibit science from progressing without express public support in advance would be retrograde and repressive, and would stifle creative scientific research or drive it overseas. This is not what our recommendations are intended to achieve."

My interviews with former ministers throw further light on this, by showing how the economic mobilization of science and technology has not only become the dominant thrust of science policy, but also the dominant thrust of economic policy. They also described how they were involving scientists in this view by encouraging them to think about their research in economic terms, in return for continued financial support. Within this situation, which has been termed 'the Schumpeterian Competition State' (Jessop 2002) the focus of the role of the state is to secure

national competitiveness on the global market not just through the promotion of innovation but also through the social and economic conditions for innovation.

In this context, Thorpe and Gregory (2010) argue that any attempts to influence technoscientific trajectories – as the alternative sociotechnical imaginary presented by the public in these dialogue reports arguably do – tend to be conceptualised as 'resistance', and perspectives which need to be 'brought around'. Public engagement activities, they argue, tend to construct a confrontation between an 'anti' public and 'pro' experts, with the public always holding the negative position and the approach to consensus or even mutual understanding seen as needing to bring people around to the inevitable.

Ben Hurlbut (2015), in considering responsibility in synthetic biology research, describes a similar mechanism for excluding public imaginaries, but one that focuses on the power of the scientific (rather than policy) imaginaries in shaping policy trajectories. He argues that in describing the problems that synthetic biology can solve, synthetic biologists are also taking authority to decide what challenges need to be addressed, what sociotechnical futures are considered good or bad, and what promises should be made. This puts a responsibility on society not to stand in the way of these future benefits, presenting social and ethical issues as 'epiphenomena'. This has the effect of rendering 'moral deliberation subsidiary to authoritative imaginations of technological futures'.

Both of these descriptions paint a picture of reinforcing power and interests that combine to make public imaginaries of more contingent or careful progress problematic. The power of scientific imaginaries to decide our future is reinforced by the policymakers understanding that science and innovation will deliver our Schumpeterian competitive future. Any views contrary to that are undermining the power of science and the hope of a better future and therefore need to be minimised or addressed.

This interpretation appears to provide a reasonable explanation for why public dialogue has so little influence on public policy, and is certainly in keeping with the accounts given by former science ministers, as well as more historic work around the emergence of an iron-triangle between science, industry and government

(Adams 1981; Pielke 2002) and of the way in which science is embedded within 'working worlds' that generate both questions and support for science (Agar 2013). But it does not tell the whole story, for a number of reasons. Firstly, to construct the public discourses and imaginary expressed in the dialogue reports as being 'anti' science or holding back development would be a distortion. It is not that the public imaginary and discourses are more or less positive about science, they have a different understanding of how it sits in our world, the role it fulfils and how it should be governed. It is not a binary decision for or against particular sciences, nor even a challenge to the basis of the Schumpeterian Competition State. Rather, the public is providing a qualitative assessment of the extent to which this is desirable and the circumstances under which it would be so.

Secondly, interviews with policymakers – civil servants in particular, but also ministers who deal with policy that makes use of science (rather than those making policy about science) – indicated that they were not constructing public opinion as being simply against science. They expressed an appreciation of the nuances of the public discourses, with one civil servant even arguing that this strengthened the evidence base. They nevertheless admitted that it was difficult to build such views into policymaking – both because of the 'level' at which decisions are made and because of the process of making a decision.

To explain that further, the policy model that interviewees described involved a hierarchy of decisions, with those big picture matters, relating to the shape of the world and the broad framework within which policies need to fit, being made by politicians through their negotiations within political parties and at the ballot box. Any public (or indeed expert) views that aimed to influence such decisions would not have any success outside the political processes.

The policy discourse analysis in particular also showed a preference for dealing with social and ethical issues as epiphenomenal matters that can be separated from the technologies and managed away, returning them once more into 'expert' matters of risk or legal assessments. The public imaginary, which sees these issues as fundamental parts woven through the science and technologies themselves, is difficult to account for in this way. In dealing with the public imaginary, these issues would have to be kept alive and a continual matter for public consideration and

discourse, thereby maintaining these issues as on-going 'problems' rather than being resolved. This public imaginary, as well as clashing with the overarching goals of government, simply does not fit into the 'machinery' of policymaking.

This latter point leads to an interesting question about why regulation and what I refer to as the 'machinery' of policymaking (the rules and structures within which decisions and policies are made) takes the form it does. Again, in his work on synthetic biology, Hurlbut (2015) argues that the shape of regulatory structures is based upon imaginaries of science – in particular the way in which social and ethical issues are seen as the 'epiphenomenal consequences of scientific creativity' has been important in shaping ELSI research in the life sciences, for instance (Hurlbut 2015). The dominant sociotechnical imaginary both describes and shapes how we see science and the role of the state. There is a circularity then, whereby the policymaking process has been built around the notion that social and ethical issues are separate to the technologies themselves, and, as a consequence, the policymaking process has to separate social and ethical issues from the technologies themselves in order to deal with them.

Added to this, others (for example Hedgecoe & Martin 2003; Pickersgill 2011) have pointed out that this dominant imaginary is also likely to shape how the discussions have taken place within the public dialogues. In looking at the rhetoric within the discourses, I have pointed out how the shape of the public discussions is very much shaped by techniques such as 'hyperbolic framing', which make it very difficult for participants to find a way to object to the science or technology being discussed. The discussions are very clearly framed and directed by the dominant sociotechnical imaginary articulated by the experts participating in the debates, as well as the officials commissioning the discussion in the first place – and indeed act to reinforce and share this dominant imaginary. For example, encouraging the public to express aspirations and concerns already frames social and ethical issues as epiphenomena. The public discourses coming out of these discussions perhaps express a tension between the public counter-imaginary and the dominant sociotechnical imaginary, within which the whole exercise is functioning, possibly masking even greater differences in imaginaries.

Similarly, the dominant sociotechnical imaginary is also likely to shape how policymakers and experts read the outputs of the discussions – exercising a similar degree of constraint upon the expert and policy readers. Looking at the outputs through the lens of the dominant sociotechnical imaginary, along with the current policy framework which strongly reflects that imaginary, it is possible to understand how the views of the public are seen as what Hedgecoe and Martin (2003) describe as 'roadmaps' – a list of conditions which must be met in order for particular technologies to develop unhindered and for the dominant sociotechnical imaginary to come to fruition.

Furthermore, Jasanoff and Kim (2009) have argued that in the case of nuclear power in the USA, conflicts between the sociotechnical imaginaries of the public and experts encouraged a perception of the public as 'emotional, untutored in probabilistic thinking and incapable of rational intervention in technical debates'. As I have described previously, this perception is likely to be built and reinforced by the public discourses' focus on people rather than technologies, and on nature. Echoes of this perception were evident in my interviews with policymakers, particularly with the CSAs who questioned the public's ability to understand the issues of the day and asserted that they acted in a non-rational manner. Looking at the public this way further undermines the value of the outputs of public dialogue as a source of evidence for decision-making – particularly when compared to the expert discourses which demonstrate their rationality, impartiality and status so powerfully through their use of technical vocabulary.

In summary then, while the views expressed in the public dialogue process are driven by the sociotechnical imaginaries held by the participants, by framing the questions, using particular illustrations of technologies and asking participants to bring the ideas to life in their own minds, public dialogues also appear to co-opt people into the dominant 'elite' imaginary of science driving progress. Similarly, regulation and policy is both designed to follow the shape of the dominant imaginary, but is also acting as a lens through which the public discourse is being seen and dealt with. Social and ethical issues are both understood to be epiphenomena, but also need to be treated as such in order to be dealt with in the regulatory 'machine'. As a result, public concerns can't be accommodated because

they clash with the dominant imaginary (i.e. appear to present obstacles to growing the economy) and because they don't fit into the machinery of government.

b. The problem of expertise

Further to, and arguably as a part of, the different sociotechnical imaginaries revealed in the analysis of discourses and interviews, a clear preference from policymakers for 'expert' advice was also evident. The policy documents and the interviews made many mentions of and demonstrated strong reliance on expert sources; there was a tendency to make social and ethical issues 'expert matters' by converting them into risk or legal questions; stakeholder groups or NGOs – groups which could be seen as acting as experts in public issues – were described as key sources of public perspectives into policymaking. And the interviews showed how little value was put on public opinion generated through dialogue, with policymakers alluding to how they didn't take the public views seriously until experts had come up with the same.

I have previously described how the public discourses might be at an ontological and rhetorical disadvantage when compared to the expert discourses, which might explain at least some of this difference in perception of expertise. As I have described above, my findings also chime with claims from others that the predominance of technical experts in the policymaking process means that their science-centred vision determines science policy and limits organisational capacity to consider or contemplate the contexts within which this works (Wynne 1998; Hurlbut 2015; Irwin 1995). But I would argue that my interviews reveal something further about the nature and influence of expertise in policymaking.

To begin, one point that my interviewees make repeatedly, is that it is not just natural science expertise that is important – they also draw on advice from economists, social scientists, legal experts and stakeholders. It is not the 'scientific' status that is important to be included in the discussions, but the 'expert' status. So while the different visions for science expressed in the public dialogues make these outputs less likely or more difficult to incorporate into policymaking, the fact that they are not being seen as drawn from 'experts' is further undermining their power and value. Policy draws on experts. The public are not seen as experts.

A good example of this comes from the policy Class C2 discourse. In discussing the moral and ethical issues raised by the public in the course of the policymakers' evidence gathering, the public's objections are diminished by questioning whether the views inputted are representative – the claim is made that the state of public opinion is not understood; Next the report argues that those objecting to animal human hybrid embryos are the same people who object to all embryo research – their objections are not to do with the non-humanness but to do with the 'embryoness' of the technology in question and therefore not worthy of consideration; finally, the report appeals for 'expert' authentication of the public concerns, asking whether there are any scientists who share the same concerns.

Further to that however, as I have described earlier, once the social and ethical issues have been raised by the public (which is seen in the policy discourses as the public's key role in the scientific process) addressing these issues becomes an expert matter. In class C1, concerns around nanoscience are seen as matters of risk (rather than moral hazard), which can be quantified and managed by risk experts. Class C3 sees problems with human-animal hybrid embryos as a legal question, for example. At no point are the public discussed as part of the solution – the public identify problems, experts deal with them. In the interviews with policymakers, the CSAs in particular also question the public's capacity to understand the issues and to form rational views.

Substantive expertise

That is too simple an explanation though. How do policymakers know and decide who is an expert? Is an expert anyone who shares the elite sociotechnical imaginary? I would argue not. Several of the interviews suggested that there was something substantive about expertise in policymaking – the policymakers clearly valued the opinion of those who had first hand knowledge of the subject being discussed.

For example, a former CSA recounted how his experience in an area of physics meant that he could challenge and update a model that would have produced grave consequences had it been incorrect. A former CSA also gave a particularly clear

illustration of the importance of first-hand knowledge when describing the involvement of a volcanologist in the 2010 ash cloud incident. In the quote given on page 173, he emphasises how this volcanologist wasn't just an expert in volcanoes but in this precise volcano.

The former ministers also talked about their previous experience in relevant businesses in explaining the unique contribution they were able to bring to the roles. They also described how expertise was sought from those working in the field. To use Collins and Evans's 'types of expertise' then (Collins & Evans 2009), there is evidence that 'contributory expertise' is valued and sought out in policymaking and that substantive knowledge is helpful.

These examples are problematic though as various studies (for example Jasanoff, 2009; Salter, Levy, & Leiss, 1988) have shown that the science used for policy making is characteristically different from science generated in pure research settings. This at least partly because science and policy considerations become closely integrated during production and use, resulting in science in the policy setting always being coloured by values. This means that the 'pure' science that CSAs and other experts have 'contributory expertise' in is not the same science they are dealing with in a policy situation. The CSAs themselves also admit that they are not experts in all of the areas of science on which they are asked to comment. In interviews, they described how they don't have detailed knowledge of all areas or science but nevertheless feel able to navigate a route through and give 'intelligent commentary' on scientific issues they are unfamiliar with. Arguably, this is also what the 'expert' organisations, such as the learned societies, are doing in their reports to policymakers, when they speculate about future uses of technologies whose purposes are as yet unfixed.

There appears therefore to be the view that this first hand knowledge of a particular area of science gives you transferrable expertise in other areas. This is what Collins and Evans (2009) describe as 'referred expertise', whereby contributory expertise in one field is used in relation to another field. The public in contrast are seen to be simply drawing on their life experience and non-technical skills to come to their viewpoint – Collins and Evans's 'ubiquitous discrimination', which is the way in

which those with little scientific knowledge use relationships, status, life experience etc. to make technical judgements.

The existence of these two sets of skills is evidenced by the fact that the two groups come to different assessments of the same material – different discourses around the same technologies, as I have described, for instance. It is however problematic to assume that that different assessments are the result of different levels of qualities of judgement skills that come from scientific training. They could equally come from different outlooks or sociotechnical imaginaries, as I have described above. Indeed, research in political science on expertise and its transferability across fields has found that experts excel mainly in their own domains. Michelene Chi, Robert Glaser, Marshall Farr (Chi et al. 1988) argue that there is little evidence that a person highly skilled in one domain can transfer the skill to another. They point to the work of Minsky and Papert (1974) on artificial intelligence which noted that "a very intelligent person might be that way because of specific local features of his knowledge-organising knowledge rather than because of global qualities of his thinking." Furthermore, research looking at problem solving in political sciences found that non-domain experts (chemists) solved political science problems much like novices (Voss & Post 1988). Tetlock (2005), looking at expert political judgement similarly found that specialists were not significantly more reliable than non-specialists in predicting what is going to happen in their own area of study. While a little knowledge might make someone a more reliable forecaster, knowing a lot made some less reliable (Tetlock 2005). Collins's own early work on replication of scientific results highlighted how even within science, when there is no 'objective' test of an experiment's quality, the scientists draw on non-scientific criteria such as faith in the experimenter's honesty, size and prestige of the laboratory or professional group affiliations (Collins 1985).

Arguably then, the explanation for the different judgements being made by the public and experts lies not with different 'expertises', but with the different outlooks that are being drawn upon in exercising 'ubiquitous discrimination'. It is possible that these are closely linked however – the acquisition of scientific skills might involve being co-opted into the expert imaginary too, for instance – creating the illusion of a particular set of transferrable skills. But rather than being a substantive quality, the concept of 'referred expertise' (which is undoubtedly recognised by policymakers,

even if it is not referred to in such terms) does appear to be a reflection of outlook – ubiquitous discrimination exercised in the framework of the dominant sociotechnical imaginary. In other words, I am not arguing that experts are chosen or designated because they share the elite sociotechnical imaginary, but that it is the sociotechnical imaginary, rather than the skills they have gained by making a contribution to a particular scientific field, that accounts for the particular way in which scientific experts reach judgements and advice for policy.

A good illustration of this in action was the way in which two of the ministers described the experts they most valued in advising on bovine TB. The minister who supported the badger cull said how important the advice of the veterinary scientists had been, citing their expert knowledge of the field as being the key to their insight. The minister who opposed the badger cull however said how valuable the advice of the scientists had been, similarly citing their expert knowledge of the field as being key. Both therefore made reference to similar sources of real and referred expertise – neither the scientists nor the vets had made policy on bovine TB before, so they were both exercising referred expertise. What neither interviewee said however is that, for whatever reason, the veterinary scientists were typically pro-culling and the scientists anti-culling. It wasn't simply the technical expertise that was being valued and judged by the Ministers, but the expertise and outlook combined. This reinforces the point about the challenge of incorporating views drawn from the public's counter-sociotechnical imaginary.

Regardless of the reality of its existence however, this understanding of the existence of some kind of 'referred expertise' that allows scientists to exercise expert judgment in whichever field they choose could, on one hand, explain why the advice of the public has less impact than that of experts. Even when they are speaking outside their own domain, the 'referred expertise' perceived to be held by scientists is more valued than the ubiquitous expertise offered by the public. The public are seen to be offering the wrong 'type' of expertise then – something that will be important to bring to light in any plans to improve the impact of public dialogue exercises in the future.

Furthermore, this classification could help make sense of the policymakers' tendency to turn social and ethical issues into expert matters of 'risk' and 'law'. If

you view the public as drawing on only 'ubiquitous' skills that everyone has, compared to the 'expertise' offered by the scientists, public opinion appears to be the opposite of technical expertise. In this light, converting social and ethical matters into risk and legal issues not only keeps these matters in the expert domain (arguably therefore an act of boundary work) but also turns them into matters to which expertise can be applied – and where policymakers can be much more comfortable of the epistemic authority of advice.

Situational/relational nature of expertise

Beyond that however, expertise was also seen by policymakers as a situational and relational quality – it was conferred by having a particular job or being known to have particular expertise. While civil servants talked in interviews about peer-reviewing advice, this was secondary to knowing people or having them recommended by other experts. As I have described in Chapter 6, when asked about how they chose scientific experts for advice, the policymakers interviewed put a great significance on individuals' status or location within institutions or scientific networks – the CSAs described how they would ask appropriate bodies or networks to recommend people and the ministers expressed satisfaction that those employed by the appropriate agency would have sufficient expertise, for instance.

This should not be surprising. Others have previously described how expertise is a reflection of an individual's status and place in a network (for example Epstein, 1996; Jasanoff, 2004; Wynne, 1992). Jasanoff in particular has described how in the UK, confidence in governmental advisers rests on the reliability of persons rather than technical competence, arguing that "In British advisory committees, trust is created through embodiment in trustworthy people: peers, professors, tested public servants, representatives of established interest groups or responsible citizen organizations. Over and above any demonstrations of technical competence, such individuals have proved their right to represent the public interest through years of devoted service." (Jasanoff 1997). Further to that, she also argues that the evidence gathering and consultative process only allows the public to participate by invitation and that this is designed to exclude opinion that "looks radical, irrational or lacking in significant social and scientific support" (Jasanoff, 1997).

Both these points are important for public dialogue. If the outputs of public dialogue are seen as non-expertise, then it will always be difficult to have any impact with a system where expertise is valued and taken notice of. As I have explained above, this arguably even results in 'public' issues around social and ethical concerns, being transformed into 'expert' matters of risk and legality. This approach to evidence gathering (or evidence valuing) also provides some explanation for why the policymakers focused upon 'stakeholders' rather than 'the public' – these 'representatives of established interest groups or responsible citizen organizations' are seen as trustworthy and reliable and understand how their views will fit into the policymaking process.

c. Networks

As well as valuing expertise from those who have contributed to the field, or who have a relevant position of authority, the interviews with policymakers showed very clearly that their networks were important sources of advice and expertise. In particular, when it comes to seeking the views of the public, my interviews show that policymakers tend to think in terms of 'stakeholders' – organisations that represent public interests (or the interests of some sub groups of the public). As the interview with the formal special adviser in particular shows, these stakeholders were often drawn from politicians and advisers' professional networks.

This correlates very strongly with thinking in political science, around the importance of groups – that it is not just institutions, cabinets and elected officials that make decisions, but that policy often emerges as a result of pressure or influence from groups and associations by direct lobbying or behind the scenes negotiations. Policy networks (Rhodes 1997; Marsh & Rhodes 1992; Rhodes 1990) and the advocacy coalition framework (ACF) (Sabatier 2006; Sabatier & Jenkins-Smith 1993; Sabatier 1998) are two of the most recent innovations in policy analysis and both emphasise the importance of groups and interactions.

Policy network analysis is structure oriented, focusing on shared resources and power dependency. It is based on the idea that modern policy problems are complex and therefore no state agency has the resources to address them alone. Instead, agencies are dependent upon cooperation and resources from other actors

(Rhodes 1997). Well-resourced actors form dominant coalitions which decide the rules of the game – how policy problems are perceived, which solutions are acceptable etc. (Marsh & Rhodes 1992; Smith 2000; Smith 1993).

Policy networks exist on a continuum of cohesion, from loose issues networks (whose membership encompasses a wide range of interests, perhaps with limited resources) (Smith 2000), to tight-knit policy communities, which are more stable, with restricted membership, shared responsibilities for delivering services and integrated membership (Heclo & Wildavsky, 1974; John, 2013). Schneider and Ingram (1997), looking specifically at the role of science in policymaking, described the network they identified as a 'policy community', which is 'the more closely knit, coherent, stable and closed forms of networks. They exist where there is a high degree of unity and exclusivity among scientific and professional actors who have reached a consensus on existing problems, potential solutions and desired outcomes. There is continuity among actors extending over long periods of time' (Schneider & Ingram 1997). Significantly for this research, they concluded that unless participants in the policy process share membership of the policy community, their knowledge is considered irrelevant, with the effect of excluding or ignoring those who might be adversely affected or oppose the policy community's view. This could provide a further explanation as to why the outputs of public engagement are not taken account of.

Where policy networks are resource focused, the Advocacy Coalition Framework (ACF) is focused on agency and beliefs. Policy actors hold 'policy core beliefs' which are their normative goals for policy and perceptions of the best ways of achieving these goals (Sabatier 1998). The success of policy participants depends on their ability to translate their policy core beliefs into actual policy. To do this they seek out allies with similar core beliefs and coordinate actions with these allies in advocacy coalitions (Sabatier & Weible 2006).

Central to the ACF is the idea that most policy relevant activities happen in a policy subsystem, which is defined as "the group of people and/or organisations interacting regularly over periods of a decade or more to influence policy formulation and implementation within a given policy area/domain" (Sabatier 1998, p.111). For instance 'the biotechnology policy subsystem in the UK' has been a unit of study

(Montpetit 2011). Coalitions must compete for influence over policy or public opinion. But they do this not just by asserting interests over another group's, but also by attacking the premises and understandings of the other (Smith 2000). Actors are likely to consider as credible only those who share their beliefs (Kahan et al. 2011; Siegrist et al. 2000) and over time, initially loose groups with amorphous beliefs will coalesce into increasingly distinct coalitions with coherent belief systems, with neutral actors dropping out (Sabatier & Zafonte 2001). Importantly, researchers using ACF have found that scientists tend to be members of advocacy coalitions, being primarily motivated (like any other actor) by their convictions and beliefs and in most well developed sub-systems, agency officers and most researchers active in the field will be members of specific coalitions in terms of sharing a set of policy core beliefs (Montpetit 2011).

When it comes to the various policy subsystems around the issues that public dialogues consider (there would be a policy subsystem around synthetic biology, geoengineering, human embryo research and so on), the policymakers and the scientists would be described as being inside a coalition, but the actors in a public dialogue exercise are not. The dialogue organisers are likely to be connected to the 'public engagement' policy sub-system, but not the one relating to the issue in hand – in fact the neutral stance taken by organisations like ScienceWise means that they can only act as channels and facilitators and never advocates. Arguably the sponsoring organisation (BBSRC in the case of synthetic biology, for instance) is, but, as I have shown in the comparison of expert and public discourses, the sponsor organisations' inputs to policy (the expert reports) do not tend to reflect the public dialogue outputs fully, showing a tendency to discount or externalise public perspectives.

The net result, if the advocacy coalition framework or the policy network approach is to be considered, is that the outputs of public dialogue are outside the networks or coalitions that exert policy influence. This is in contrast to the scientific community, the NGOs and policymakers, who are well networked and appear to be engaged and made use of in policy decision making.

There is however one further dimension that is important. Coming out in the interviews, it is significant that as well as being outside policy networks or advocacy

coalitions, public dialogue does not bring with it any agency. NGOs and other stakeholder groups often represent membership organisations, or at least have a profile and public voice, and as such have the power to mobilise large numbers towards their position – and potentially against a policy decision that they are unhappy with. Such a threat (or possibility) is a very real concern for policymakers (politicians in particular) and so there is an incentive to involve such groups in decision making. For example, one Minister described a back and forth between groups until you get to the point where nobody is unhappy and can all accept the best of a bad deal. Another minister, when talking about Bovine TB, described how it was vital to hear from as many stakeholders as possible, as the decision was likely to be subject to a judicial review. In this instance, involving NGOs was not just a way to avoid public controversy, but also a legal requirement of due process. Public dialogue in contrast not only sits outside these networks, but is not depended upon in order to make and deliver policy – or to make policy acceptable.

Public dialogue activities then sit outside most descriptions of the types of networks and coalitions that are best able to influence policy. They don't deliver part of policy, they can't mobilise support for or against policy, involving them is not a legal requirement and they can't form issue coalitions on the substantive matters being discussed as organisations hosting public dialogues are channels rather than advocates.

Conclusions for Public dialogue

All of this might appear to paint a challenging picture for proponents of public dialogue, but I would argue that it reflects the stage in the field's development. For the past decade, the focus has been on developing the practice – understanding how to do dialogue effectively. And as I have argued, this research shows that the process does produce valuable insight into how the public come to understand new and emerging science and technologies. This however is not without problems, as I will discuss below.

For the next phase in the field's development though, I would suggest that the focus needs to be on how to improve the impact of dialogue on policymaking. In particular,

based on the research described here, I believe this new phase needs to focus on three key questions:

1. How can we involve the public in discussions about upstream issues?

As I have argued above, the current way in which upstream technologies are brought to life for dialogue participants (wittingly or unwittingly) allows the expert imaginaries to fix the meanings to abstract technologies. This is perhaps inevitable but nevertheless problematic, especially given the current move to incorporate public dialogue into the Responsible Research and Innovation agenda, which focuses on aligning the outcomes of research with the values of society (see for instance Owen, Bessant, & Heintz, 2013; Owen, Macnaghten, & Stilgoe, 2012).

This push upstream also moves towards a second tension that I have identified in this research, around the need to negotiate sociotechnical imaginaries and the difficulty of influencing the meta-narratives around policies. These meta-narratives are arguably closely related to sociotechnical imaginaries, but tend to be drawn up and agreed by the political process and therefore not subject to the kinds of decisions that dialogue seeks to/has the potential to influence.

Clearly there is an important role for discussions of this type. Bringing assumptions and aspirations about the kind of world we want to create from and with science into the open would be an important way to help policymakers understand the impact of their own sociotechnical imaginaries and to consider alternative ways to incorporate public values into their decisions and imaginaries. The failure to do this is also a longstanding criticism of dialogue practice by people such as Wynne and Irwin (Kearnes et al. 2006; Wynne 1992; Wynne 2006; Macnaghten et al. 2005; Irwin 2001; Irwin & Wynne 1996; Irwin et al. 2012a), when they talk about a lack of institutional reflexivity. But it is difficult to see how this could happen in a public dialogue situation as these issues don't appear to be open for discussion by those who commission and respond to public dialogue events – as I've explained, the ministers that need to be influenced see public dialogue as a way to educate and bring around the public, as part of fulfilling their 'elite' sociotechnical imaginary.

At best public dialogue events appear to exert influence at the civil servant level. As I have described however, according to the model that the policymakers all appeared to work with, this is exerting influence at a level below that needed to influence the big picture media meta-narratives and imaginaries. Instead, at this level, ministers appear to be taking their lead from their networks – particularly their political parties, their mailbags and from wider cultural and social cues such as the media and NGOs.

Perhaps then, rather than/as well as continuing to ask what do people think about new technologies, it would be interesting to consider where these views come from. For example, the public discourses show clear traces of environmental values – indeed the public discourses identified here share many aspects of Dryzek's 'green consciousness' environmental discourse (such as sense of nature, unnatural practices, the violation of nature), which is one of the radical green discourses he describes (Dryzek 2005). There are also hints of the 1990s anti-globalisation movement's discourse in the scepticism of the role of the private sector. Exploring current 'fringe' movements and attitudes might give us more clues about how people are likely to respond to future technological developments.

2. How can the policymaking process and machinery deal with social and ethical issues as anything but epiphenomena?

As I have described above, policymakers understand public concerns as epiphenomena at least partly because that is the way in which the machinery of government and governance works. Questions around how would that machinery cope with decisions that are never closed and constantly revisited and what structural and institutional changes would be necessary to accommodate and reflect this viewpoint will be important to consider in moving the practice of dialogue forwards.

3. How can public dialogue be better heard in policymaking?

The issue of expertise also presents a significant challenge for public dialogue. Regardless of whether or not this is a relational or substantive quality being sought, it is nevertheless seen as a substantive quality by policymakers, that provides epistemic authority. Public perspectives cannot compete with this. Much STS

discourse around this issue frames this problem in terms of justice and power. But I argue that this is not a matter of the public being deliberately ignored or excluded, but of their views being invisible, or misunderstood or distorted by being made manageable.

From my analysis and interviews, there is evidence that policymakers are open to public opinion and are indeed drawing input via organised groups and direct contact. This is supported by work of others who have found that policymakers report many different routes through which public values can be heard and accounted for in science policy (MacNaghten and Chilvers 2014). Although this might not result in the institutional reflexivity on the part of policymakers that many would want, it is not the same as the public going unheard or being excluded from the process.

But the biggest way in which public dialogue programmes like ScienceWise can improve the impact of their dialogues is likely to be through advocacy and networking. The organisers or sponsors of such dialogues could play an active role in this on behalf of participants. For instance, the UK Government's Foresight programme had a team who were responsible for promoting the findings of the Foresight projects across government and beyond, and of recording impact. The team existed for the life span of the project and so had years to build up the relationships and contacts needed to ensure impact. Furthermore, making the participation process more transparent – by making the names of the participants public and giving them a role in advocating on behalf of the dialogue, for instance – could increase impact, improve the perceived accountability of the dialogue and in turn make commissioning bodies more accountable to act on the advice of the dialogues.

It is important to point out however that even though public perspectives do not appear to have been taken into account in much policymaking around new and emerging technologies over the last decade, this does not appear to have resulted in public disquiet. While some might argue that this is the result of the dialogue process itself, even if programmes like ScienceWise have reached and had a positive impact on several thousand people, it seems improbable that this provides an explanation for a wider lack of concern – especially since even the minister

responsible for the programme did not appear to be aware of its role in democratising science. Instead, Sheila Jasanoff argues in her description of the UK's 'Civic epistemology' that the British people require a degree of 'reasonableness' in the decision making process (Jasanoff 2005). If this has been met, then there will not be disquiet. So even if the outputs of public dialogue are not heard, provided decisions have been made on a reasonable basis, then they will be accepted.

Given the apparently difficult fit that public dialogue has with the UK's policymaking process, the elite sociotechnical imaginary and civic epistemology, its persistence as the dominant way of bringing science and society closer together remains surprising. It also remains a distinctly northern European approach to the problem. Others are already suggesting that there might be other innovations in science governance practice – such as citizen science, crowdsourcing, open science and innovative governance structures (Owen et al. 2012; Grand et al. 2012; Asveld et al. 2015; Macnaghten & Chilvers 2014). Exploring and comparing the impact of such alternative approaches, including comparisons with other countries, could provide interesting research questions – and lessons for practitioners – in the future.

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Appendix 1: Documents included in the computer assisted text analysis

Corpus A: Public dialogue reports	Corpus B: Expert reports	Corpus C: Policy reports
Nanodialogues (2005-2007) Nanodialogues was developed as a result of recommendations by the Royal Society and the Royal Academy of Engineering on how the Government should take forward the new and challenging area of nanotechnology research. **Nanojury (2003)*** The NanoJury brought together 20 randomly-chosen people from different backgrounds who will hear evidence about the role that nanotechnologies might play in their future. **Nanotechnology for healthcare (2008)*** Sponsored by the Engineering and Physical Sciences Research Council, this dialogue set out to take account of a wide set of societal views and inform nanotechnology research trajectories for healthcare **SmallTalk (2005)*** SmallTalk was a series of public dialogue activities that explored the aspirations and concerns of the public and scientists around nanotechnologies.	**Nanodialogues response (2007)** BBSRC and EPSRC joint response to the nanodialogues: engaging research councils project **Nanosciences and nanotechnologies: Opportunities and Uncertainties (2004)** Royal Society & Royal Academy of Engineering report looking at future of nanoscience. Included input from a public dialogue activity.	**UK Government Response to The Royal Commission on Environmental Pollution (RCEP) Report "Novel Materials in the Environment: The Case Of Nanotechnology" (2009)** **UK Government response to the Royal Society and Royal Academy of Engineering Report 'Nanoscience and nanotechnologies: opportunities and uncertainties' (2005)**

Synthetic Biology (2009-2010) The Synthetic Biology Dialogue has been commissioned by BBSRC (Biotechnology and Biological Sciences Research Council) and EPSRC (Engineering and Physical Sciences Research Council), on behalf of RCUK, and will explore the public's views, concerns and aspirations around synthetic biology. **Synthetic Biology, Royal Academy of Engineering (2008)*** This report presents the findings of an exploratory public dialogue project, commissioned by the Royal Academy of Engineering (the Academy) and conducted by People Science and Policy Ltd (PSP) to explore uninformed and informed perceptions of and attitudes to synthetic biology in the UK.	**Synthetic Biology Roadmap (2012)** Produced by the UK Synthetic Biology Roadmap Coordination Group, which included a wide range of stakeholders, including academics, industrialists and, on behalf of the Research Councils, the Biotechnology and Biological Sciences Research Council (BBSRC), Engineering and Physical Sciences Research Council (EPSRC) and the Technology Strategy Board (TSB). **Synthetic Biology – scope, applications and implications** (2009) Royal Academy of Engineering Identifies the next steps to build on the UK's position in the field, create a regulatory framework and to explore, with the public, the ethical and societal issues involved. Includes outputs of the 2008 public dialogue.	**UK Government response to 'A Synthetic Biology Road Map for the UK' (Letter from Science Minister, 2012)**
Forensic Use of DNA (2007-2008) This project aimed to find out people's views on the forensic use of DNA, particularly in relation to the information held on the National DNA Database (NDNAD). Sponsored by the Human Genetics Commission (HGC).	**Nothing to Hide, Nothing to Fear: Balancing individual human rights and the public interest in governance of the National DNA Database (2009)** Human Genetics Commission Report which 'forensic use of DNA' dialogue fed into.	No equivalent policy document
Geoengineering (2010) The Natural Environment Research Council (NERC),	**Geoengineering the climate: science, governance and**	**Government Response to the House of Commons,**

in partnership with Sciencewise-ERC carried out this public dialogue to explore the views of the public in relation to geoengineering. In particular the moral, social and ethical implications of future research on geoengineering were assessed.	**uncertainty** **Royal Society (2009)** Report into potential of geoengineering, which included element of public consultation.	**Science and Technology Committee 5th Report of Session 2009-10: The Regulation of Geoengineering**
GM Foods (2002)* This report presents The Food Standards Agency's contribution to the UK government's dialogue on GM foods, based on a citizen's jury. The dialogue set out to independently assess people's views, especially those whose voices are not often heard, on the acceptability of GM food and how this relates to consumer choice. **Public perceptions of industrial biotechnology (2006)** IB is the application of bioscience (including genetically modified organisms) for the processing and production of chemicals, materials and energy. The aim of the project, sponsored by the Department for Business, Enterprise & Regulatory Reform (BERR), was to assess and understand the public perception and values around IB.	**GM Science Review First Report (2003)** The GM Science Review Panel. An open review of the science relevant to GM crops and food based on interests and concerns of the public **IB 2025 – Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy (May 2009).** A report to Government by the industrial biotechnology innovation and growth team, which included members from academia and industry.	**Genetically Modified Foods – Frequently Asked Questions (Defra 2004)** **The GM Dialogue – Government Response (2004)** **Government response to the Industrial Biotechnology – Innovation & Growth team report to Government (2009)**
Hybrids and Chimeras (2006) This project was part of the Human Fertilisation and	**Human Animal Hybrids (2007)** HFEA Final report of the HFEA review of human animal	**House of Commons Science and Technology Committee: Government**

Embryology Authority's (HFEA) public and stakeholder consultation on hybrids and chimera embryos. This was carried out to guide the Authority's recommendations to Government on whether this type of research should be allowed in the future. **Animals Containing Human Material (2010)** Led by the Academy of Medical Sciences, this public dialogue formed part of a broader study on the scientific, social, ethical, safety and regulatory aspects of research involving non-human embryos and animals containing human material.	hybrids, which the public dialogue feeds into. **Animals Containing Human Materials (2011)** Academy of Medical Sciences The broader study on the scientific, social, ethical, safety and regulatory aspects of research involving non-human embryos and animals containing human material, into which the public dialogue fed.	**proposals for the regulation of hybrid and chimera embryos. Fifth Report of Session 2006–07.** **Government Response to the Report from the Joint Committee on the Human Tissue and Embryos (Draft) Bill (2007)**
Stem Cell dialogue (2007-2008) This project developed public dialogue activities around the science and social and ethical issues of stem cell research, with the aim of providing an understanding of views and concerns among diverse groups, including scientists, which could then feed into policy makers' strategic decision making.	**Stem Cell Infrastructure Report (2008)** The Medical Research Council (MRC). Considers the research landscape and national needs, to determine infrastructure support for the sector.	**Government Response to the House of Lords Science and Technology Committee Inquiry into Regenerative Medicine (2013)** **Government response to the UK Stem Cell Initiative report and recommendations (2007)**
DrugsFutures (2006-2008) DrugsFutures was commissioned as part of the Academy of Medical Science's independent review of the societal, health, safety and environmental issues raised by scientific advances in brain science, addiction and drugs (BSAD).	**Brain Science (2008)** Academy of Medical Sciences Report produced by a working group chaired by Prof Sir Gabriel Horn, to consider societal, health, safety and environmental issues raised by scientific advances in brain science, addiction and drugs (BSAD).	No equivalent policy document

The Big Energy Shift (2008-2009) The Big Energy Shift aimed to encourage people to discuss the way they insulate, heat and power their homes and communities. It took place in parallel with the formal consultations on the Heat and Energy Saving Strategy and Renewable Energy Strategy.	No equivalent expert document	No equivalent policy document
ScienceHorizons (2006-2007) Sciencehorizons was the public-facing part of a stakeholder consultation on the Wider Implications of Science and Technology (WIST) carried out by the Government Office for Science's Horizon Scanning Centre. Its aim was to explore the public's views on future applications of science and technology that emerged from two Horizon Scans which involved scientists and experts thinking about future science and technology.	No equivalent expert report	No equivalent policy document

* highlights those dialogues not funded through the ScienceWise programme

Appendix 2: List of significant words for each class produced by IRAMUTEQ analysis of public dialogue documents

Number of texts: 18

Number of text segments: 5592

Number of words: 9062

Number of occurrences: 205499

Average number of occurrences for each word: 22.677003

Number of lemmas: 6602

Number of active words: 6055

Number of supplementary words: 547

Number of classes 5

3999 segments classified of 5592 (71.51%)

Class A1 15.68%	**Class A2 25.48%**	**Class A3 23.38%**	**Class A4 17.65%**	**Class A5 17.80%**
drug	application	climate	industrial	animal
young	area	geoengineering	biotechnology	human
recreational	treatment	change	gm	material
outreach	biology	public	food	embryo
user	potential	event	crop	research
person	science	mitigation	environment	create
belfast	synthetic	dialogue	product	hybrid
illicit	disease	decision	consumer	egg
child	fund	talk	release	agree
parent	nanotechnology	member	fuel	welfare
education	therapy	activity	biofuels	respondent
addiction	field	scientist	natural	cytoplasmic
alcohol	private	report	bacterium	cell
harm	medical	information	land	disagree
enhancers	investment	engagement	eat	creation
family	patient	expert	stage	man
cognition	stem	scientific	impact	survey
school	device	policymakers	gmos	figure
legal	clinical	trust	production	tissue
crime	female	recommendation	enzyme	compare
heroin	significant	policy	concern	percent
workshop	control	explain	chemical	acceptable
teacher	council	panel	process	statement

exeter	cell	government	organism	brain
service	development	principle	unite	purpose
bb2	innovation	opinion	oil	woman
addict	healthcare	engage	country	type
cannabis	male	ask	unknown	ivf
class	vision	deployment	kingdom	suffer
vulnerable	sector	issue	plant	consultation
cocaine	culture	technology	feedstocks	donate
nicotine	commercial	session	fossil	genetic
age	governance	communicate	farmer	experiment
liverpool	highlight	warm	produce	contain
glasgow	profit	datum	barrier	nationally
addictive	advance	discussion	environmental	reproductive
classification	stakeholder	science	producer	specie
peer	instance	robotics	shelf	foetal
project	regulator	comment	labelling	half
criminal	govern	organisation	reassurance	write
prison	progress	shift	aid	amount
vulnerability	cancer	independent	contamination	cow
relay	hope	jury	industry	cord
feel	risk	maker	price	acceptability
smoke	think	interest	traditional	difference
substance	drive	attitude	manchester	organ
adhd	nanotechnologies	evidence	bio	q1
commit	aspiration	credit	ecosystem	mitochondrion
kid	technology	scale	landscape	somatic
line	regard	clear	bioplastics	possibility
drink	tension	consensus	ingredient	donation
punishment	technical	political	acceptance	mouse
approach	develop	participant	economic	purely
argue	ethic	action	consumption	accept
health	role	reflect	desire	unacceptable
prescription	need	give	efficient	hfea
old	specifically	reconvene	prompt	clone
effective	infection	gather	survive	stem
behaviour	regulation	weight	increase	transfer
include	concern	speaker	supply	scnt
danger	nanoscience	urgency	assessment	section
inequality	cure	underlie	safety	blood
pressure	goal	finding	car	response
adult	consent	question	sustainable	dimension
mental	regenerative	day	economy	technique
healthy	institutional	further	green	foetus
student	diagnostic	simply	aesthetic	representative
stigma	heart	reveal	farm	es
problem	forward	online	saving	creature

catch	bank	set	predict	study
slide	priority	carbon	benefit	embryonic
restriction	fate	discuss	micro	boundary
tell	promise	inform	worry	small
work	mindful	important	familiar	supportive
chapter	nhs	naturalness	growth	monkey
afford	professional	plan	surround	total
skill	great	appreciate	perception	oppose
predisposition	focus	hazard	safe	proportion
persons	fundamental	story	long	controversial
freedom	tech	authority	appeal	baby
start	mrsa	meet	decrease	destroy
reduction	enable	subject	slope	investigate
identify	london	global	slippery	derive
society	major	extent	assess	chart
vaccine	examine	consideration	nature	ten
llegal	tie	understand	water	show
quote	note	tackle	offer	hear
brainbox	broadly	citizen	claim	adult
choice	safeguard	ethical	laboratory	strongly
buy	uncertainty	aim	deliberate	true
attach	access	openness	supermarket	nuclear
social	misuse	objective	everyday	morally
prescribe	depth	witness	cheap	viable
cope	short	world	large	permit
black	central	importance	waste	word
widely	therapeutic	vary	content	cite
someone	emerge	agenda	bioremediation	objection
home	business	communicator	buy	pain
educational	trial	consider	element	appendix
restrict	shape		struggle	unnatural
suggestion	whilst		context	vitro
focus	diagnosis		cost	deliberative
prevention	empower			mechanism
disadvantage	basic			skin
leave	body			alternative
primary	procedure			
acknowledge	condition			
provide	huge			
suggest	swansea			
limit	prospect			
availability	donor			
law	ahead			
weak	key			
shop	motivation			
emphasise	good			

stand ritalin step house depression hour				

Appendix 3: List of significant words for each class produced by IRAMUTEQ analysis of expert documents.

Number of texts: 12

Number of text segments: 14335

Number of words: 17791

Number of occurrences: 520547

Average number of occurrences of each word: 29.259007

Number of lemmas: 13889

Number of active words: 12876

Number of supplementary words: 1013

Number of classes: 5

9305 segments classified out of 14335 (64.91%)

Class B1 (17.16%)	**Class B2 (20.44%)**	**Class B3 (24.69%)**	**Class B4 (17.61%)**	**Class B5 (20.1%)**
public	crop	drug	cell	chemical
issue	gm	substance	human	nanoparticles
nanotechnologies	plant	mental	embryo	manufacture
ethical	herbicide	misuse	stem	nanotubes
dialogue	gene	treatment	animal	device
science	flow	cognition	mouse	industry
geoengineering	breed	person	tissue	production
scientific	resistance	harm	hybrid	ib
debate	food	child	create	particle
concern	variety	disorder	embryonic	synthetic
research	seed	enhancers	es	property
governance	ht	addiction	line	product
stakeholder	kingdom	participant	cytoplasmic	surface
workshop	unite	alcohol	egg	size
consultation	wild	brain	donor	material
society	weed	young	somatic	bio
technology	conventional	cognitive	nuclear	market
raise	pest	psychoactive	mitochondrial	industrial
uncertainty	wee	illness	oocyte	base

report	bt	recreational	chim	nanoscale
group	rape	al	creation	biology
question	biodiversity	user	mitochondrion	process
policy	insect	abuse	derive	large
work	oilseed	family	mtdna	chemistry
attitude	impact	individual	scnt	biological
council	farm	cocaine	research	sector
royal	relative	health	transplant	price
social	tolerant	illicit	reprogram	exposure
interest	toxin	age	germ	energy
panel	pollen	heroin	genome	computer
deliberative	maize	cannabis	pluripotent	measurement
commission	trait	school	vitro	company
review	grow	receptor	blastocyst	application
societal	field	smoke	ras	feedstocks
future	resistant	healthy	nucleus	engineer
decision	farmer	depression	immune	molecule
international	agricultural	prevalence	hesc	chip
meet	potato	psychological	ips	cosmetic
member	fee	intervention	cord	fuel
technological	habitat	death	blood	renewable
inform	soil	behavioural	sperm	waste
address	agriculture	schizophrenia	transfer	scenario
discussion	feed	social	clone	carbon
highlight	glyphosate	nicotine	stage	uk
scientist	bird	risk	interspecies	technology
acceptability	pollination	illegal	type	optical
expert	specie	survey	derivation	synthesis
academy	tolerance	adhd	therapy	atom
independent	beet	dependence	chimera	mass
forward	invasive	effect	bone	design
citizen	farmland	neurotransmitter	differentiate	nanometre
engagement	commercial	opiate	humanise	assembly
undertake	transgene	factor	disease	oxide
implication	stack	box	fertilisation	fermentation
knowledge	fitness	chronic	adult	manufacturer
feasibility	population	symptom	marrow	machine
ethic	wildlife	dopamine	transplantation	workplace
government	decline	behaviour	graft	volume
chapter	spray	problem	disagree	nanomaterials
trust	predator	effective	gamete	oil
engage	grass	dementia	rabbit	free
ensure	pesticide	feel	dna	high

area	spectrum	crime	contain	sensor
database	transgenes	estimate	culture	chassis
objective	consequence	tobacco	model	produce
direction	target	addict	specie	build
role	invertebrate	parent	reproductive	standard
open	distance	emphasise	hfe	low
climate	arable	education	agree	global
explore	ecological	vulnerability	recipient	titanium
confidence	corn	patient	bank	feedstock
wide	cultivation	overdose	entity	zinc
organisation	allergenic	relapse	chromosome	billion
nanotechnology	semi	memory	organ	structure
political	cross	alzheimers	licence	value
opinion	management	epidemiological	transgenic	biofuels
challenge	abundance	action	vivo	electronic
deployment	sugar	measure	implant	electronics
discuss	presence	classification	prohibit	air
perspective	practice	prevention	genetic	biologically
gap	nutritional	enhance	nhp	metal
meeting	organism	drink	offspring	scale
technical	wheat	medicine	involve	tool
literature	virus	learn	grade	light
project	tillage	ill	material	biofuel
publication	transgenic	evidence	fetal	electron
ndnad	allergy	side	therapeutic	characterisation
framework	ecology	association	lot	sale
benefit	assessment	reward	protein	dioxide
arise	leaf	treat	parkinsons	capability
write	confer	engagement	true	precision
initial	introduce	efficacy	hfea	length
awareness	approval	enhancement	inter	green
anticipate	release	incidence	investigate	top
medical	eat	class	developmental	sustainable
exercise	allergen	service	cancer	system
draw	compatible	image	alter	small
consider	al	datum	live	dimension
perception	threshold	programme	nhps	fine
consideration	natural	support	encode	pharmaceutical
ask	case	recommendation	replication	biochemical
horizon	unique	neural	isolate	advance
time	canada	prevent	clinical	component
series	pathogen	month	appearance	biomass
epsrc	commercially	onset	know	area

aware	toxic	agent	appendix	toxicity
view	unintended	function	replace	drive
recommendation	selection	skill	permit	instrument
representative	spread	relationship	replicate	form
conclusion	predict	legal	mix	tonne
topic	occur	trial	origin	iron
development	consume	harmful	hear	laboratory
bbsrc	existence	nerve	skin	platform
maker	productivity	clinical	antibody	circuit
emerge	emergence	foresight	technique	exploit
recognise	fungus	pregnancy	act	step
environmental	effect	consistent	genetically	economy
proposal	volunteer	dose	patient	attractive
paper	separation	criminal	rise	expect
fund	density	common	specific	business
identify	counterpart	cause	give	require
finally	environment	england	experiment	deliver
play	mediate	dependent	amount	strength
party	modify	idea	early	nanoscience
respond	control	study	host	offer
theme	construct	neuron	evolutionary	add
application	survival	experience	license	manipulation
fundamental	organic	effectiveness	induce	fibre
full	diet	justice	scientist	recommend
regulatory	broad	home	committee	delivery
believe	salt	woman	expression	hazard
vision	allergenicity	vulnerable	viable	worker
institution	safe	show	mixture	quantity
board	mutation	relate	purpose	fossil
submission	landscape	vaccine	normal	enable
consensus	eu	region	guideline	communication
strand	modern	underlie	primate	route
bring	microbial	inject	allow	figure
innovation	assess	candidate	neural	opportunity
position	reduce	fear	closely	world
privacy	escape	influence	successful	efficient
foundation	approve	collection	arrest	land
kind	diversity	finding	obtain	centre
clear	combination	severe	function	end
pace	depend	performance	heart	ingredient
criterion	genetically	suffer	development	cheap
scope	undesirable	law	majority	water
coordinate	significantly	argue	insert	pollution

impact	toxicity	focus	alternative	roadmap
website	persist	compound	code	micro
nanoscience	introduction	seek	transmission	modelling
dedicate	negative	man	think	force
hold	yield	agency	viral	resolution
moral	comparison	variant	legislation	new
equally	traditional	adverse	facilitate	today
alongside	sea	instance	complete	expensive
need	bacillus	scheme	result	secure
relevant	regime	professional	copy	competitive
collaboration	evidence	continue	survive	growth
community	observe	recent	similar	highly
evaluation	delay	follow	aspa	part
justify	grind	suggest	researcher	biotechnology
finding	quality	begin	functional	enzyme
broad	result	increase	source	igt
national	likelihood	train	destroy	define
response	ecosystem	outcome	fate	disposal
encourage	leave	tend	infect	transport
resolve	probability	fold	transmit	exist
british	affect	advice	successfully	consumer
section	rate	table	develop	technique
safety	increase	context		interface
ongoing	adverse	promise		storage
surround	deliberate	care		demand
expertise	restrict	choice		ability
cover	evolve	prohibition		single
peer	widely	term		skin
inquiry	agreement	medical		direct
argument	loss	de		power
participant	frequency	peer		investment
perceive	examine	activity		reach
subject	similarly	find		mineral
provide	detect	identify		order
respondent	rare	attention		intensive
analysis	favour	identification		cost
assessment				emission
realised				being
office				simple
balance				store
recommend				concentration
current				spatial
economic				marine

valuable				coat
state				molecular
house				underpin
course				pathway
real				european
regulation				incentive
potential				physical
properly				toxicological
				final
				compete
				invest
				dna
				employ
				total
				nanotechnology
				operate
				operation
				primarily
				europe
				temperature
				contact
				advantage
				network
				layer
				speed
				move
				pound
				rely
				composition
				shape
				quantify
				equivalent
				century
				sequence
				cycle
				university
				integrate
				parallel
				incorporate

Appendix 4: List of significant words for each class produced by IRAMUTEQ analysis of policy documents.

Number of texts: 11

Number of text segments: 2589

Number of words: 5909

Number of occurrences: 94673

Average number of occurrences for each word: 16.021831

Number of lemmas: 4470

Number of active words: 3785

Number of supplementary words: 685

Number of classes: 4

1561 segments classified out of 2589 (60.29%)

Class C1 (16.72%)	**Class C2 (29.15%)**	**Class C3 (29.08%)**	**Class C4 (25.05%)**
gm	embryo	commission	ib
crop	human	nanotechnologies	innovation
herbicide	hybrid	information	council
conventional	chimera	member	fund
grow	animal	royal	igt
gene	creation	public	sector
maize	hfea	section	business
plant	act	society	pound
farmer	draft	system	industry
acre	cytoplasmic	regulatory	bbsrc
farm	bill	dialogue	strategy
food	legislation	operation	board
cultivation	hfe	paragraph	department
benefit	law	share	leadership
generation	licence	confidence	forum
resistant	purpose	government	skill
tolerant	prohibit	approach	epsrc
person	fertilisation	inform	lead
soil	allow	effort	synthetic

conclude	research	european	programme
evaluation	fall	medicine	biology
risk	embryology	website	support
wildlife	remit	safety	technology
rape	parliament	early	initiative
oilseed	proposal	ensure	energy
effect	woman	understand	market
country	tell	view	product
cost	create	way	strategic
narrow	permit	price	sustainable
variety	white	saving	investment
commercial	license	hospital	project
agriculture	regulation	enhance	engineer
pest	day	stage	industrial
fses	propose	nanotechnology	centre
offer	inter	response	chemical
unit	implantation	international	capability
organic	viability	therapy	work
biodiversity	revise	maker	new
farmland	mix	work	facility
fse	legal		bio
ecology	inquiry		rural
deep	regulate		change
study	committee		affair
result	authority		uk
suggest	regard		opportunity
scale	gamete		procurement
resistance	power		academic
relative	egg		invest
compare	prohibition		biotechnology
trait	vitro		carbon
www	definition		train
aebcs	storage		high
debate	reproductive		competition
trial	cover		physical
impact	argument		drive
coexistence	legislative		demonstration
counterpart	paper		chemistry
wild	leave		cogent
weigh	opposition		semta
eat	tissue		climate
beet	question		exist
atrazine	circumstance		growth

organism	sperm		deliver
pose	receive		manufacture
publish	specifically		key
basis	minister		network
uncertainty	specie		excellence
pesticide	humananimal		implementation
insect	flint		interdisciplinary
sow	respect		priority
breed	scrutiny		company
gov	provision		access
depend	subject		uks
approval	clear		agency
sample	ban		collaborative
attitude	entity		successful
release	terminology		plan
strand	amend		dti
finding	nuclear		sscs
adverse	line		ministerial
import	cell		job
liability	apply		build
toxic	statutory		biological
loss	clarify		renewable
allergenicity	m		institution
tolerance	oppose		grant
disadvantage	house		contribute
october			recommendation
flow			role
people			rcuk
frequently			green
environment			accelerate
manage			multidisciplinary
consumer			ktns
fee			demonstrator
introduction			cst
participant			activity
			facilitate
			chair
			solution
			academia
			economic
			million
			agenda
			launch

			closely play professional emerge

Appendix 5: Question Framework for Semi-structured Interviews

A – types of expertise and networks

1. What was your role in Government?

2. What did it involve? What was your objective?

3. Why do you think you were chosen for that job?

4. What kind of skills do think you brought to the job? (ask specifically about science background)

5. How was most of your time spent?

6. How did you decide who to talk to? What sort of people? How did you identify them? Do you usually know them already? How do you know they are the right people?

7. Did you ever work with people who had conflicting advice? How did you deal with conflicting advice?

8. Were there any instances where the public seemed to have a different view than the experts? Why do you think that was? How did you resolve it?

9. How did you know what the public were thinking (esp. cf Lords role)?

10. Have there been any instances where the science didn't help or wasn't sufficient to make recommendations? What did you do? Was there an opportunity to revisit the decision?

11. Do you think it is ever possible to split the science from advice – to act on the science alone? Would that ever be desirable?

B. Public

12. How does the view of society feed into this? How do you know what the public thinks?

13. Have you been involved with any public dialogue events? [if not involved – as whether he thinks it is important, why, what can public bring?]

14. What kind of insight did you think the public brought to the decisions/policy? Would you describe it as ‘expertise’?

15. Did you think it was useful? Why?

16. Did you act upon these views? Do you know of any examples where something raised in dialogue affected decisions?

17. Most of the evidence suggests that public dialogue has limited impact on policy. Do you have any ideas why that might be?

18. Have you heard of the term RRI?

19. What does it mean to you?

20. Do you think it can become a realistic way of doing research? Why? What are challenges?