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Governing Nanotechnologies by a Logic of Pre-emption

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To my parents

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Abstract

This thesis sets out to answer the question of how regulatory regimes come into being, surfacing the limited attention paid to hegemony in traditional accounts of policy-making. In detail, I address the conundrum of how a particular interpretation of the regulatory problem with a new technology, and of its solution, could catch on under conditions of uncertainty. Indeed, I seek to address this research problem of how to regulate a new technology through the two original and rich case studies of nanotechnology governance in Germany and the United Kingdom. Until 2009, the governance of nanotechnologies was marked by soft approaches to nanotechnology regulation, such as the UK industry's "Responsible NanoCode," or the German Industry Association's "Guiding Principles for the Treatment of Nanotechnologies." Problematised against experiences with strict regulation of genetically modified organisms, I explore how under conditions of uncertainty this particular soft approach to regulating nanotechnologies could catch on.

In my analysis, I identify a new form of regulation which is characterised by – what I conceptualise as – a *logic of pre-emption*. This *logic of pre-emption* manifests in a new regulatory regime marked by the 'responsible development of nanotechnologies.' In so doing, it leads to a new way of regulating the unknown that rearticulates the notion of regulation against the background of innovation. Deploying political discourse theory, I carve out the role of fantasy and the affective dimension of nanotechnology governance and the contingent constitution of the regulatory object as important vectors impacting on the upcoming regulatory regime. Methodologically, I contribute to the conceptual work on hegemonic policy analysis by building on Jason Glynos' and David Howarth's 'logics of critical explanation' that I articulate in my empirical enquiry together with concepts from rhetorical policy analysis.

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Nevertheless, I showed nomadic tendencies and worked from many different places in these four years. I would like to show my gratitude to my host institutions. In spring 2009, I worked at the Institute of Local Government Studies, University of Birmingham (Great Britain). A good colleague at this time was Stephen Ruari Jeffares who helped with advice on political discourse theory and on life in Birmingham. In autumn 2009, I was based at the Institute of Philosophy (nanoOffice), Technical University Darmstadt (Germany) thanks to Alfred Nordmann who did not only invite me for this stay but whose interest in my study and whose expertise in nanotechnology was also invaluablely helpful. The last year I spent at the Center for Technology and Society, Norwegian University of Science and Technology,

in Trondheim. I moved here for personal reasons; and thanks to my hosts, I had the opportunity to establish a professional life here and to finally write up my thesis.

The main body of this study is based on data generated in in-depth interviews. My dissertation, thus, would not have been possible without the help of my interviewees. They dedicated their time very welcomingly supporting the work of a student who wanted to learn from strangers. Thank you! During conducting my PhD, I was also privileged to meet many outstanding academics in personal meetings, at seminars and at workshops, whom I would like to thank for their interest in my work and for their input, thoughts, support, and reflections: Maarten Hajer, David Howarth, Sheila Jasanoff, Matthew Kearnes, Barbara Prainsack, Jacob Torfing, Henk Wagenaar, and Dvora Yanow.

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Heidrun Åm

Introduction

"Paradoxes are nothing but trouble. They violate the most elementary principle in logic: Something cannot be two different things at once. Two contradictory interpretations cannot both be true. A paradox is just an impossible situation, and political life is full of them." (Stone 2002:1)

In August 2009, the news agency Reuters spread the news about seven Chinese factory workers who had developed severe lung damage from inhaling nanoparticles during the production process (of paints). Two of the female factory workers had died from the conditions. The science journal *Nature* featured the story (Gilbert 2009). The connection between nanoparticles and the lung diseases of the factory workers was postulated by a paper published in the *European Respiratory Journal* (Song, Li & Du Eur 2009). The article triggered much discussion, for example in the *European Respiratory Journal* itself, in which nanotoxicologists objected to the assumption that nanoparticles caused the lung diseases (Brain, Kreyling & Gehr 2010). Indeed, Reuter's initial report had quoted a U.S. government expert who had downplayed the role of nanoparticles in the deaths, arguing that "the study was more a demonstration of industrial hazards than any evidence that nanoparticles pose more of a risk than other chemicals" (Lyn 2009). Similarly, Anthony Seaton, an expert in occupational medicine, pointed out that the incident said more about a total failure of health and safety measures (the workers were handling the paints without protection) than about nanoparticles' toxicity. The *Nature* article also cited Ken Donaldson, who had made news in 2008 with his studies on nanocarbontubes behaving like asbestos fibres, as questioning the results of the Chinese study: "I don't doubt that nanoparticles were present, but that does not mean they were the main arbiters" (Gilbert 2009). He considered the plastic material the patients worked with as the more likely culprit (ibid.).

This case brings out the multiple problems regulatory policymaking faces in regard to emerging technologies. Governance under such conditions of uncertainty has to deal with competing truths and problems of definition. Indeed, nanotechnology exemplifies this problem particularly well as a brief analysis of the science of this emerging field demonstrates: Broadly speaking, nanotechnology refers to intervening or to using materials on the nanoscale, which is often limited to 1nm to 100nm. 'Nano' is thus a measurement of scale representing 10^{-9} of a meter. In order to illustrate how small this is, talks at nanotechnology conferences or introductions to the nanofield for lay people frequently state that the relation between a football and the globe is analogous to the relation between a

meter and a nanometer. Others refer to the width of the hair for illustrative purposes, which is approximately 50.000 to 80.000 nm. At the nanoscale, the characteristics of elements change because the nanoscale signifies the interface between the quantum world and the world of mechanical physics. That is, mechanical physical laws are no longer valid at a scale where quantum mechanics dominates (Kulinowski 2006:16). Nanotechnology thus seeks to use these new functions and properties for products or manufacturing processes or to manipulate atoms and molecules in order to produce new materials.

With this in mind, the concept of 'nanoparticles' which informed the debate following the death of the Chinese workers refers to particles that were constructed or that had experienced nanotechnological intervention during their production. However, defining nanoparticles or nanotechnology is far from straightforward, as any definition of nanotechnology cannot be disentangled from the different visions constituting the field. To clarify this, we have to consider that the above-introduced term 'nanoparticle' could also refer to particles naturally occurring on the nanoscale, like fine particulates. Nanotechnology at the same time cuts across heterogeneous and previously unrelated research fields ranging from physics (quantum physics, material sciences, electric engineering) and micro-electronics to chemistry or molecular biology (Williams 2006:331).

In addition, nanotechnology at the same time appears to have endless possibilities of application. The potential applications of nanotechnology are so broad that nanotechnology appears as a panacea for almost any problem humankind faces (Kearnes & MacNaghten 2006:282). Indeed, nanotechnologies take high priority in many research and development policies worldwide, and they are continuously dealt with as the "key technologies of the 21st century." For instance, a classical and influential example promoting the revolutionary promises of nanotechnology is the U.S. report "Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science" (NBIC Report), published by Mihail Roco and William Bainbridge (2002) who both work for the U.S. National Science Foundation (Woods-Bennett 2008:209). The report discusses, for instance, how nanoscale genetics can play a role in preserving food production, and thus preventing world hunger, while equally claiming that nano-enabled biosensors will ensure public health and prolonged lives (see Bainbridge and Roco 2002:34). In sum, the ability to intervene at the atomic and molecular level is repeatedly attributed the

capacity to shape any facet of human activity (Matsuura 2006:20) and to be powerful enough to change the future of humanity (Woods-Bennett 2008:230).

Against this context, the risk of health problems caused by nanotechnologies (as in the case introduced above) presents itself as somewhat inconvenient. However, appeals to the advances offered by nanoparticles cannot be divorced from potential negative flipside of using these new properties that arise at the nanoscale. In short, nanomaterials may bear new risks. For example, the element gold, which is yellow and inert as bulk material, becomes red and toxic (Clift 2006:49) in a certain particulate form. In addition, nanoparticles are small enough for crossing the membranes of human cells. Then again, the exposition of the human body to fine particulate is nothing new; vivid discussions around diesel particulate or asbestos fibres come to mind. Nevertheless, any equivalence of nanoparticles to asbestos is perturbing, and the question of how far nanoparticles are new (and bring on the benefits indicated above) or not new (and thus part of the ordinary issue of fine particulate) is equally confusing, to say the least. The question really is whether and which engineered nanoparticles (which are manufactured by means of nanotechnology) differ from naturally occurring nanoparticles. Yet, again, in discussions, studying matter on the nanoscale and producing new matter on the nanoscale is often blurred. Importantly, it is unknown whether nanomaterials act and react differently than other materials or differently than the same material in bulk form.

In other words, nanotechnology brings to the fore the difficulties of regulatory policy-making under conditions of uncertainty. Until 2009, the governance of nanotechnologies was marked by soft approaches to nanotechnology regulation, such as the UK industry's "Responsible NanoCode," or the German Industry Association's "Guiding Principles for the Treatment of Nanotechnologies." Such documents classically recommend that nanotechnology should be handled responsibly, transparent, and with a willingness for dialogue. Nanotechnology governance is often hailed as a turning point in approaching new technologies. Policy statements on nanotechnology offer frequently a thorough discussion of the ethical, societal, and health implications of a technology that is, supposedly, still in its infancy. Nanotechnology is largely regarded as offering an opportunity to apply "learnt lessons" and "to get it right the first time" (see i.e., Goldenberg & Einsiedel 2006, Balbus, Denison, Florini & Walsh 2006, Kenneth & Thompson 2008, Metha 2006). These notions

refer to missed chances with other technologies and scientific risks (e.g., BSE-crisis) and to public reluctance towards these (e.g., GMO).

Set against the uncertainties introduced before, it is particularly interesting how governing bodies could put in place regulatory regimes for nanotechnologies under these conditions. How did they deal with competing truths, opposing demands, and problems of definition? And what constituted the move to forms of soft regulation when in other regulatory fields, such as biotechnology governance, Britain and Germany were among those who have adopted a precautionary approach to regulation? To be sure, risks arising from genetic modification have not been proven and thus remain as uncertain as the risks of nanotechnology. Thus, when problematized against experiences with genetic modification, it is paradoxical that a soft regulatory approach adopted for nanotechnologies seems to take such new and still homogeneous forms across nations. At the same time, it would be a misinterpretation to read this shift towards flexible policy instruments too quickly as de-regulation. Policy instruments such as environmental management systems, corporate reporting systems or codes of conduct can as well be seen as new techniques of control designed to obtain constant oversight (Levi-Faur 2005:22). If we see codes of conduct as a new form of control-mechanism, we can turn the puzzle on the head and wonder how soft 'soft regulations' are and whether not tight oversight is introduced into nanotechnology. What then justifies the vast amount of attention nanotechnology receives in the form of reports, working groups, stakeholder forums, citizen conferences, ministerial meetings, and so forth? After all regulatory action on genetic engineering seems to be more justified as genetic engineering intervenes in life itself and thus, encompasses a relatively clear policy field. In contrast, nanotechnology covers a range of disparate areas and constitutes a diffuse field. Furthermore, new toxic substances are produced every day, for example, within the chemical industry, without gaining similar prominence on the regulatory policy agenda.

This dissertation responds to such questions, seeking to answer the key research question of how *this particular* regime of regulating nanotechnology came into being under conditions of uncertainty. Indeed, what regulatory practices emerged and how did they take hold? Nanotechnology thus serves here as a significant case to analyse the emergence of a regulatory regime. More specifically, it prompts a number of connected questions. How did it come to be taken for granted by policymakers that nanotechnology was something to be

concerned about at all? And if policymakers were to regulate nanotechnology, what was nanotechnology anyhow?' How was it defined over time and in which political contexts?

In answering such questions, I will conduct an analysis of two case studies: nanotechnology governance in Germany and the United Kingdom. Germany and the UK were chosen as cases because both countries made clear efforts to shape nanotechnology regulation and were what I term 'early adopters' in the field of nanotechnology governance. On the one hand, the report of the UK Royal Society and Royal Academy of Engineering titled "Nanoscience and nanotechnologies: opportunities and uncertainties" received much international attention from its commissioning in 2003 onwards, and UK actors chaired important EU working groups on issues of nanotechnology regulation. On the other hand, Germany has been the clear nanotechnology leader in Europe in terms of patents and publications in the field. Both states however demonstrated certain parallel political developments in the 1990s with the rise of social-liberalism, marked by the election success of New Labour in 1997 and the Red-Green Project in 1998. In addition, both states experienced public resistance in biotechnology governance (against genetically modified organisms [GMO]) and severe crises of public confidence in public institutions after governance failures in the course of the bovine spongiform encephalopathy (BSE) crisis. Nevertheless, notable differences also exist between the two cases. Concerning biotechnology governance, for example, the UK has the most liberal regulation of embryonic stem cell research in Europe, while Germany adopted a restrictive approach (Gottweis & Prainsack 2006).

Existing theoretical approaches on regulatory policymaking tell little about explaining the emergence of a specific regime in a specific context because they have tended to focus on developing large, overarching explanations to explain the development of regulation. In general, the regulation literature (see Hood, Rothstein & Baldwin 2001, Majone 1994) distinguishes between normative theories, positivist theories, and theories of the risk state. In detail, normative theories of regulation assume that the state should only operate if the market does not produce an optimum itself (Majone 1994:81). These approaches thus develop explanations of moves towards regulation as the result of "functional or market-failure" (Hood et. al. 2001:63). The positivist theories about regulation (i.e., Stigler, Wilson) provide "interest-driven" (Majone 1994:82) instrumental accounts which assume that practices of regulation are influenced by the different size and power of interest and lobby groups (Hood et al. 2001:65). Theoretical approaches that see the "regulatory state as a risk

state" (i.e., Giddens, Beck) (Moran 2007:26) develop typical metanarrative accounts of structural changes in society and the economy but they often give opinion-responsive answers suggesting that "public policy follows public opinion" (Hood et al. 2001:64) as whether 'public opinion' can be simply reduced to an independent variable. After this general categorisation of traditional approaches to regulatory policy-making, let me present two scholars in more detail: Among the best known theoreticians on regulation is Giandomenico Majone who assumes that regulations paradoxically increase instead of decrease as the state retreats from public ownership in the wake of neo-liberalism. According to Majone, new demands of keeping control arose with the retreat of the state; these demands led the state to increasingly rely on regulation for control (Majone 1994:78). Along with this rise of scope and depth of regulations came a change in the function of the state as *regulatory state*. Despite its implicit aim of providing state-control, the new regulatory work does not show a control-structure, but regulation has become less rigorous and less burdensome; it works, for example, with economic incentives (Majone 1994: 80). A similar argument is suggested by David Levi-Faur (2005), who writes about the global diffusion of *regulatory capitalism*. He suggests as well that neoliberalism implicates increasing regulation. He supports his argument by citing the empirical example of the telecommunication and energy sector showing the increase of regulatory agencies as a result of increased privatisation.

As concerns the research question of this thesis—how a specific regulatory regime emerged—scholars like Majone and Levi-Faur operate too high because they discuss big structures on the global and national level. A solution to this problem of overarching, de-contextualised explanations could be found in cases studies. In fact, there are relatively few thick descriptive case studies. One such attempt is the work of Hood, Rothstein and Baldwin presented, for example, in their book (2001) *Government of Risk: Understanding Risk Regulation Regimes*. They provide a sound comparative analysis of nine British regulatory regimes against a set of variables, which they developed. Thus, they order a complicated, messy policy field. However, their description and categorization does not explain how regulation developed. For example, their reduction of the external variables of the regime's context to market failure, public perception, interest groups or the world of regulatory bureaucracy restricts the theories' power to explain the emergence of nanotechnology regulation. Traditional studies on regulatory policy-making do not pay attention to the construction of meaning in and through policy-making; for example, they take the regulatory object (nanotechnology) as given and thus, they are blind to how the (changing) construction

impacts on regulatory policy-making. As I will argue, there was no market failure, few interest groups had a strong profile in the field, and data about public perception show ignorance. Most importantly, such explanations fail to capture the uncertainty when actors might not even be able to determine their interests, the messy reality of nanotechnology governance or how nanotechnology entered into the regulatory agenda at all.

In sum, traditional approaches to regulatory policy-making either understand the cases (i.e., Hood, Rothstein and Baldwin) *or* they understand the overarching structures (i.e. Levi-Faur, Majone) but they do not fuse these explanatory levels. According to my rationale, we need to understand both: the cases *and* their conditions; we need theoretically informed contextualised case studies: An empirical study of a regulatory regime in question shall neither subsume the concrete case under universal laws nor reduce any explanation to the particular context of the case (Glynos & Howarth 2007). But more importantly, traditional accounts of policy analysis do not get how actors deal with uncertainty and contingency. Uncertainty poses particular problems for governments, as decision-making is highly politicised when no recourse to 'facts' is possible when faced with new technologies. To decide what is true or false includes choice and contingency. Hence, knowledge and power are two sides of the same question: "who decides what knowledge is, and who knows what needs to be decided?" (Lyotard 1979:8). However, traditional approaches of policy analysis treat a regulatory issue such as an emergent technology despite the just mentioned complexities as linear and determined development without acknowledging that technology development is a political process. Consequently, they either subsume regulation as response to overarching structural drivers or they reduce agents to instrumental, calculating actors. Thus, we need theoretically informed cases and a comprehensive theoretical approach making sense of uncertainty and acknowledging contingency and hegemony in the production of meaning. Power, generally, has been largely neglected in existing studies on nanotechnology, with the exception of the work of Joscha Wullweber (2010) and Petra Schaper-Rinkel (2006), who, however, do not carve out what this implies for nanotechnology regulatory policy-making.

Hence, this thesis seeks to address the lacuna of explaining the emergence and sedimentation of the nanotechnology regulatory regime by drawing on post-structuralist policy analysis. A post-structuralist policy analysis acknowledges uncertainty and contingency; deploying a post-positivist epistemology, it draws particular attention to the constitutive role of language.

My approach complements existing poststructuralist studies on regulatory policy-making with political discourse theory's insight on hegemony and the role of fantasy. From this perspective, a regulatory regime can be understood as a hegemonic discourse, which constitutes certain rules (or logics) guiding practices and which is – at the same time – constituted, reproduced and transformed in these practices. By carving out how fantasmatic appeals grip policy-makers, I will generate innovative insight on the role of affective, emotional responses in nanotechnology regulatory policy-making which brings to the fore the politics and contingency of the emergence of a regulatory regime.

The poststructuralist policy analysis, that I employ, acknowledges that we have to ask what the conditions of possibility are that – under conditions of uncertainty – meaning can be created in terms of what nanotechnology is and how nanotechnology can best be governed. In uncertain situations, we can take recourse to imagination in order to make sense of events. Ezrahi (2004) suggests that we in our time experience a shift from foundational to dynamic conceptions of reality in which reason is increasingly complemented by "imagination as the faculty which consciously mediates the making and unmaking of political worlds" (Ezrahi 2004:260). In fact, an abundance of studies of nanotechnology and society deals with narratives, visions, and imaginations in nanotechnology (see i.e., Ferrari & Gammel 2010, Wickson 2008, Berne 2006). Much has also been written on nanotechnology regulations (see i.e. Stokes 2009, Bowman & Hodge 2007, Owen 2007). But in contrast to the study at hand, none of these account for the constitutive role of discourse in explaining nanotechnology regulations or set forth a critical explanation of the conditions of possibility for this discursive formation to emerge.

Analysing hegemony in public policy from a poststructuralist political discourse perspective remains an innovative endeavour (see the work of David Howarth, Jacob Torfing, Steven Griggs, Stephen Jeffares, or Jeremy Jacobs). With my empirical enquiry into regulatory policy-making on nanotechnologies I contribute to the conceptual work on hegemonic policy analysis which has culminated in Jason Glynos' and David Howarth's book "Logics of Critical Explanation." Building on their formalized framework, I will conceptualise practices that subscribe to, carry on, and reproduce the nanotechnology regulatory regime as social practice. Practices that challenge, deconstruct, and change the existing regulatory regime, I call political practices. Accordingly, the employed theoretical framework distinguishes between three logics as basic units of critical interpretation and explanation: social logics

that characterize social practices or regimes; political logics that enable social practices, their institution and contestation; and fantasmatic logics that assist in explaining what drives political practices (Glynos & Howarth 2007). Through my empirical work, I demonstrate that political discourse theory, formalized in the logics-framework and complemented with concepts from rhetorical policy analysis provides a fruitful approach to generate new results on hegemony in technology governance (see particularly the discussion in chapter 7).

Methodologically, I investigate the practical modes through which the governance and regulation of nanotechnology have been accomplished by attending to their broader political construction and their socio-political context. In my approach to policy analysis and hegemony, I provide a critical explanation in several steps: problematization, genealogy, articulation, and evaluation/judgement. In terms of analysis, rhetorical shifts, general equivalences—for example, in terms of analogies, and metaphors—and a corpus of arguments in the articulation of demands are tracked. For example, the nanotechnology regulatory debate concentrated on questioning whether existing regulations were sufficient or whether new regulations for nanomaterials were needed. In this regulatory struggle, the issue whether nanotechnology was considered "new" or "not new" became an issue of politics as well as the question of what was classified as "nanotechnology."

Contributions to understandings of regulation

This dissertation argues that a new mode of regulation can be observed in nanotechnology governance, compared to the likes of biotechnology governance. Several academic articles in the field, such as Barben et al. (2009), diagnosed a uniqueness of nanotechnology governance. Nanotechnology governance supposedly is outstanding because of the amount of dialogue initiated at the interface of science, politics, and public. In addition, these dialogues are said to come in early; reiterating the anticipatory aspect in nanotechnology governance. In nanotechnology, this literature says, policy-makers are aware of the co-production between science and society; and decision-making acknowledges that it must include "foresight, self-awareness, and imagination" (Barben et al. 2009).

My first contribution is to demonstrate that the uniqueness of nanotechnology governance is produced by the continuing imagination of potential conflict and the strong demand to avoid

polarisation and protest. I develop an explanatory device to account for this new development in science policy, which I call a *logic of pre-emption*. This political logic is carried by the assumptions that conflicts shall be anticipated (pre-) and settled before they even emerge (emptied). Anticipation is nothing per se new in policy. Particularly in the context of environmental policy, anticipatory policy-making had been a term which signifies the move towards a "more pro-active environmental policy regime" (O'Riordan 1989) since the end of the 1980s. A related term is precaution in policy-making. Prominently, the Precautionary Principle was introduced in technology governance to "intervene pro-actively to pre-empt harm" (Feintuck 2005). However, even if the logic of pre-emption, I conceptualise, has certain features in common with precaution and anticipation (for example foresight and intervention), it is different in its focus on pre-empting *conflict*. In this respect, the logic of pre-emption identified in my study of nanotechnology governance is also different to Anderson's valuable work on pre-emption (Anderson 2010). Based on Deleuze's logics, he identifies and compares a logic of precaution, a logic of pre-emption and a logic of foresight as ways to cope with future in policy-making. The use of similar terms shall, however, not mask over the differences in our results. He subsumes pre-emptive war within his logic of pre-emption. But pre-emptive war *initiates conflict*. In contrast, the logic of pre-emption, I identified, aligns all efforts to *avoid conflicts*. This strong demand to depoliticise is new in technology governance.

My second contribution to policy analysis and to the nanotechnology governance literature is to highlight the role of fantasmatic appeals in policy-making, in particular the centrality of imagining conflict. While authors like Kearnes (2009), Kearnes and Rip (2009), and Barben et al. and Guston (2007) contributed significantly to characterising nanotechnology governance, they did not explain how nanotechnology developed; how this particular regulatory regime caught on. They acknowledge the background of public engagement and the rise of horrific fantasies, but my analysis necessarily complements their work by addressing how policy-makers took the horror fantasies as 'true' and how they initiated action on it. That is, by bringing in fantasmatic appeals and emotional, affective responses in policy-making, I demonstrate the link between individual agency and collective decision-making. I will demonstrate that the imagination of potential conflict is captured by former experiences of protests against genetically modified organisms (GMO) and governance failure in the BSE-crisis. Nanotechnology governance in this sense can be interpreted as the

answer to the problem of GMO. While GM governance anticipated risks and met them with precaution, nanotechnology governance anticipates conflicts and meets them pre-emptively.

Third, in addition to the fantasmatic aspect, I carve out the importance of considering context and the role of articulation. Indeed, I contribute to the literature of nanotechnology and society with a detailed rich comparative case study. To analyse how actors used the term nanotechnology in regulatory debates in concrete contexts allows me, for example, to point to the emptying of meaning of the term 'nanotechnology.' In fact, I bring out the contingency in the constitution of nanotechnology and how this impacts heavily on the emergent regulatory regime.

Structure of the Thesis

Having in this introductory chapter set out the main lines of inquiry and research questions of the thesis, the next two chapters develop further the theoretical and methodological approach deployed in the thesis. Chapter One on the theoretical underpinnings of the thesis challenges existing poststructuralist approaches to regulatory policy-making and then sets out to bring in political discourse theory's insights on hegemony in policy analysis to critically explain the emergence of regulatory regimes. The second chapter on methodology explains how hegemony can be empirically analysed and what my particular research strategy in the analysis of nanotechnology regulatory policy-making was. These two chapters are followed by the presentation of my empirical analysis.

In general, I distinguish between a first and second period of nanotechnology governance (period I and period II). This structure is represented in the chapter organisation. The first period (innovation-period) lasted approximately from the late 1980s to the year 2002. In the second period, the responsible development of nanotechnologies emerged. Chapter Three and Four thus address the emergence of nanotechnology as a regulatory object, with Chapter Three in particular focussing on the first period in both Germany and the UK. Here I argue that the contingent articulation of nanotechnology in early nanotechnology governance formed the conditions of possibilities for a soft mode regulation characterised by the logic of pre-emption to emerge. Importantly, I demonstrate in Chapter Four that the move to regulating nanotechnologies was *an internal response by state elites* to protect the

nanotechnology-project. In Chapter Five, I then show how, in detail, policy-makers set into place a regulatory regime in order to stabilise nanotechnology development. Nanotechnology was linked with environmental, health and safety discourses, and a risk regime was established, characterised by the quest for a "responsible development of nanotechnologies" and driven by *a logic of pre-emption*. Chapter Six and Seven explore the manifestation of *a logic of pre-emption*, that is the sedimentation of the discourse of "responsible development." Indeed, I argue that when it comes to the implementation of particular practices, rules, and regulations under the guise of pre-emption, the very logic of the pre-emptive regime becomes contested. In the face of such challenges policy-makers in Germany and the UK, who constructed the regulatory object nanotechnology in the first place, deconstruct it again. But the responsible development of nanotechnology maintained its hegemony by promoting a new way of regulations which avoids clear definition and strict rules: an adaptive, flexible mode of technology regulation thus caught on. In the concluding Chapter Eight, I turn to discussing such broad conclusions as to changes in regulatory governance identified in my study. I now begin by setting out my theoretical approach

1 Theory: Towards a Poststructuralist Policy Analysis to Explain the Emergence of Regulatory Regimes

In this chapter I review different theoretical approaches to analysing regulatory policy, set out their limits and build upon them for my study of nanotechnology governance. As outlined in the introduction, my aim is to critically explain the development of a regulatory regime on nanotechnologies, marked by codes of conduct and public engagement. In contrast to genetically modified organisms (GMO), governance in the two European countries in analysis has not adopted the precautionary principle. This is puzzling as it indicates a change in how we deal with emerging technologies which are marked by widespread uncertainties. A simplified answer would be that legislation on GMO was enacted in response to citizen protests against trials with genetically modified plants and against the consumption of genetically modified food. However, this answer just raises another question: why did no protests catch on against nanotechnologies? After all, both technologies imply human intervention at the molecular scale, and the long-term consequences of nanotechnology are as unknown as those of genetic modification. Hence, I require a theoretical approach to help me answer questions regarding policy *emergence* (of a new kind of adaptive governance with soft regulation), policy *change* (from GMO regulation to nanotechnology regulation), and *conflict* (or the prevention of conflict).

Following my problematisation of nanotechnology governance, it has to be asked how a current regime became hegemonic under conditions of radical contingency. A theory that considers both uncertainty and the constitutive role of language is poststructuralism. Indeed, I will argue that it is best to draw on political discourse theory to critically explain¹ how regulatory regimes emerged. The theoretical framework shall enable me to develop a critical explanation of the nanotechnology regulatory regime that goes beyond empirical descriptions of regulatory institutions and rules. I investigate practices of regulation and the political construction and transformation of regulatory regimes in context. Thus, I consider the 'politics' of regulation (in terms of the practices, discourses and institutions) against the 'political' in regulation (in terms of what enabled the institution or contestation of practices). We have to ask what the conditions of possibility were that – under conditions of uncertainty

¹ How does explaining and being critical go together? "In this model, the *explanandum* consists of problematized social phenomena that are always to some degree mediated by existing theoretical structures *and* by the discursive practices investigated." (Glynos & Howarth 2007:47)

– meaning could be created in terms of what nanotechnology is and how nanotechnology could best be governed. Poststructuralist theories of language come in as meaning is understood as 'the play of signifiers.' The aim is to interpret social practices by situating their meanings in broader historical and structural contexts (Howarth 2000: 11–12).

This chapter has five parts. Section one presents the mounting critique against classical policy analysis around the 1980s, which laid the foundation for the rise of interpretative approaches to policy analysis. Second, I provide a broad and brief discussion of the interpretative turn. I will identify five common denominators within the variety of approaches collected under the term 'interpretative turn': post-positivism, anti-rational choice, a focus on meaning making, taking language seriously, and the acknowledgment that you cannot abandon uncertainty. While a broad brush across these five themes allows me to establish a certain unity among the abundance of approaches within interpretative policy analysis, the differences might be stronger than the similarities. Indeed, this section has to be read as a positioning of myself within the field. Particularly, I take a stance for a poststructuralist policy analysis. In contrast to mere hermeneutic or phenomenological accounts, which solely focus on the generation of meaning, I highlight the necessity to consider the constitutive role of language, context, and radical contingency.

The third section introduces the philosophical backbone of this thesis which is to dwell on uncertainties, to put uncertainty in the centre of political analysis (Finlayson 2007:550). I will distinguish between ontic and ontological conditions of uncertainty underlying this study on nanotechnology. The ontic dimension of uncertainty refers to the interrelation between postmodern knowledge, scientific development, and risk governance. The ontological dimension of uncertainty comprises the negative ontology adopted in this thesis, deriving from Lacan's 'ontology of lack,' Derrida's 'indecidability,' and Lyotard's 'radical contextualism.'

In the fourth section, I review three existing poststructuralist studies of science and technology regulations: Sheila Jasanoff's work on biotechnology regulations, Maarten Hajer's study on environmental regulation and ecological modernisation, as well as Herbert Gottweis's "Governing Molecules." I will arrive at the argument that these theoretical approaches fail to account for fact that subjects who gained actor-position in technology governance must inherently be persuaded of the need for change and have the will to initiate

change. If subjects are complicit in concealing problems, they will not contest existing regulatory regimes. Finally, I will introduce Political Discourse Theory as a poststructuralist, theoretical framework for policy analysis and hegemony.

1.1 The problem of positivist policy analysis

The rise of the policy sciences was strongly connected with the wish, and belief, that the social sciences should help to generate understanding of the policy process and data for better (democratic) policy-making (Lasswell 1951:3). From the beginning the policy sciences were intertwined with positivist beliefs. That is, they were conceptualising human behaviour as rational process, and they were assuming that human behaviour showed patterns that can be detected by quantitative social sciences. Their aim was to predict the likely course of actions. The founders of the policy sciences, such as Lasswell and colleagues, conceptualised decision making as a rational process in which policy-makers would first analyse the problem and define the goals, then evaluate alternative policies and their possible consequences, and finally, opt for a policy (Rothwell 1951:ix). The task of the social scientist was to deliver appropriate information for these informed choices.

However, criticism arose when these approaches failed to deliver what they promised to do: to gather data and to provide prediction for informed decisions in policy-making. A Lasswell-inspired policy analysis could not guide policy-making in the rational way it was expected; facts remained contested and decisions politicised. Policy analysis did not reach their aim "to bring the unstable, ideology-driven and conflict-ridden world of politics under the rule of rational, scientifically derived knowledge" (Wagenaar & Cook 2003:140). The expected improvement of social conditions by applying sterile, mechanically produced knowledge stayed wanting (ibid.). An example of the mounting critique against traditional approaches to policy analysis is expressed in the following quote:

Since the Second World War, scientific information and analysis have been sought increasingly as aids to the resolution of practical policy problems. This growing demand for usable science has encouraged a rapid increase in the supply of would-be scientific policy guidance and advice. Much has been accomplished; but a growing tide of critical commentary indicates that all is not right. As Lindblom and Cohen have characterized the situation, analysts are dissatisfied "because they are not listened to," while policymakers are dissatisfied "because they do not hear much they want to listen to." Many factors influence these laments, the most obvious being ignorance and conflict. For in practice, scientific inquiry cannot discover most of the things that policymakers would like to know. Much of what it does discover remains uncertain or incomplete. How, then, is "scientific" knowledge any more reliable a guide to policy than other forms of knowledge, prejudice, or propaganda?

Moreover, experts often disagree on what science knows and on what that knowledge means for policy. If the knowledge produced by science is not consensual, what special claim for hearing can it make in a world of multiple opinions and biases?
(Clarke & Majone 1985:6)

This Clarke and Majone article was published in a special issue of the journal "Science, Technology, & Human Values," which addressed the question of how peer review of regulatory sciences could help restore authority in a "perceived crisis of legitimacy of regulatory agencies" (Jasanoff 1985:30). The quote points to two problematisations which shall guide the theoretical considerations on the following pages.

The first problem for traditional models of policy analysis is that that they have limited explanatory power in conditions of uncertainty, where policy problems are contested, ambiguous, shifting or paradoxical. For example, Clark and Majone talk about risk assessments in regulatory sciences, and they describe how regulators are unsatisfied by the data they get from sciences. Much knowledge remains uncertain. In my empirical study on nanotechnology in the next chapters, we will frequently encounter demands to 'fill the knowledge gaps.' And we will get to know actors who are worried that nanotechnology products are marketed quicker than risk research will produce results. In general, the risk research results might only be valid in certain contexts, e.g. experimental conditions in the laboratory, and regulatory sciences often cannot provide data on long-term affects. As a consequence, the authority of scientific knowledge is doubted and its particular status among other forms of knowledge becomes questioned. I will address this uncertainty and the general issue with the 'postmodern science.' The latter encompasses a loss of trust in sciences, the decreasing belief that sciences can provide absolute truth, and the increasing acknowledgment that everything that includes human behaviour is per definition not predictable.

Second, classical modernist policy analysis has many blind spots that prevent it from delivering appropriate data. For example, Hajer (2003) convincingly showed in the case of governmental nature development plans in the Netherlands how the best designed policy plan (a reconstruction of farmland along ecological premises) can fail, when it does not take into account that top-down decisions can be rejected locally by those affected by the decisions. Because policy analysis tried to copy methods of natural sciences in order to deliver causal laws about social behaviour (Fischer 2003:209), crucial aspects such as the formation of political communities and identities were ignored.

In the context of rising criticism against the modernist project of policy sciences, those critical voices in social science could get louder – those who never quite agreed with conducting social sciences along the premises of sciences. The 'interpretative turn' could gain a foothold. This post-empiricist conception of policy science addresses the multidimensionality and complexity of social reality (Fischer 2003:209). Interpretative Policy Sciences no longer tries to press social reality into the grid of independent and dependent variables, but tries to put the uncontrollability of social action and the centrality of judgement and interpretation to the fore of the analysis (Fischer 2003:226). The interpretative turn, which I will develop in the following, can thus be seen as an answer to the challenge of postmodern knowledge, and it developed out of the recognition of the shortcomings of a positivist research agenda.

1.2 Interpretative turn

The 'interpretative turn' is not a unified scheme, but rather a collection of independent developments in different disciplines ranging from sociology and political sciences, to linguistics or geography. It also triggered the emergence of new disciplines. The sociology of scientific knowledge, for example, rose as a discipline at the beginning of the 1980s and is now maybe 'the' important field within Science and Technology Studies (STS). Another example that gained importance at this time is "Cultural Studies," with its founding fathers Raymond Williams and Stuart Hall. This 'cultural turn' nowadays has manifested in its own Cultural Studies departments at many universities. I said 'cultural turn' now instead of 'interpretative turn.' Indeed, 'the turn' has different names according to different disciplinary and methodological practices. Yanow and Schwartz-Shea (2002) list, for instance, the argumentative turn, the rhetorical turn or the narrative turn (p. xi). As even the name is unclear, it is even more unclear what the turn encompasses.

In the following, I will introduce the 'interpretative turn' which *I* adhere to as composed of five common denominators: post-positivism, anti-rationalism, a focus on social meaning, language and uncertainty. While this might seem to be an – at the first glance – unnecessary revision of what has been said by others in more detail and more accurately, I feel it is necessary to pinpoint which understanding of the interpretative turn guides this study on

nanotechnology governance. As said, the range of theoretical models within the interpretative turn is wide and contradicting, and from this a need for definition derives.

A first important denominator among interpretative approaches to policy analysis is that they were established in the context of the development of a post-positivist social theory and methodology (Gottweis 2003: 247). This post-positivism critically engaged with ideas of scientific validity and reliability proposed by critical and logical positivisms (Yanow & Schwartz-Shea 2002: xii). Positivism has its roots in the Enlightenment, when the sciences became an important, new source of authoritarian knowledge (complementing the hitherto knowledge monopoly of priests and monarchs) (Yanow 2006:8). Along with the rising authority of scientific knowledge, the question of what 'scientific' means became important. As Yanow (2006) recounts, the new scientific reasoning, which assumed that there were a range of universal laws that could be discovered and applied in different contexts, increasingly gained ground; these laws would allow for prediction and thus control. In the 19th century, this understanding of 'science,' which derived from physics and other natural sciences, was transferred for application on the social world. This was the foundation of 19th century positivism (Yanow 2006:8). It was a century in which different variations of positivism developed, such as critical positivism, which had at its core the belief that knowledge claims are only scientific and trustworthy if based on the senses (sight, sound, touch, taste, smell) and therewith, science should consist only of descriptions of experience (ibid.).

While traditional approaches to policy analysis promote, i.e. there is a strict differentiation between fact and value in scientific analysis (which is what makes, according to them, an enterprise a *scientific* enterprise), interpretative approaches assume that researchers cannot leave behind *a priori knowledge* informing their studies. Until today, the mainstream literature in social sciences is guided by a positivist search for replicable causal generalizations (Fischer 2003b:212). Traditional approaches to policy analysis did not experience a severe backlash in the 1980s, but rather are dominant in policy sciences (Glynos & Howarth 2007:1ff). We see their manifestation policy analysts' research designs that aim to conduct quasi-experiments, pursue multiple regression analyses, survey research, perform cost-benefit analyses or employ even mathematical simulation models on social reality (Fischer 2003b:212). Interpretative approaches, in contrast, object to the basic assumptions of positivism. Developed out of phenomenological and hermeneutic

philosophies, interpretative approaches assume, for example, that the researcher is influenced by the *a priori knowledge* that he brings to the field and that this shapes his attention, experience, and interpretation. For example, the perception of colour depends on whether categories in the form of words are available for the colours (Yanow 2006:10). That does not mean that sensual experiences have no validity, but that these experiences are historically and socially contextualized because the subject of study and the research are both historically and socially situated (Yanow 2006:10).

Second and tightly connected with the interpretative approaches' general rejection of positivist ideals is their critical engagement with rational choice theories in particular. Rational choice theory is among the most popular orientations within positivist social sciences today (Fischer 2003:210). Common denominators among theoretical approaches of rational choice are that they focus on the "instrumental actions of individual policy actors" (Griggs 2006:173). Based on the contention that individuals possess rank-ordered preferences when confronted with different policy goals, these approaches assume policy-making is marked by cost-benefit analysis. Thus, individuals evaluate the costs and benefits of different policy actions and choose the policy which is most likely to provide the best output of the individual actor himself or his institution. The aim of rational choice approaches is to predict the decisions of policy actors and to provide universal explanations of the policy-making process (Griggs 2006:173ff). In his critical perspective on rational choice theories, Steven Griggs (2006) highlights that the "parsimonious assumptions that privilege the instrumental actions of individual policy actors" go unquestioned in rational choice theories. In addition, the focus on simplified, individual patterns of action overrules the uncertainties, complexities and ambiguities in decision-making processes (178). With reference to Green and Shapiro's (1994) critique, Griggs also points to rational choice's failures in addressing the empirical (179). After I have herewith identified what the 'interpretative turn' is by saying what it is not (not positivism, not rational choice), I will now turn to the constructive side of the 'interpretative turn.'

Third, one shared orientation within the interpretative turn is "an overarching appreciation for the centrality of meaning in human life in all its aspects" (Yanow & Schwartz-Shea 2006: xii). This common point of reference encompasses the basic assumption that shared meanings motivate people to action and link individuals with collectives. What this meaning consists of is then at the centre of political conflict (Stone 2002:11). Consequently,

interpretative policy-making shifts attention toward the generation of meaning. It is the starting point for post-positivist policy analysis in contrast to its mainstream counterpart.

Such social science is based on a turn from the dominant emphasis on rigorous empirical proof and verification to a discursive, contextual understanding of social knowledge and the interpretative methods basic to acquiring it.
(Fischer 2003b:211)

Linked to empirical research, the interpretative turn implies that physical objects are not seen as having an intrinsic meaning structure, but that human actors actively construct their world. Policy analysis in turn has to identify the ideas and social understandings upon which their world was constructed (Fischer 2003:48). The similarities of interpretative approaches vanish, however, when we dig deeper into understandings of meaning-making.

More hermeneutical and phenomenological-inspired approaches within interpretative policy analysis focus on the social construction of intersubjective understanding. Phenomenological analysis explores "the ways in which humans weave not only the social world in which we live but the very identities we construct for ourselves as we live in those worlds" (Yanow 2006:6). Building on the work of Schütz, Husserl, Berger and Luckmann, in the focus of analysis of these hermeneutical approaches is the question of how humans create meaning from experiencing (Husserl: how do you know?). Schütz's main interest was lived experiences and how meaning-making is informed by *a priori knowledge* (Yanow 2006:12-13). The analyst's aim then must be to understand the meaning of the social phenomenon from the actors' perspectives (their self-interpretations) by focusing on the interpretation of the phenomenon by the actors themselves (Fischer 2003: 51). The research method is to understand (*Verstehen*), to flesh out different understandings of social phenomena (Fischer 2003: 52), and to see subjective sense-making in the context of the shared meanings in communities (Yanow 2006:10-11).

More poststructuralist approaches within interpretative policy analysis, in contrast, criticize "the phenomenological search for the essential meanings of phenomena and is sceptical of its strong conception of human subjectivity in constituting meanings" (Howarth 2000:39-40). Accordingly, the analyst's aim must be more encompassing and should ask how meaning is made possible in the first place (Howarth 2000: 5). Poststructuralist policy analysis investigates into how meaning has been accomplished by attending to its political construction and to its broader socio-political context. In this conception a particular

meaning of phenomena can become hegemonic because different strands of discourse were weaved together that fix identities of objects and practices in a particular way (ibid. 102). Accounting for hegemony in policy analysis is important. Solely generating data on the meaning of political communities, like Dvora Yanow suggests, does not help me to explain how a certain regulatory regime emerged (Yanow 2000:20). I can generate data on the meaning of nanotechnology for political communities such as regulators, industry or environmentalists, but this gives the wrong picture that all these 'meanings' stand equally next to each other. I claim we have to ask how one meaning came to dominate over another and which exclusions this hegemony implies. As Foucault says, the production of truth is always connected with power. If something was successful in getting truth with big T, it is due to power. Finally, the discourse theory I apply also assumes that meaning can be only partially fixed "because systems of meaning are contingent and can never completely exhaust a social field of meaning" (Howarth 2000:8). Thus, my approach is rooted in poststructuralism and puts indecidability and contingency in the focus. But before I turn to the central role of uncertainty, I will briefly say something about the role of language in interpretative approaches.

Forth, another common denominator among so-called argumentative, rhetorical, post-structural, critical, narrative, interpretative, and so on policy analysis is that they take language seriously (White 1992 and Edelmann 1977 after Yanow & Schwartz-Shea 2002: xii). In fact, one of the many names of the turn is the 'linguistic turn' (Rorty 1967). Whereas positivism believes that there is 'a truth out there' that can be represented by the neutral medium language, critical policy analysis pursues an anti-representational view and accounts for the constitutive role of language (Gottweis 2003:249). Rorty (1989) said, for example, that changes and revolutions are always closely related to and constituted by changes in the way language is used (27-28). This means that I conceptualize, for example, risks of nanotechnologies or promised applications of nanotechnology as articulations rather than as fact. I will pick up the topic of the role of language in policy analysis in more detail in the methodology chapter. For now, I turn to the last common denominator of interpretative policy studies and therewith to the common denominator which I put at the centre of my theoretical approach: uncertainty.

1.3 Uncertainty: Postmodern knowledge and radical contingency

How could the uncertainties and ambiguities in the field of nanotechnology be eliminated and at the same time an accurate analysis be provided (Hajer & Wagenaar 2003)? In contrast to mainstream policy analysis, my analysis puts the dealing with uncertainty at the centre of research. On the one hand, this uncertainty is empirical, what I call the ontic dimension of uncertainty. On the other hand, uncertainty has an ontological dimension which forms the theoretical premise of this thesis. For example, in the ontic understanding, we talk about the assumption that nanotechnology is out there and that we can assess risk in risk assessments. The uncertainty in this respect is that we have to wait for test results. In addition, the uncertainty in the ontic understanding comprises that it is contemporary belief that there exists not only one truth. The ontological understanding of uncertainty concerns the meta-theoretical framework of my thesis. It comprises, for example, the assumption that everything is contingent and that if meaning becomes possible, i.e. if it is assumed that existing regulations cover nanomaterials, then we have to analyse the conditions of possibility for this to occur. I will now first talk about postmodern knowledge. That is, about the ontic dimension of uncertainty.

1.3.1 *Postmodern knowledge, scientific development and risk governance*

The authority of scientific knowledge which was established during the Enlightenment has become increasingly fragile since the second half of the 20th century (Frank 1983:106). Traditional discourses of legitimacy asserted universality of scientific claims, but the possibility of such an objective truth has been questioned. This shift is characterised as postmodernity, in which the contestable nature of (also scientific) has been reactivated (Frank 1983:7). Scientific knowledge had always been in competition with narrative kinds of knowledge:

Scientific knowledge cannot know and make known that it is the true knowledge without resorting to the other, narrative, kind of knowledge, which from its point of view is no knowledge at all. [...] For example, what counts as a proof (the proof of the proof) can only be established within the bonds of a – already scientific – debate and the consensus of the experts.
(Lyotard 1979(1997):27)

The implication for policy analysis is that, if there is not one truth, a space for persuasion is opened in which actors try to convince each other to see a situation in the same light as they

do (Finlayson 2007:550). Politics then takes place in a world of multiple realities. Social actors, like politicians, citizens, scientists or interest groups, hold multiple and changing meanings about phenomena; this makes events politically controversial (Fischer 2003:55f) and can lead to public contestation. These disagreements over meanings range from the means of policies, and the goals of policies, to what the policy problem actually is (Finlayson 2007:550). A solution to such policy conflicts by referring to 'scientific facts' is no longer possible if research 'results' are conceptualised in the postmodern sense as "arguments designed to convince other scientists to see a particular phenomenon one way or another" (Fischer 2003b: 222). Interesting for the policy analyst, then, is how agreement can still be reached. A policy is understood as an intellectual discursive construct which cannot solely be explained by identifying institutions, actors and decisions (Fischer 2003:54f).

The critical perspective on scientific conclusions as arguments derives from the "Sociology of Scientific Knowledge" (SKK), an important branch within the "Studies of Science and Technology" (STS). Similar to the endeavour in policy sciences to open the 'black box' of Easton's system theory (that is, to find out what exactly is going on in the practices of policy-making), the sociology of scientific knowledge wants to open up the practices of the generation of scientific knowledge (Hess 1997:81). The central question within STS is how societies produce authoritarian knowledge. STS seeks to illustrate how the cognitive and material products of sciences embody beliefs about the world. For them, natural and social order is constituted at the same moment "or, more precisely, coproduced" (Jasanoff 2004:19). For example, STS sheds light on how scientists interpret results, or on how socio-political context affects the choice of research designs. Social constructivist studies on sciences acknowledge that technical, social, political, and economic impacts are mutually reinforcing in technology development, what they call the 'seamless web' of society and technology (Bijker, Hughes, Pinch 1987:1f). Importantly, SKK broke with technological determinism by emphasizing "contingency and choice rather than forces of necessity in the history of technology" (Winner 1993:367). Regarding emerging technologies like nanotechnologies, a constructivist approach accounts for that a technological artefact could be different (Faulkner 2001:83). For example, different meaning could be ascribed to technological artefacts, communities enrolled in the technology's development can differ or different benefits can be highlighted.

The core of postmodernism is doubt (Richardson 1994:517). As knowledge is crucial to regulatory policy-making, the postmodern perspective on knowledge has an impact on how we can conceive discretion in regulatory policy-making. Postmodern knowledge's suggestion that sciences do not produce 'the truth' has implications for the authority of the scientific claims and results of risk assessment. As Rosa (1998) summed up: Within a positivist perspective on risks, risks were 'out there' and could be discovered by technical risk analysis. From a social constructivist perspective, risks do not exist in objective reality, but instead are social interpretations. Consequently, risk can no longer be separated from perceptions of risk (Rosa 1998:20). Subsequently an abundance of studies on risk perception (e.g. Slovic) developed that pointed out, for example, differences between expert and lay interpretations of risk. Studies on risk perception distinguish between 'objective' and 'perceived' risk. They analyse the role of communication, particularly the role of the media, and they consider contextual factors that could have an effect on the perception of risk, such as the political system or various societal determinants such as gender and ethnicity (Boholm 1998). Another example of a postmodern perspective of risk was developed by the social anthropologist Mary Douglas. She coined the term 'risk culture' to analyse the cultural ascriptions and social implications of risk as a concept and asserts that risk is always morally intertwined and related to how people make sense of events or objects (Phillips & Ilcan 2007:106).

In case of a crisis of knowledge, the epistemological basis in which governing is grounded has changed. In addition, the increase of actors in policy-making has moved the political spaces of governing. These two shifts I refer to as 'governance.' One could argue that the knowledge base for governing has always been precarious and ambiguous, and that the only difference is an increasing awareness of the uncertainty. For example, Foucault detailed in a historical vein how populations were made governable by means of statistics. Categorising and monitoring have been central governmental technologies since decades. But new is an increasing awareness that statistics produce order rather than discover order. This awareness in turn increases complexity as we clearly see in nanotechnology governance, where uncertainty is stressed and governing extremely complicated. This awareness "in the sense of a kind of 'self-confrontation'" (Beck 2006: 32) has been termed 'reflexive governance' by Ulrich Beck. This reflexivity occurs in – what Beck calls a 'second modernity' – "where modernization finds itself ever more occupied with the mastering of problems arising from the process of modernization itself" (ibid.:34). Beck argues that we live in a 'risk society'

today which results from the changing nature of science (the more we know, the more uncertainty grows).

Suddenly the whole earth is the laboratory – the monster has escaped and risks are now intensely mobile, flowing in, through, over and under national and indeed other borders.
(Urry 2004:92)

A general trend in the 'risk society' is to constantly try to tame risks. According to the governmentality line of literature, which builds on a Foucauldian analysis of power (Foucault, Dean, Rose, and O'Malley), risk can be seen as a central technique of liberal government. The main question, then, is how exactly do governmental technologies govern by identifying certain populations 'at risk,' by grouping them and by conducting their conduct along particular political rationalities.

Summing up this short introduction to postmodern knowledge and risk governance, our approach needs to bear in mind the construction and strategy of risks:

Risks do not exist. They come into existence through complex and multiple processes of inscription, interpretation, and boundary work carried out by a variety of actors and informed by scientific and political discourses. Typically, different actors involved in a risk-regulation dispute tell different risk stories. Eventually one story begins to dominate the risk definitions in a policy field. We therefore need to conceptualize the risks of molecular biology as gradually emerging in a political space set up by interrelated discursive practices.
(Gottweis 1998:77)

Gottweis's quote hints at the fact that the failure of reliable interpretations of the world (the lack of truth with big T) is not due to subjective interpretations, but that the failure has structural reasons. A political space can emerge and one story can gain hegemony because of the structural arrangement of words (Howarth 2000:43) and thus the structural arrangement of social bonds, such that any language partner can undergo a displacement if there is a move made in the language games (Lyotard after Frank 1983:17). I will clarify this complicated thought in the next section. We now approach the ontological dimension of uncertainty.

1.3.2 Indecidability, radical contextualism, a negative ontology

The proposition of the poststructuralist policy analysis, which is introduced here, is to dwell on 'undecidability.' Uncertainty is seen as an integral part of political judgement and

decision-making, and the proposal is to shift it into the centre of political analysis, to study and to understand politics in its light (Finlayson 2007:550). The concept 'undecidability' (or indecidability) derives from the work of Jacques Derrida. He is an important postmodern theoretician alongside scholars such as Lyotard, Deleuze and Foucault. From their poststructural perspective, meaning is in constant flux and is uncontrollable, there are no closed structures. Poststructuralism developed out of a critical involvement with structuralism, which searched for general ordering principles and universal regularities (Gottweis 2003:248f). The decisive attack poststructuralism made on modernism was directed at the metaphysical concepts of controllability and system (Frank 1983:37).

This important shift from structuralism to poststructuralism is often represented by explaining the differences between Saussure and Derrida. According to Saussure's theory of language, words articulate concepts (like the idea of a cat) by establishing a link between a signifier (cat) with the concept (idea of a cat) and a sound image ([kaet]) (see Howarth 2000:18). Saussure's theory was radical because he introduced the claim that the relationship between the signifier and the signified is arbitrary (Culler 1976 after Howarth 2000:20). In addition, he argued that the signifiers are only established in relation to other signifiers as a system of related terms (Howarth 2000:16, Torfing 1999:87, Gottweis 2003:248).

Thus in the formal and relational theory of language that Saussure advocates, the *identity* of any element is a product of the *differences* and *oppositions* established by the elements of the linguistic system.
(Howarth 2000:22)

That is, signifiers, as elements of a system, get significance in relation to each other and to the structure as a whole (Howarth 2000:16). For example, the signifier 'mother' is given only in relation to 'father', 'son' or 'daughter' (Howarth 2000), as is 'socialism' only in relation to 'capitalism' or 'feudalism' (Torfing 1999:87). This theory of language was translated to social institutions and action (coined as 'structuralism'), assuming that there is an "*analogy* between language and social relationships" (Howarth 2000:17).

Derrida's critique introduced the idea that structuralism fails to question the conditions of possibility, for example, what makes words function as language at all (Howarth 2000:38). One problem with Saussure is that he presumes the existence of concepts. Language in a way becomes only a tool for revealing ideas, while Rorty, Derrida and Co assume that language is constitutive to reality. In developing a poststructuralist discourse theory, Derrida

also highlights that meaning is never fixed, because chains of signifiers can be inserted into new contexts constantly. When Derrida talks about the 'play of signifiers,' he refers to the infinite capacity of signs that can be repeated in new contexts (Howarth 2000:42). That Derrida sees every signification as being in flux brings uncontrollability of the world into view (Gottweis 2003:248). Derrida argues further that the production of identities (or signifiers) needs not only the placement of elements in relation to each other, but also a relation of all elements to what they are not. Thus, Derrida brings in the constitutive outside of structures (Howarth 2000:42f). He observes that "no element can function as a sign without referring to another element which itself is not simply present" (Derrida 1981 after Torfing 1999:54). In contrast to Saussure's closed structures, Derrida talks about *indecidability*. In sum, Derrida's poststructuralist discourse theory stresses "the inability to fix meaning in any final way, and the impossibility of completely closed systems of discourse" (Howarth 2000:42-43).

Poststructural policy analysis then builds on an ontology which gave up on the notion of centred, closed structures. That means it recognizes that social interactions occur within structures which are contingent and in constant flux.

Social interaction occurs within a context of sedimented structures; however, since these structures lack a privileged centre and do not totalize and exhaust the field of identity, they are constantly changed by the articulations they make possible but fail to master. Post-structuralism thus emphasizes the instability and contingency of the structural context of social interaction.
(Torfing 1999:54)

The quote touches upon the issue of radical contextualism and on the lack of a centre. I first turn to radical contextualism. According to Lyotard, there are many potential linkings of phrases, as genres, but at each time, in each moment, there is only one, and this particular one occurs only once and it can never occur again. This is because each phrase is linked to the preceding phrase, and when a phrase comes along, different genres of discourse try to incorporate it (Lyotard 1997:227[1979]). As concerns the lack of a centre, the crucial take-home message of this section on the ontological dimension of uncertainty is that radical contingency marks all social relations.

Radical contingency opposes empirical contingency's sense of possibility with a sense of *impossibility*: the *constitutive* failure of any objectivity to attain a full identity. Other formulations of radical contingency as an ontological premise include 'lack in the Other' (Lacan), 'structural undecidability' (Derrida), and so on, all of which question the idea of a fully constituted essence of a practice, regime or object, in the name of an irreducible negativity that cannot be reabsorbed.
(Glynos & Howarth 2007:110)

What follows from these poststructuralist assumptions, when considering the emergence of regulatory regimes, is that it is of capital importance to recognize that study objects and subjects under investigation are essentially instable. Thus, they have no essential, necessarily intrinsic, causal or determinate capacities, but they are contingent, historical and precarious (Glynos & Howarth 2007:11). This perspective allows for focusing on the constructed and political character of policy problems. The central implication of such an analysis of policy-making is that I, as the researcher, do not find a pre-given, ordered world 'out there' which I can explore, but I must assume that political phenomena and their meanings are constantly changing (Gottweis 2003:248f). This meta-theoretical background is important because it defines the level of problematisation of the policy analysis conducted in this dissertation. From the theoretical considerations, it follows that an object of study is also constructed, which means we constitute a range of disparate empirical phenomena and then locate the problem at the appropriate level of abstraction and complexity in our research (Glynos & Howarth 2007:167). Similar to Foucault's 'practice of problematisation,' we thus start by identifying a domain of objects and practices in need of analysis and critique and continue with a genealogical accounting that explains their political and ideological emergence (ibid.). I will come back to this when I talk about articulation in the methodological section.

In the following section, I will present three existing poststructural approaches to the study of science and technology regulation in order to exemplify the application of the above introduced theoretical considerations. A second aim is to review what I can take from existing theoretical models for the explanation of *emergence*, *change* and (the pre-emption of) *conflict* in nanotechnology governance.

1.4 Examples of poststructural studies of science and technology regulation

In this section I will review the following approaches to regulatory policies: Sheila Jasanoff's work on biotechnology governance, Maarten Hajer's work on environmental regulation, and Herbert Gottweis's study on governing molecules. All three works can be seen as milestones in the academic discipline which significantly contributed to rethinking science policy from a discourse-analytical perspective. Their work of course has to be seen against the background of wider literature in the field, such as Hawkins's and Thomas's "Making Regulatory Policy," Giandomenico Majone's "Evidence, Argument, and Persuasion in the

Policy Process," and Susan Wright's "The Formation of Regulatory Policy for Genetic Engineering in the United States and Britain." In my review, I attempt to clarify how Jasanoff's, Hajer's and Gottweis's perspectives contribute to explaining *emergence*, *change* and *conflict* in regulatory regimes. Each discussion will briefly show what the contributions and shortcomings of these approaches are to explaining the emergence and change of regulatory regimes. Set against the importance of these studies (their approaches influence heavily on this thesis), I will argue that their theoretical models fail to fully explain hegemony in regulatory regimes and how fantasies grip policy entrepreneurs.

1.4.1 *Sheila Jasanoff: Co-producing science and technology*

A well-known scholar who has been dealing with the question of science and technology regulation from an interpretative perspective is Sheila Jasanoff, professor at the John F. Kennedy School of Government at Harvard University. For more than 20 years, she has been engaged in a comparative analysis of regulatory politics in various areas, for example, the different classification of toxic substances or distinct regulations on biotechnology in the U.S. and European states. Sheila Jasanoff explicitly situates her work within poststructuralist policy sciences (Jasanoff 2005:19).

Sheila Jasanoff argues that the meaning of new interventions in nature and life through developments in life sciences is constantly being contested. For example, the insemination of a woman with her dead husband's sperm caused a policy debate in the UK, in which the act was interpreted on the one hand as the wife's right and as a victory of (collective) family descendants, but as egoism on the other hand in disregarding the wishes of the dead owner of the sperm. In her book, "Designs on Nature," Jasanoff empirically shows how different frames on what genetic engineering means influenced the various policies adopted in different nations. In Germany, the question of genetic manipulation was, from the beginning, situated within a wider political and ethical discourse of what science is allowed to do, taking regress to Nazi-Germany and eugenics. In Britain, the uncertainties about the spread of genetically engineered plants and about long-term consequences were dominant themes in the protests against the planting of GMO. The protests against scientific interventions into food have to be seen in the British context of the mad cow crisis and the political failure in handling it. While GMO got labelled *Frankenstein food* in the British public regulatory discussion, the American regulatory discourse assumed that the end product does not differ

from conventional products, even if the process included genetic modification. This product-narrative is a crucial explanatory device for the liberal regulatory regimes on GM in the U.S.

Important theoretical concepts in Jasanoff's work are 'civic epistemology,' 'co-production,' and 'frames.' The concept 'civic epistemology' shall cover the way publics in a political culture share understandings about what authoritative scientific claims are or can be. A scientific claim has to be presented and defended in particular ways to be considered true, and these particular ways differ among nations (Jasanoff 2005:249). The concept of 'co-production' asserts that "the products of sciences, both cognitive and material, embody beliefs not only about how the world is, but also how it ought to be. Natural and social orders, in short, are produced at one and the same time – or, more precisely, coproduced" (Jasanoff 2005:19). When Jasanoff draws from the repertoire of interpretative social sciences, she mainly uses framing and narratives. For example, the starting point of her comparative study on biotechnology regulation is that policy problems do not arise on political agendas due to external events, but that public problems are "framed in a particular way by cultural commitments that predispose societies" (Jasanoff 2005b:141). Using the concept 'narrative' often synonymously to 'frame' as a 'way of knowing' (ibid.), Jasanoff asserts that both frames and narratives are rooted in the institutional practices of a society. Regulatory institutions accordingly are equipped with different capacities to deal with the uncertainties of, for instance, biotechnology – uncertainties which encompass not only scientific, but moral components as well (ibid.).

As regards the change of regulations, Jasanoff sets out for an analysis that can account for the durability, the emergence of taken-for-granted status of frames and what makes frames change (Jasanoff 2005:25). However Jasanoff's focus on political culture, on "how cultural commitments are rewritten on changing terrain" (Jasanoff 2005:28), stands in the way of her fully accounting for change. Jasanoff argues that political culture plays a crucial role in formulating science and technology politics. Political culture shows, according to her, a certain stability which contributes to explaining national governance styles. Political culture refers in this respect to the system of how a political community decides on collective decisions (Jasanoff 2005:21). Against these theoretical considerations, we can, according to Jasanoff, gain insight in how societies deal with changes when we consider the emergence of new social identities. For instance, changes in categories such as 'experts' or 'ethicists' or 'surrogate mothers' imply change. This relationship between individual changing identities,

or changes in one category and their relationship to changes in general cultural responses, does not seem to be fully worked out in Jasanoff's account: how much is persistent and how much changes and why? In fairness to Sheila Jasanoff's work, to explain the change of a regulatory regime was not her concern, but to explain differences in regulatory styles. Her aim is to spotlight "self-perpetuating normative commitments that give societies a claim to coherence and solidarity even in the face of shocks and change" (Jasanoff 2005:40). Thus, she does not want to explain the change of regimes, but the stability of regimes, despite a changing terrain to which the regime responds.

As concerns conflict, Jasanoff mentions "the counterforce of reaction that are likely to be set loose by powerful new ideas when actors seek to defend or impose them" (Jasanoff 2005:28). With reference to the social anthropologist Clifford Geertz, Jasanoff argues that new ideas are produced and carried on by institutions that regulate and promote biotechnology. However, her presentation of analysis sometimes stays at the level of description. For example, she shows how in America the demand for risk governance of genetic engineering decreased when biotechnology became articulated as a high-precision science; and how the regulatory focus shifted from a process-narrative to a product-narrative. However, the reader has to pay close attention to the analytics in the dense, empirical study. This problem becomes obvious, for example, when Jasanoff says she is going to explain the different framings of biotechnology as a regulatory problem in the U.S., Germany and Great Britain. She claims to discuss the processes of persuasion and key actors, but in the end, her explanation amounts to little more than the fact that the Greens participated in German and British politics. From an analytical discourse approach explaining a regulatory regime, I would expect, among other things, a contextualisation of the question: How did the Greens manage to get a key actor on this question in both countries?

In contrast to Hajer, whose approach I will discuss in the following, Sheila Jasanoff does not take the interpretative turn far enough to account for the social production of actors. While she recognises that scientific knowledge and technological artefacts are co-produced, she ignores that the same is true for actors and institutions. As Faber (2007) says:

Studies of change need to examine how agency is achieved as a strategy and not simply what is argued from the position of agency.
(Faber 2007:159)

In addition, her focus on political culture limits the explanatory value of her theoretical model concerning regulatory change. In sum, Jasanoff's study serves as an invaluable reference point for the comparison of nanotechnology governance to biotechnology governance, but her theoretical approach does not provide the explanatory devices I need to answer my research question.

1.4.2 Maarten Hajer: Discourse-coalitions and story-lines

Maarten Hajer (1993) provided a trenchant analysis of the emergence of a regulatory regime on air pollution in Great Britain after the dying of trees in Sweden. What air pollution in Great Britain has to do with the deaths of forests in Sweden might not be obvious at the first glance, and indeed policy-making faced the same challenge. Once scientists in Sweden had discovered that the deaths of the woods were caused by polluted rain, Hajer convincingly shows how 'acid rain' became a story-line which enabled the articulation of British air pollution and Swedish dying trees as the same problem. The polluted air condensed and was blown to Scandinavia where the pollution came down with the rain. It took a long time to convince British regulatory agencies of this definition of the problem. Hajer's main argument in the acid rain controversy is that two distinct approaches to pollution competed in British environmental politics: a 'traditional-pragmatic approach,' which was deeply sedimented in British political institutions, and a new 'ecological modernization approach,' which brought together a powerful coalition of a set of actors, including environmentalists and industry, who were directly lobbying government (Hajer 2005:299). The discourse coalition 'ecological modernization' could emerge because it was held together by the story-line 'acid rain.' In the end, they were successful in replacing the hegemony of the old discourse-coalition who insisted on empirical evidence.

This well-known example illustrates the main explanatory devices of Hajer's discourse-coalition approach. Complementing Foucault's discourse theory with consideration of social interaction, Hajer defines discourse as "an ensemble of ideas, concepts and categorizations" (Hajer 1995:44). He suggests the concepts 'discourse-coalition' and 'story-line' as methodological middle range concepts in the conduct of such a discourse analysis (Hajer 1995:61). A discourse coalition is composed of a set of actors who subscribe to the same story line; they are held together by shared definitions of reality (Hajer 1997:123). A story line connects distinct events by words. Story lines are frequently reproduced narrative

constructs which make meaning by linking elements of many different areas of the social world; one example is 'acid rain' (Hajer 1997:109,113). Story lines appeal to common sense – their vague content is often not questioned. They are emblems of a large discursive construct: for example, 'acid rain' stands for and illustrates a general ecological crisis (Hajer 1997:112). This allows for the black boxing of elements (from thoughts and habits to forces and objects), that is, of putting relations into a black box, which is not opened any longer (Latour/Callon 1981 after Hajer 1997:116).

Hajer's approach is valuable for many reasons. For one, he opens up the consideration that actors are not pre-given, but are enrolled in specific policy discourses. That is, actors do not have a fixed role, but are positioned in excursive exchange (Hajer 1997:114). In addition, he acknowledges the construction and socio-political embeddedness of policy problems. Besides, his approach shows how policy analysis can provide new insights by looking at how issues are discussed. In sum:

Discourse analysis then opens up methodologically sound ways to combine the analysis of the discursive production of meaning with the analysis of the socio-political practices from which social constructs emerge and in which the actors that make these statements engage.
(Hajer 2005:300)

Set against all the advantages of Hajer's theoretical model, the problem with Hajer's work is that he cannot satisfactorily explain the change of regimes and the settlement of conflict.

As for the emergence and change of regimes, the rise of a new discourse-coalition which subscribes to a story-line features prominently in Hajer's explanation of policy emergence and change. But he cannot explain why actors adhere to the coalition and its story-line. Hajer argues that institutional change must be seen as embedded in a discursive dynamic. In this dynamic, it is defined what a policy issue is, or how much institutions are able to deal with new problems. Hajer holds that "in the struggle for discursive hegemony, coalitions are formed among actors [...] that, for various reasons (!) are attracted to a specific (set of) story-lines. Discourse-coalitions are defined as the ensemble of (1) a set of story-lines; (2) the actors who utter these story-lines; and (3) the practices in which this discursive activity is based" (Hajer 1995:65).

It is the 'attractiveness of specific story-lines' I take issue with. How is this defined? Hajer says himself:

[However], the fact that story-lines reduce the discursive complexity does not explain why actors from various backgrounds adhere to them.
(Hajer 1995:66)

He argues that the specific reasons why actors support a story line can only be shown in the context of cases. But if his theoretical model cannot explain how story-lines catch on more generally, he cannot explain either what holds this discourse coalition together. What does it mean that actors have an affinity to a story line? What stimulates this affinity and what can interrupt it? How does a story line catch on, and what is the theoretical explanation of change, i.e. that the new discourse coalition around 'acid rain' could gain dominance over the old discourse coalition? The last question addresses the issue of conflict settlement.

As for the settlement of conflict, Hajer also draws on story lines as explanatory devices, but this can only explain harmony within a discourse coalition and not how a story-line gained hegemony over other story-lines. Hajer suggests that story-lines can regulate "conflicts over inter-discursive problems" (Hajer 1997:62). In his words:

Story-lines are essential political devices that allow the overcoming of fragmentation and the achievement of discursive closure.
(Hajer 1995:62)

Hajer deducts this integrative function of story-lines from their metaphorical mode of operation, i.e. if you mention one element of the story-line, the entire story-line is implicit and this masks fragmentation and complexity (Hajer 1995:62-63). He argues that a story-line unites ambiguous discursive practices (such as analogies, clichés or general fears) as 'discursive cement' on which a network of previously separate actors is built. According to Hajer, story lines are therefore also "*the prime vehicles of change*" (63). What again remains wanting in this explanation is how actors are gripped by a story-line.

In sum, Hajer proposes useful middle range concepts for policy analysis, but they need to be integrated into a comprehensive theoretical account (such as political discourse theory, as I suggest) in order to provide a framework for a study on emergence, change and conflict in regulatory regimes.

1.4.3 *Herbert Gottweis: Narrating biotechnology*

Another important author who brought insights from the STS community to the policy sciences was Herbert Gottweis. His first contribution to technology governance from a poststructuralist perspective was his 1998 book "Governing Molecules." In this work, he sets out to develop a poststructuralist analytics of government which pays attention to how language and discourses are used to endow scientific phenomena, but as well social, political and economic contexts, with meaning (Gottweis 1998:3). Central for Gottweis is the question of how individuals, nature or (technical) artefacts turn into political artefacts. Importantly, he points out that political spaces do not simply exist; they become inscribed and represented as political by processes of demarcation and boundary drawing. Drawing on a Foucauldian understanding of power, his innovative approach shifts away from the traditional attention of political sciences on institutions towards the political in seemingly apolitical sites, such as laboratories, and to the micropolitics of meaning (Gottweis 1998:330-331).

In his empirical analysis, Gottweis conceptualises the life sciences according to his theoretical approach as sites where, through new techniques to write life processes, fundamental parameters of what life means and what makes a human being have become contested and renegotiated (Gottweis 1998:40f). In his study, he shows how the creation of regulatory policies "entailed the careful crafting of a complex chain of signification" (Gottweis 1998:80) which constructed the meaning of 'recombinant DNA hazard' (Lenoir 1994 after Gottweis 1998:78). His book traces shifts in the molecular biology discourses which were closely related to the widespread controversies surrounding the field (i.e. protests against trials with genetically modified crops). For instance, he shows how a specific representation of risk was promoted in the molecular biology discourse, when molecular biologists themselves became positioned as the experts in the advisory boards for regulation. In another example he convincingly shows how the signification of the risks of molecular biology cannot be analysed separately from the articulation of molecular biology as the 'high-technology industry of the future' (Gottweis 1998:156).

Important theoretical concepts in Gottweis's approach are narratives and their ordering function. He emphasizes that ordering is important in a poststructural perspective: if we assume that "truth cannot be out there" (Rorty 1989), the articulation of science and

technology are the result of complicated processes of inscription and representation (Gottweis 1998:21). Narratives then "bring elements of clarity, stability, and order into what usually tends to be the complicated and contradictory world of politics. This power to create order is an attractive quality that makes narratives essential for the shaping of policies, the settling of conflicts, or the securing of legitimacy for political action" (ibid:31-32). Gottweis distinguishes between political metanarratives and policy narratives. Political metanarratives, like the discourse of modernisation, constitute the political imaginary of a particular society, the political visions, and opportunities that are seen in a particular situation (Gottweis 1998:34). His argument here is that actors or institutions have to be understood within the wider discursive context in which they are constituted and framed in a policy field (ibid: 327). Policy narratives refer more specifically to the "social construction of the fields of action for policymaking" (ibid: 33-34). They "function as network of meaning," which can integrate various sites of government (ibid: 30).

How does Gottweis account for emergence, change, and conflict in regulation? Gottweis accounts for important elements of hegemony in policy struggles, but stops short at explaining how certain narratives become the only possible alternative. In "Governing molecules," Gottweis shows that the dominant narratives of molecular biology (about bringing high-technology and economic benefits) became subject to a crisis, mainly because of the struggle over the deliberate release of genetically modified crops. New social movements and green parties had evolved, and genetic engineering faced criticism from many sites. Gottweis stresses that the change towards precautionary genetic engineering regulations (manifested, for instance, in Germany in the Genetic Engineering Act) shall not be read as response to pressure from these groups. Rather, he suggests that a new discursive constellation emerged that opened up new ways of perceiving genetic engineering's risks. The new regulatory discourse could gain hegemony by "re-absorbing discourses of polarity into a system of 'legitimate differences' and by defining the locations where differences can be articulated" (Gottweis 1998:320-321). In other words, the hegemonic regulatory discourse transformed antagonistic voices into voices of 'legitimate differences' and thus as part of the system. According to Gottweis's conception of hegemony, it is crucial for the domination of a social field to re-absorb opposition; by this logic of equivalence the formation of opposing poles is avoided, which would threaten the discursive field from the outside (ibid: 265).

I have embraced a significant amount of Herbert Gottweis's approach, and his traces appear throughout my case studies. A limit to Gottweis's theoretical conception, however, is that the approach does not help us to understand "why different narratives have proved to have more or less appeal and mobilizing capacity" (Torfing 1999:240).

In sum, all three approaches fail to fully account for why particular regimes grip. That is, they cannot successfully explain hegemony. Therefore, I now turn to Political Discourse Theory, an approach within poststructuralist policy analysis which accounts for hegemony and for how subjects are enrolled.

1.5 Hegemony and Policy Analysis

In 1985, Laclau and Mouffe set out to develop a political discourse theory. Their book "Hegemony & Socialist Strategy. Towards a radical democratic politics" was meant as a critical engagement with leftist projects of the time that were mainly influenced by Marxist thought. The problem of Marxist thought is that ultimately, everything is seen as influenced by the economy: the political class struggle asserts the existence of classes distinguished by income base and by what they must do to sustain a living. In the literature, the problem has been discussed as the problem of essentialism (Torfing 1999:19). Poststructuralist policy analysis, in contrast to essentialism, builds on the insights of Derrida, who points out that there cannot be an essential principle that structures social totality (also not the economy), because no principle can itself escape the process of structuring (Derrida 1978 after Torfing 1999:19).

Laclau and Mouffe's discourse theory, which is also called the "The Essex School of Political Discourse Theory," employs a wide understanding of discourse. In contrast to the branch of discourse analysis which focuses on the linguistics of texts and speech, and in sharp contrast to Habermas's discourse theory of rational argumentation, Laclau and Mouffe develop a political theory on identity, meaning and hegemony. Political discourse theory is also distinguished from interpretative, hermeneutic, and ethnographic approaches in policy sciences, which analyse meaning-making in political communities. Political discourse theory aims at transcending the particular. That is, social interactions (the particular) have to be explained in relation to their discursive context (Torfing 1999:81). That does not mean that individual action and self-interpretations are determined by discourse, but that the process is

mutually reinforcing and intertwined. A discourse brings elements into relation to each other; such elements comprise not only texts, but also actors, objects, events, and so forth. A discourse is the structured totality which follows from articulatory practices. Articulatory practices establish relations among elements such that the identity of these elements is modified due to the articulatory practice (Laclau and Mouffe 2001:141 [1985]). Laclau and Mouffe's concept of discourse includes "all the practices and meanings shaping a particular community of social actors [...] discourses constitute symbolic systems and social orders, and the task of discourse analysis is to examine their historical and political construction and functioning" (Howarth 2000:5). Laclau and Mouffe's discourse analytical framing resembles Foucault's later genealogical writings, which show how discourses "are shaped by social practices and the way they in turn shape social relationships and institutions" (Howarth 2000:8).

Let me exemplify this in relation to nanotechnology. The articulation of 'nanotechnology' establishes a relation among elements like research projects of different scientific disciplines "such that their identity is modified as a result of the articulatory practice" (Laclau & Mouffe 2001:105), insofar as they become moments of a nanotechnology discourse. For example, the discovery that the protein moesin is a key player during mitosis, with its ability to control cell shape, was an earlier finding within molecular biology, a field which contributes to the understanding of cell processes in the human body. Now, the same research result is articulated as a moment of 'improving the quality of life' and as a step towards 'novel, low cost health care.' The reason for this new articulation is that the research project had been conducted at the London Nanotechnology Centre under the level 'nanomedicine' (see LCN, Healthcare Research). Nanotechnologies make the non-fixed nature of scientific disciplines explicit; boundaries between categories like chemistry, biology, molecular biology or different branches of physics cannot persist, if scale is ascribed important status. The nanoscale, then, establishes chains of equivalences among previously separated disciplines, indicating the incomplete and open character of their identities. By the discourse of nanotechnology, the identity of the research (projects, people, institutions, and funding programmes) is modified. In detail, the imaginaries that are raised by nanotechnology-articulations interstratify the elements and make them moments of a nanotechnology discourse which can mean a supposed new future, either full of possible benefits or fraught with potential risk. Nanotechnologies seem to operate like synonyms for sciences bringing growth, development and improvement. 'Nanotechnology' is constituted in such articulations

and the coherence among the moments is established by its regularity in dispersion. Its manifestation and over-presence in scientific talk is exemplified by a British nanotechnology graduate student's response to my question as to why he was going to study nanotechnologies: "It's new, it's everywhere and you can apply it in many different areas."

As we can see, this discourse theory builds on Saussure's linguistic theory of discourse in which signs, sound-images (signifiers) and concepts (the signified) only make sense by putting them into relation to each other. In applying this theory of language on social systems and in basing it on Derrida's extension, which rejects closed and centred systems, political discourse theory distinguishes between the discursive and discourse. The difference is the degree of fixity/unfixity (Torfing 1999:93). The discursive is indecidable and uncertain, while the discourse partially fixes moments in a field of discursivity (ibid.). The signifying function of discourse can never be finite. There is always a surplus of meaning which escapes and stays part of the discursivity (ibid: 92). Contingency and articulation are possible because the transformations of discursive elements into moments of discourse are never finished or total (Laclau & Mouffe 2001:143 [1985]). While every discourse seeks to dominate the field of discursivity, not all are similarly successful. Those discourses which manage to gain hegemony form nodal points (Torfing 1999:98), or empty signifiers.

Hegemony broadly refers to leadership and dominance. Seen from a historical perspective of political theory, the term was coined by Marxist thinkers to grasp unity within and across social classes (Torfing 1999:107f). Gramsci extended this notion of hegemony of political leadership to include 'moral-intellectual leadership.' Hegemony, then, is then a term to grasp how alliances among separated identities are produced by transforming them into a collective will. Laclau and Mouffe overcome Gramsci's focus on social classes and thus allow for a carving out of the contingent logic of articulation (Torfing 1999:108-109). As Torfing (1999) well explains, we can speak of hegemony according to Laclau and Mouffe, if a wide range of demands and identities are inscribed into the same discursive formation. Hegemony, then, is gained by constructing such a dominant discursive formation. The field of discursivity subverting discourse provides "the condition of possibility of hegemonic articulation" (102). That is, "*hegemony brings us from the undecidable level of non-totalizable openness to a decidable level of discourse*" (ibid.).

As concerns conflict, political discourse theory assumes that the aim of opposing political projects is to gain hegemony. The elements of the discursive can be articulated into moments of discourse by opposed political projects (Howarth & Stavrakakis 2009:15 [2000]). The theoretical point of departure is that social fields are interwoven by social antagonisms. The limits of a discourse are established by constructing a constitutive outside. The outside is constitutive for the 'inside' because by negating something, frontiers are drawn and the limits of the 'inside' are erected (Torfing 1999:124). Thus, delimitation and demarcation is central for the stabilisation of the hegemonic project. The "differential character of the discursive identities" (ibid.) is achieved by means of logics of differences and equivalences (on which I will say more later on). So, hegemonic formations are constitutive, dependent on this antagonistic and dismissed other to form and to consolidate.

Another important element for a project to become hegemonic is the universalisation of the hegemonic project as the only possible alternative (Torfing 1999:120, Moebius 2008:166). A hegemonic project is a complex discursive-material web of relations that is successful in producing particular patterns of thought or action as the only alternative (Moebius 2008:167). An important concept within Laclau and Mouffe's approach to hegemony is the empty signifier – nodal points instituted by the articulatory practice "that partially fix the meaning of the social in an organized system of differences" (Torfing 1999:109). Hegemonic projects try to underpin their particular discourses with empty signifiers. These are undefined and very ambiguous terms, such as freedom, democracy or nation, that figure as nodal points which fill the hegemonic formation with content (Moebius 2008:167).

Empty signifiers are general equivalences – metaphors. The production of hegemony and empty signifiers always proceeds stepwise by means of metonyms. First contiguity among terms is produced. For example, in the British health reform triggered during Thatcherism, the discourse that public services should be run like private companies could gain hegemony because links were established between the health system and the market, including aspects of the market such as individual choice and competition.² The subjects of the health services (doctors, nurses, care) were redefined as greedy subjects who have to be controlled, monitored and who will only work properly if they see personal gains for themselves. The relationship between health personnel and patients was redefined as one between salesmen

² For the empirical example, I refer to the Norwegian documentary "Helsefabrikken" (Health factory) <http://factionfilm.no/?cat=production&id=85>

and customers, all of whom are striving for personal benefit. At the same time, hospitals became articulated as cost factors, and the post-war ideals of solidarity were set aside. What a good society is was redefined from solidarity and trust to efficiency, greed and individual choice. Hospitals should compete with each other for patients. For each patient, hospitals get money from the government. It is still public services, but it acts like the market. For this quasi-market to work, it was necessary to introduce pricing tags to invoice at cost different kind of surgeries, patient care and so forth. These tremendous changes could not have occurred without establishing contiguity between health services and the marketplace.

From the perspective of Political Discourse Theory, then, change in regulatory regimes can be interpreted as responses to discursive changes brought about by organic actors in hegemonic struggles over societal dislocations (Torfing 1999:241). That is, actors react to "what is constructed as facts in and through discourse" (ibid.). In other words, while, for instance, positivists explain change as logical response to economic and political pressures, our discourse theoretical approach says change in political discourse is constitutive to enabling change. Various actors try to define and interpret what a policy issue is within a discursive formation. If a potential policy issue cannot be accommodated within hegemonic discourses, these hegemonic discourses are dislocated. That a dislocation occurs means, if events cannot be symbolized by or be inscribed in the discursive formation, the social order is disturbed (Torfing 1999:130). If social imaginaries cannot domesticate events within their discursive structure, they can break down. Such is the "disruptive force of dislocation" (ibid: 53). Dislocation is an important argument by Laclau held against structural determinism and thus, it is an explanatory device for change:

Dislocation refers to the emergence of an event, or a set of events, that cannot be represented, symbolized, or in other ways domesticated by the discursive structure – which therefore is disrupted. [...], Laclau conceives dislocation as a permanent phenomenon inasmuch as there is always something that resists symbolization and domestication, and thereby reveals the limit, incapacity and contingency of the discursive structure. It follows that dislocation continuously prevents the full structuration of the structure. Dislocation is the traumatic event of 'chaos' and 'crisis' that ensures the incompleteness of the structure; it is precisely this incompleteness, this lack of objectivity that deprives the structure of its determining capacity. Dislocation is, in other words, the concept of the impossibility of structural determination. As Laclau (1990a:41-3) puts it, dislocation is the very form of temporality, possibility and freedom.
(Torfing 1999:149)

While Torfing mentions the twofold meaning of dislocation in this quote, he does not explicate it, like Glynos and Howarth very helpfully do in the "Logics of Critical Explanation." When dislocation refers to events that cannot be represented, we can say this

is an ontic understanding of dislocation. A dislocation is ontical when the subject's mode of being is disrupted by experiencing moments that cannot be represented within his social order. In contrast, dislocation as a permanent phenomenon is an ontological understanding of dislocation. In this meaning dislocation is a necessary element of a poststructuralist, negative ontology. It is a theoretical concept which signifies the assertion that "each and every symbolic order is penetrated by an impossibility that has to be filled or covered-over for it to constitute itself" (Glynos & Howarth 2007:14).

It is the ontical understanding of dislocation which is relevant for trying to develop explanatory devices for the change of regulatory regimes. We can see the disruptive force of dislocation when hegemonic struggle intensifies after dislocation occurs. The number of floating signifiers increases, and policy issues, actors, institutions, potential regulatory objects, and potential regulatory sites can be redefined (see Torfing 1999:240). In the new hegemonic discourse that emerges, the sources, extent and responses to crisis will be redefined. At the same time the imaginaries of what could be a good solution, that is the repertoire of alternatives, might have changed during the hegemonic struggle. Nevertheless, social actors do not react to discursive changes in a linear vein. The new hegemonic discourse is not fixed, but is constantly contested and transformed, as in, for example, the implementation of policy (Torfing 1999:241).

Indeed, subjects can respond to dislocatory events in various ways (Laclau after Glynos & Howarth 2007:115). People can express a grievance, showing that something constitutes an issue for people. If grievances are not appropriately addressed by authorities, a request can harden into a demand, which can turn into a political contestation of the norms of a regime (Glynos & Howarth 2007:115). However, subjects can also be complicit in concealing contingency. In Glynos and Howarth's ontological dimensions of socio-political reality, subjects react to contingency and challenge social relations in the *political dimension*, while they are complicit in concealing the radical contingency of social relations in the *ideological dimension* (ibid: 113). It is fantasies that ensure that the radical contingency of social reality remains in the background (ibid: 145). If the subject is gripped by ideology (ibid: 117), this has to do with the subject's modes of enjoyment (ibid: 131). The *ideological dimension* is the opposite of the *social dimension* in which the radical contingency of social relations has not been registered (Glynos & Howarth 2007:14).

The theory's strongest point is its recourse to fantasy, which allows for an explanation of why some narratives appeal more than others. It may seem strange to link regulatory policy-making with fantasy. The term is associated with imaginations that are at a distance from reality (Glynos 2008:2). In addition, 'fantasy' can have a pejorative connotation as something many people believe is false, like an illusion or a naïve dream (ibid.:3). This commonsense definition of 'fantasy' must be put aside; political discourse theory uses the concept 'fantasy' as employed in psychoanalysis. 'Fantasy' signifies "the mode or ethos with which a subject engages in a practice" (ibid.) because it structures the subject's desire:

[...] the logic of fantasy names a narrative structure involving some references to an idealized scenario promising an imaginary fullness or wholeness (the beatific side of fantasy) and, by implication, a disaster scenario (the horrific side of fantasy).
(Glynos 2008:10)

But fantasy is the theory's strongest and weakest point at the same time. The advantage is that it links the subject with the structure. That is, how certain narratives engage subjects is linked with the fantasmatic appeal of a narrative. The subject has to be gripped. In this sense, fantasy as explanatory device links structure (discourse) with individual action. But in a way, the theoretical approach only relocates the same problem to another problem: from 'why do some narratives become prevailing' to 'why do some fantasies grip and others not?' I stick to the concept of fantasies nevertheless for fantasies are crucial for concealing the radical contingency of social relations (Glynos & Howarth 2007:147). And in the case of nanotechnology governance, as we will see, fantasmatic logics of, on the one hand, 'promises that are yet to come' and, on the other hand, 'horrific fantasies' can be fruitfully applied. Furthermore, that horrific fantasies gripped state elites provides the means to understand why the political logic of pre-emption could catch on. The theoretical approach allows me to carve out the role of fantasmatic appeals, i.e. the imagination of conflict, and how affective, emotional responses to these fantasies impact on policy-making. I will dig deeper into fantasmatic logics and how they grip subjects in the following chapter on methodology.

1.6 Conclusion

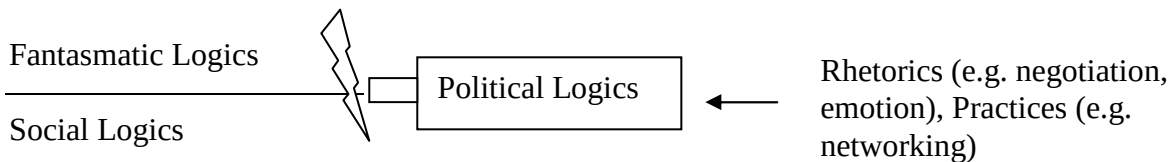
By way of conclusion, I build on political discourse theory's insights on hegemony to complement existing poststructuralist approaches to regulatory policy-making. Bringing in hegemony means to account for that power is involved in the production of meaning. Three

theoretical premises are important considering the here outlined poststructuralist conception of hegemony. First, hegemonic projects do not only try to make sense and to constitute a symbolic order but to universalize the hegemonic project as only possible alternative (Moebius 2008:166). Second, it is crucial for the social field that the formation of opposing poles which would threaten the discursive field from the outside is avoided. Opposition needs to be absorbed in the hegemonic project (Gottweis 1998:265). Third, hegemonic projects are often underpinned by ambiguous terms (empty signifiers, nodal points) such as freedom, democracy or responsible development – terms that fill the hegemonic formation with content (Laclau & Mouffe 1985).

As concerns the emergence and change of regimes, I conceptualise change as response to discursive changes brought about by organic actors in hegemonic struggles over societal dislocations (Torfing 1999:241). While Jasanoff can only explain why political cultures are persistent, and Hajer cannot account for the attractiveness of story lines, and Gottweis cannot tell why narratives grip, I argue that change is fostered when subjects are gripped by fantasmatic narratives so that they decide to act upon discursive change. The theoretical concept that allows me to study how subjects are gripped and moved is the notion of fantasy. Change stays wanting if subjects invest in fantasies that mask over contingency, alternatives or inequalities. In this respect, fantasy is linked to ideology (Glynos 2008). After having clarified my ontological premises, I will now turn to introducing the grammar of concepts guiding my study of nanotechnology governance. A general critique which a Laclau-inspired discourse analysis often faces is that it is difficult to apply empirically. However, Glynos and Howarth made an effort to translate political discourse theory and its conception of hegemony into a methodologically feasible framework. Their logics of critical explanation, which I will introduce in the following, will govern the empirical analysis of this study.

2 Methodology

Following the theoretical assumptions of this thesis, the analytical framework presented in this chapter introduces a grammar of concepts as a means of critically explaining hegemony in policy analysis. With their "Logics of Critical Explanation," Jason Glynos and David Howarth (2007) offer methodological concepts that allow for breaking down Laclau's discourse theory, which I intend to use for my study. However, their concepts are still too abstract for some parts of empirical analysis. I suggest that they introduce a meso-level. For empirical analysis, however, the conceptual framework still has to be complemented with refined categories, concepts, and analytical strategies. I argue that this can be provided by the analysis of rhetorics.

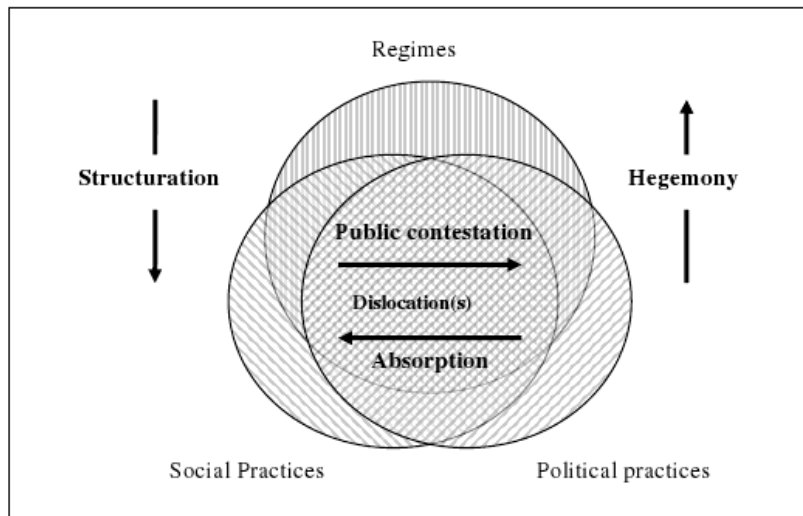


As the graphic shows, I suggest that demands are played out in political logics by means of rhetorics and practices. This can be, for instance, by metaphors and analogies that create or disturb chains of equivalences; but chains of equivalences can as well be established (or interrupted) in practices such as networking.

The subsequent research strategy presented in this chapter in general follows a poststructuralist ontology and epistemology. Research methods always have to be understood in the context of ontology and epistemology (Yanow & Schwartz-Shea 2006: xi): how do things exist in the world and how do we know about them. In other words, analytical frameworks and research designs contain "assumptions about the reality status and knowability of their subjects of inquiry" (Yanow & Schwartz-Shea 2006: p. xv). In the following, I will first introduce what the means of critical explanation of hegemony in policy analysis are, as developed in Glynos and Howarth's 2007 "Logics of Critical Explanation." Throughout the chapter, I will describe the steps of critical explanation: problematization, genealogy, retroductive data generation, articulation, and evaluation. At the same time, I will outline how I proceeded in generating the data required for a critical explanation of the nanotechnology regulatory regime.

2.1 Methodo:Logics of critical explanation

Working within the framework of political discourse theory, my methodological point of departure is in practices or regimes of practices (Glynos & Howarth 2007:14). Therefore, I am not talking about regulatory policy-making but about regulatory regimes. The term denotes practices and their context, the social structure that emerges out of political practices and which grips social practices (ibid:125).



(Glynos & Howarth 2007:124)

Practices and *regimes* are thus important concepts in my analysis. The graph depicts the relationships between regimes and practices; social practices are distinguished from political practices. This corresponds with the different *ontological dimensions* of social reality which I introduced above. *Social practices* are largely repetitive, ongoing, routinized activities. These are the things we do largely unconsciously and every day, like picking up the kids from school, but which nevertheless contribute to reproducing the wider systems of social relations (Glynos & Howarth 2007:104). For using a – or for comparing to a – terminology of "Science and Technology Studies" (STS), these social practices compose the *hinterland*, which Woolgar and Latour identified in scientific laboratories, that is, the unspoken assumptions, standardised instruments, routines of note-taking, and so forth (see Law 2004:27f). When these normal ways of doing things get challenged, this happens per *political practices*, which seek to transform existing norms and practices for new and different ideals. Political practices entail the construction of political frontiers, and if they are

very successful – that is, if a political movement becomes hegemonic – the entire regime can be changed. This is why in the graph the arrow goes from political practices towards regimes. An important element of political practices is public contestation; that is, the public articulation of grievances into demands (Glynos & Howarth 2007:122). The explanatory device which allows us to characterise *practices* is *logics*.

A *logic* is what makes a practice tick: a set of rules, what makes these rules possible, and what do they make possible and exclude (Glynos and Howarth 2007:134). As an explanatory device, the concept '*logics of critical explanation*' is developed by Glynos and Howarth (2007) in a way that logics can be situated somewhere between causal mechanisms and self-interpretations of actors. Logics replace conceptions of 'causal mechanisms' because the latter aim at a generalisation in the sense that the context in which they function is left out. Causal mechanisms delocate the practices under investigation from their contexts and from the acting subject (Howarth & Glynos 83ff). In contrast, poststructuralist approaches assume that meaning and significance only function under particular circumstances and that actors are not determined or compelled by causal mechanisms. 'Logics' is thus a concept opposed to causal laws or mechanisms. But at the same, the concept of logics is employed to overcome the pure particularism of phenomenological and hermeneutic accounts, which only focus on meaning making. Phenomenological and hermeneutic accounts make practices intelligible by analysing the subject's self-interpretations, but fail to link these narrative accounts to theoretical concepts external to the practices in investigation; or if they do, they still fail to explain change, emergence or sedimentation (Glynos & Howarth 2011:80f). In contrast to causal mechanisms or self-interpretations of actors, the poststructuralist approach to critical explanation introduced here employs *a three-fold typology of logics* as units of explanation (Glynos and Howarth 2007:106). Jason Glynos and David Howarth differentiate among three logics, according to dimensions of social reality: social logics, which characterize social practices or regimes; political logics, which enable social practices, their institution and contestation; and fantasmatic logics, which assist in explaining why subjects are complicit in concealing contingency (ibid: 21).

2.1.1 Social logics

Social logics refer to the rules of social practices. With social logics we can characterise the purpose, form and content of practices (Howarth & Glynos 2007:106). The word rule hints

at a certain coherence, unity or pattern. According to Laclau, a social logic can characterize the "coherence of a discursive practice" (ibid: 139). We can grasp this coherence or unity when the social practices show a "regulatory in dispersion" (Laclau & Mouffe 2001 [1985]). That is, we observe social practices, and when we identify a certain logic, we judge that they have something in common, that they show a certain pattern, while each practice still remains particular. In this respect, the social logic also allows me to show how a logic bridges the self-interpretation of actors and causal mechanisms, because social logics simultaneously hold "on to the idea of a pattern *and* an open-endedness" (139). An important point here is that social logics "acquire their meaning in precise conjunctural and relational contexts" (Laclau and Mouffe 1985:142 after Glynos & Howarth 2007:140). In other words, "social logics are always contextual entities, arising in particular historical and political circumstances" (Glynos & Howarth 2007:137).

Social logics, in particular, provide access to the practices under investigation, enabling us to grasp the point of a practice or institution, as well as the rules and structures that organize them.
(Glynos & Howarth 2007: 159)

From the fact that a social logic must be understood in the empirical context of its instantiation (Glynos & Howarth 2007:185), it follows that they require therefore a "passage through the self-interpretations of subject." (ibid: 159). This is an important point for the data required, as outlined in the research strategy later on in the chapter.

Examples of social logics provided by Glynos and Howarth are, for instance, *the logics of marketisation and centralisation* as part of a network of social logics that characterise the Thatcher regime (ibid: 137). Or: The practices of separating different 'races' and 'peoples' are the translation of dubious ideologies and theories into practice in *the logic of apartheid* (ibid: 138). Examples of social logics in UK universities which allow us to characterise the new audit regime are: *the logic of competition* (how individuals interact with each other as rivals), *the logic of atomisation* (isolating individuals from each other but also isolating individuals from their skills, virtues and other characteristics), *the logic of hierarchy* (top-down governance, steering universities like firms), and *the logic of instrumentalisation* (commoditisation of research and teaching for enhancing skills of the workforce) (Glynos & Howarth 2007:171f).

2.1.2 Political logics

Political logics make it possible to explain why social practices or regimes were instituted and contested (Howarth & Glynos 2007:106). They are the focus of my analysis. The political logics proceed out of social demands; they explain the institution of the social: How did it emerge? How was it contested? Political logics can be seen as explanatory devices within Derrida's method of deconstruction, as they help to identify the origins of practices and institutions, which are often forgotten and unconsciously reproduced. Political logics function as *logics of equivalence and difference*.

Insofar as political practices entail the construction of new frontiers to challenge old social structure in the name of an ideal or principle (thus implying a new set of inclusions and exclusions), one can say that the political logic of equivalence predominates. But insofar as there is a breaking down of those frontiers so as to maintain existing social structures (thus retaining the old distribution of inclusions and exclusions) we say that the political logic of difference predominates. (Howarth & Glynos 2007:106)

These important notions within political logics derive from Laclau and Mouffe's *chains of equivalence and difference*. These concepts point again to the ambiguous relationship between the particular and the universal. Actually, every social actor occupies a differential position in the social fabric (Laclau and Mouffe 2001:xiii [1985]). But a social actor needs to establish equivalences to other particularities if he wants his political aims to gain ground. From this follows a question of representation (ibid.): A certain particularity comes in to stand for a universality transforming the particularity. This is an equivalential chain, which again is a hegemonic relation. The tension between the particular and the universal, of course, is ever present in this hegemony, and thus reversible. In addition, the identity created by the chain is received by saying what it is not (ibid: 127).

The function of representing the system as a totality depends, consequently, on the possibility of the equivalential function neatly prevailing over the differential one; but this possibility is simply the result of every single struggle always being already, originally, penetrated by this constitutive ambiguity. (Laclau 1996:41)

The quote shows how ontological presuppositions (negative ontology, radical contingency) come into play within the methodological concepts. Logics of differences and equivalences reduce or intensify contingency and complexity (this function is tremendously important in the nanotechnology regulatory discussion, as we will see particularly in Chapter Three, Four, and Seven):

[We, thus, see] that the logic of equivalence is a logic of the simplification of political space, while the logic of difference is a logic of its expansion and increasing complexity. Taking a comparative example from linguistics, we could say that the logic of difference tends to expand the syntagmatic pole of language, the number of positions that can enter into a relation of combination and hence of continuity with one another, while the logic of equivalence expands the paradigmatic pole – that is, the elements that can be substituted for one another – thereby reducing the number of positions which can possibly be combined.

(Laclau & Mouffe 2001:130 [1985])

Logics of equivalence and difference are thus the explanatory means by which we can capture the drawing and erasing of political frontiers (Glynos & Howarth 2007:144). An example of the logics of equivalence is when different demands for workers rights are linked with student protests by stressing one signifier which both have in common: to be against the system. As an example for a logic difference, Glynos and Howarth mention the case of a ruling power which tries to enforce differences between ethnic or national groups in order to prevent the rise of united opposition against the regime (ibid: 145). Insofar as the logics of difference or equivalence function to challenge or institute a new regime, they are political logics (ibid: 143).

Importantly, in political logics, the political dimension is in the foreground. If we briefly recall what was written in the theory chapter: in the political dimension, social actors experience dislocation and they react by (re)activating contingency and thus, they challenge prevailing ideals (Glynos & Howarth 2007:112-113). Thus, political logics are connected with public contestation, which is a demand that "publicly contests the norms of a particular practice or system of practices in the name of a principle or ideal" (ibid: 115). Only when requests harden into a demand and are publicly articulated, can we talk about a political demand or a political practice. (ibid: 185) This study restricts politics not to the terrain of government, but to any aspect of public contestation (Glynos & Howarth 2007:114f). The political refers to the antagonistic dimension which is inherent in social relations (Mouffe 2000:17). The radical contingency of social relations constantly demands (political) decisions in an undecidable terrain (Torfing 1999:64f). In this respect, politics is about decision-making within conditions of indecidability (ibid.). I now move from the political dimension to the ideological dimension, in which subjects cover over the experience of dislocatory moments instead of using the moment for contesting a regime.

2.1.3 *Fantasmatic logics*

Fantasmatic logics enable us to understand why subjects are gripped, why they adhere to social practices and regimes (Glynos & Howarth 2007:107). As Glynos and Howarth say:

[...], by invoking fantasmatic logics we suggest that one condition for subscribing to an existing or promised social practice concerns the extent to which it can tap into the subject's existing mode of enjoyment and thus fantasmatic frame. **When working in tandem with political logics, fantasmatic logics may be invoked to help explain why certain demands – or responses to demands – succeed in gripping** or interpellating a particular constituency. Equally, they can be mobilized to account for the way explicit challenges to existing social structures or institutions are blocked.
(Glynos & Howarth 2007:107, my emphasis)

If political logics – as we learned above – operate as "signifying operations" (Laclau after Glynos & Howarth 2007:145), fantasmatic logics can be seen in relation to them as "the force behind those operations" (ibid.). The relation between a fantasmatic and a political logic is further that a practice is *not* considered as a worthy contestation (ibid.) when the subject is gripped by fantasies. In relation to social logics, one can say that fantasies ensure that the radical contingency of relations stays in the background (ibid.). Practices which pre-empt dislocation (ibid: 146) are somewhere in the middle between social and political practices, because the role of fantasy is, in this respect, to contain the political dimension (ibid.). Apart from its concealing function, fantasies also provide the necessary support for political demands to become hegemonic, because they manage to articulate universal (fantasmatic) appeals (Glynos & Howarth 2007:123). The fantasy directs the political practices in this respect, and they fill the political practice with content, so that they become worthwhile to pursue (ibid: 147). Methodologically, we can identify fantasmatic logics typically in narratives that promise a "fullness-to-come" (ibid.). Another indicator for fantasies are paradoxes or contradictory features of "aspects of social reality" (ibid: 148), for example, when nanotechnology is presented as new and outstanding but also common and ordinary at the same time.

In sum, all three logics together help to explain: what, how, and why?

If social logics assist in the process of characterizing *what* a practice is, and political logics show *how* it is challenged and defended, then fantasmatic logics can be said to generate reasons for *why* practices are maintained or transformed.
(Glynos & Howarth 2007:108)

For me as a researcher, the 'logics' function as concepts with which I can relate the data I generated to abstract theory. That is, I articulate what I see in the self-interpretations of actors from the perspective of the theory that informs my study. The concept of *articulation* then is, as Glynos and Howarth point out, an important answer to the problem of double hermeneutics. On the one hand, articulation occurs when social actors "articulate discursive elements along the axes of equivalence or difference" (ibid: 265). This implies that what is articulated as a 'risk' or an 'emerging technology' is constantly constituted in a historically specific way (Gottweis 2003:249). On the other hand, our analyses articulate empirical data along theoretical concepts. Articulation hints at the fact that the relation between empirical and theoretical elements cannot thus be seen as essential. Rather, "social science explanation involves the articulation of different theoretical concepts together in a concrete empirical context, in an effort to provide a singular critical explanation of a problematized phenomenon" (ibid.).

Logics are thus constructed through the process of articulating self-interpretations to contexts by means of a theoretical framework consisting of a set of concepts and ontological assumptions. It is this articulatory aspect and its theoretical presuppositions that a mechanistic approach denies and a hermeneutical approach underplays. Accordingly, we suggest that what makes possible the simultaneous singularity and generalisability of each case is the background theoretical framework informing the analysis, coupled with the articulatory process itself.
(Glynos & Howarth 2007:189)

The quote elucidates that it is the researcher who is tying data and theory together. He judges whether "a particular empirical phenomenon counts as an instance of 'x' in deciding what the precise relevance and importance of 'x' is" (ibid.:184). In John Law's words:

The argument is no longer that methods discover and depict realities. Instead, it is that they participate in the enactment of those realities.
(Law 2004:45)

But how those realities are enacted is not an arbitrary choice. Rather, our research-expertise derives from theoretical knowledge and from "having immersed oneself in a given discursive field consisting of texts, documents, interviews, and social practices" (Glynos and Howarth 2007:189). Such in-depth data, which obviously is necessary – and I am here introducing the next section – requires a concrete case (context). At the same time, the quote illustrates how our analytical framework, which is the 'logics of critical explanation,' enables the comparison across particular case-studies. The concepts lift the generated data onto a more abstract level. In sum, 'logics of critical explanation' offer a theoretical framework bridging ontological background (meta-level) with the methods on the micro-level (language,

rhetorics, and arguments – see below); they thus introduce a necessary meso-level. I will now turn to the research strategy and methods for empirical analysis.

2.2 Research strategy and methods

The positivist legacy within political sciences is still strong, and doctoral theses are accordingly expected to formulate hypotheses which are tested throughout the study. Hence, a positivist approach to policy analysis would at this place start off with defining independent and dependent variables and with a design on how to best measure the relation between *x* and *y*. My research strategy, of course, will be articulated differently as we have already dismissed such "simple causalities" (Gottweis 2003:258f). Besides, interpretative methods allow for a flexible response 'in the moment' to observational or interviewing circumstances (Yanow & Schwartz-Shea 2006: xvi). Therefore, it is not a strict and unmodifiable 'research design' that will inform this study. Rather, I talk about a 'research strategy.' The research strategy that I propose is composed of providing a genealogy of the problem at hand, conducting rhetorical policy analysis, and generating "thick description."³ Case studies, interviews, and document analysis are presented as means for generating the latter.

Indeed, I already started to introduce my research strategy in the "Introduction" to this thesis when I formulated the emergence of the soft-mode nanotechnology regulatory regime as a research problem in need of explanation. This problematisation shows how the research question is, from the beginning, intermingled with the theoretical structure (i.e. regimes). The back and forth between problematisation and hypothesis-formulation, their revision in the light of new insights or feedback, moments of being persuaded of something, and the formulation of new assumptions in the research process is captured by the term *retroduction* (Glynos & Howarth 2007:18ff). Glynos and Howarth locate *retroductive* reasoning between deductive and inductive reasoning (ibid: 18ff). Such a problem-driven research approach starts with identifying "a domain of objects and practices in need of analysis and critique" (ibid: 253). I thus want to recount now briefly, how I ended up analysing the nanotechnology regulatory regime from the theoretical and methodological perspective that has been

³ Introduced first by the social anthropologist Clifford Geertz (1973), the concept is nowadays frequently employed to refer to qualitative research which generates in-depth knowledge by submersing in the field, particularly ethnography.

introduced. The retroductivity also indicates that accounting for the problem in a genealogical vein is a good start for research into nanotechnology, as for other empirical fields.

2.2.1 Genealogy of problematisation

I first learned about nanotechnologies six years ago. In the course of a side job as a science journalist, the term nanotechnology started to pop up in research projects I was reporting on at different sites. I understood that nanotechnology was a hot topic in material sciences and chemistry. But in an interview with a risk researcher, which actually was about nuclear power plants, he happened to mention nanotechnology as a new area of concern. As a master's student in political sciences, I found it interesting to be confronted with these two opposing stories – the big new, important scientific development in sciences on the one hand, and the new risk area on the other hand. Looking at the topic as simplified, I set out to write a seminar paper with the aim of analysing the regulatory discussion on nanotechnologies. I assumed there were actors who promoted nanotechnologies and others who defined it as a risk, and I simply wanted to find out who was dominant.

The first challenge I met was that policy-making is not carried out by one regulatory agency; in a situation characterised by governance instead of government, multiple actors are at play on different levels. It is difficult to evaluate and understand their stance and influence in a debate. The second, obvious challenge in and for nanotechnology governance is that a regulatory discussion based on the assumption 'first get the facts right' just does not work, because the required data do not yet exist and can maybe never exist, since we have no prior experience about intervention at the nanoscale (Nordmann 2011).

From the beginning, my theoretical approach to nanotechnology was characterised by taking rhetorics in policy-making seriously. As I said, my initial focus was on arguments in the regulatory debate. But a third challenge was that the deeper you immerse yourself in the nanotechnology debate, the more unclear it gets what nanotechnology actually is. And when it remains unclear "what nanotechnology is anyhow", why and how do you enforce regulations? Here we arrived at the current problematisation constituting the research puzzle of this work.

After having identified the aspects of reality that I want to explain, a second step of poststructuralist research strategy can be to develop a genealogy of how the status-quo of the problem at hand emerged (Glynos & Howarth 2007:167ff). In my case, the nanotechnology regulatory regime, characterised by the general equivalent responsible development, is in the focus of analysis. As Jeffares neatly says:

Policy analysis in this vein starts with the identification of taken-for-granted hegemonic practice and then involves a deconstruction of these equivalences to reveal general equivalents, before performing a genealogy of how and why these general equivalents came to be.
(Jeffares 2009:108)

The following provides an illustration of how I perceive the political process that I analyze and what the story could be that I want to tell:

Time ₀ (T ₀)	T ₁	Dislocation POLITICS	T ₂	T ₃
A new technology is launched (GM) New practices are suspicious, debate, protests.	Although certain nanoparticles are used, no attention is given to that. Nanotechnology provokes certain dislocatory effects in regulatory regimes. It disrupts, for example, practices that are based on evidence-based policy-making.	Triggers: More talk about funding, nanoinitiatives, nanotechnology gets an issue Also: Article by the scientists Joy: "Why the future does not need us" ETC group report UK: Prince Charles UK gov. demands RS/RAEng report ...	Political Logics: Different demands emerge, are contested and existing regimes are challenged Logics of Equivalence, e.g. naming Logics of difference, e.g. 'not nano' Discourse coalitions can be formed. Rhetorical strategies are employed.	Emergence of the current regulatory regime Codes of conduct, etc.
Move to Regulating GM	Ignored; reiteration within practices	Dislocation	Re-order Regime	



In short, I want to show how from a time where GMO caused protests, concerns and regulation, we arrived at a time where nanotechnology is approached by soft laws and meets little opposition. I assume that the uncertainties and complexities of nanotechnology issues led to disruptions in regulatory practices. Eventually, this led to a dislocation of the current regulatory regime. It has to be analysed what the triggers of this dislocation were in various contexts. Subsequently, a political struggle about nanotechnology regulation emerged. This struggle which is highlighted by an eclipse in the graphic is the part that I want to analyse in my dissertation within the context of T0 and T1. Important elements of the political logics in T₂ are networking, rhetorical strategies, naming, and arguments. In the following, I will introduce the significant role of rhetoric in policy analysis.

2.2.2 *Rhetorics and Policy Analysis*

Although Glynos and Howarth offer methodological concepts that allow for breaking down Laclau's discourse theory, they are difficult to apply in the very process of the analysis of data. I suggested above that they introduce a meso-level. For *empirical analysis*, however, the conceptual framework can benefit from the tools of Rhetorical Policy Analysis. To contextualise this, I will now dig deeper into the relationship between poststructuralism and language, which I postponed in the theory chapter.

Inherent in the ontical uncertainty that is the space of persuasion in policy-making – if it is not possible to refer to facts, if political claims are open and contestable, persuasion in decision-making is carried out by arguments (Finlayson 2007:550), emotions, and ethos (Gottweis 2007). If there is not one truth, we try to persuade others to see "things in the same light as we, to define the situation in a particular way" (Finlayson 2007:550). Consequently key authors such as Majone (1989), Fischer and Forester (1993), and Gottweis (2006) argue that policy analysis needs to direct attention to arguments in policy-making. In fact, another name for the 'interpretative turn' is the 'argumentative turn' (Fischer & Forester 1993). Gottweis points out that rhetorics – although its key role is never questioned in politics – might have been disregarded by policy analysts because of the image problem of rhetorics as manipulative acts (Gottweis 2007:240), while the ancient art of rhetorics actually dealt simply with the function and role of words (ibid: 241). The important scholars who

rediscovered rhetorics for social sciences were Stephen Toulmin, Chaim Perelman, Michel Meyer and - particularly in the policy sciences – Giandomenico Majone (ibid.).

The premise in the study of rhetorics in policy analysis is that we can study ideas, demands or narratives by analysing materials in which they manifest – "in concrete, observable and analysable words" (Finlayson 2007:230). According to Fischer (2003), social actors interact with each other and negotiate the world by narrating about events, by interpreting past experiences and by constructing future scenarios – for all this, language is necessary, which makes language a "powerful constitutive force within politics" (Fischer 2003:55). Political reasoning is in this respect, as Stone (1988/2001) says, "reasoning by metaphor and analysis. It is trying to get others to see a situation as one thing rather than another (9)." The analyst then must pay attention to the rhetoric of social and political narratives and practices (Gottweis 2003:255f).

The tight interrelation between political logics and rhetorics is best expressed in the following quote by Lyotard:

[to] speak is to fight, in the sense of playing, and speech acts fall within the domain of a general agonistics.
(Lyotard 1997:10 [1979])

Lyotard addresses the general endeavour to fix elements as moments of discourse; this process is in constant flux, and elements are articulated and re-inscribed constantly into different discourses. We as the analysts then have to track rhetorical shifts, governing discourse, and moments of rupture. How can we do so? I will now introduce concepts of rhetorical policy analysis on the micro-level of data analysis (i.e. arguments of facts, political rhetorics, arrangements of narratives, and logos, ethos, and pathos).

An important starting point is Gottweis's rhetorical policy analysis because his approach opens up for integrating emotions into policy analysis (via the rhetorical notion of ethos), and integrating emotions and passions is significant for identifying the operation of fantasies. From his perspective, emotions are not responses to discourses and rhetoric, but emotions are themselves rhetorical praxis which have effects in the world (Gottweis 2007:240). When proofs are presented in persuasive speech so that those being addressed are led to emotions, this is referred to as pathos-dominated argumentation (ibid.:242). Other argumentative

strategies are ethos (persuasion by character; by the credence of the speaker) and persuasion by logos (appealing to reason by argument) (ibid.). As for logos, Finlayson (2007) suggests different types of arguments, which proved to be helpful tools in my own analysis: arguments of conjecture (being concerned about facts), arguments of definition (focus on the names of things), arguments of quality (they want a particular thing, person or act to be conceived as something), and arguments of place (555). Arguments of place are of importance because they are part of a political rhetoric which aims at preventing a certain course of action, for example, by showing that an action could bear potential harm (ibid: 556). Thus, arguments of place rule certain issues off the agenda (ibid: 555). Other useful tools for textual analysis are genre analysis (generic features of policy documents which manifest authority) and to consider the arrangement of the narrative, to be alert to metaphors and analogies, and to identify commonplaces (ibid: 556f).

Commonplaces feed directly into the central concern of rhetorical strategy: the appeal.
(Finlayson 2007:557)

Which data, then, are required for making such a rhetorical analysis feasible?

2.2.3 In-depth research – developing thick descriptions

Having introduced the problematisation of nanotechnology governance as the centre of this thesis, as well as my theoretical framework and methodological concepts, I am now at the point where I can consider the kind of data my research strategy needs to generate. My study assumes that there is something new in technology governance which we can identify when closely observing how nanotechnology is dealt with politically. My research should accordingly be able to show what is characteristic for nanotechnology governance (social practices and social logics) and the conditions of its emergence (political logics, fantasmatic logics). As concerns social practices, we need to account for realities that are not shown in practices and in beliefs about practices, but that are produced in them (Law 2004:59). The method at hand would accordingly be ethnography (ibid.). However, my study aims to develop a critical explanation of a bigger picture than, for instance, nanotechnology regulations in a particular government agency. I attempt to learn something about practices in various settings via the interpretations which involved actors have in their practices. Thus, I access practices indirectly via interviews and documents. In addition, I see them as part of rhetorical practices. I do not claim that this is a better approach than ethnography, but that

this was the best feasible strategy to answer my research question. My focus is on political logics (how the regulatory regime emerged) – I thus need to generate data which allows me to analyse and illustrate how chains of equivalences and differences are played out. Hence, I generate a corpus of texts (documents and interview transcripts) whose content is not regarded as "facts," but as articulations of the self-interpretations of actors, that is, of how actors make sense of what they are doing.

The study explores a set of questions such as how nanotechnology turned into a policy issue: when did the topic arise chronologically, which actors and institutions were defined as significant for the field, which texts circulated and were ascribed importance, and did governing discourses change over time? How was nanotechnology constituted as a field (how is nanotechnology defined and in which contexts, how do actors dealing with nanotechnology make sense of nanotechnology/their practices, what initiated their work, what are the practices of governing nanotechnologies/what do the people have to do/do, what challenges do policy-makers experience when dealing with nanotechnology, which governing discourses is nanotechnology articulated into).

While some of these research interests can be answered in a more descriptive manner, others (i.e. the constitution of nanotechnology, argumentative strategies, the identification of narratives, discourses or demands) clearly require that a mere summary of political statements be overcome by lifting the generated data onto a more abstract, analytical level with the conceptual analytics carrying the study. After all, the research strategy always has to have the research goal, which is to critically explain the emergence of a regulatory regime, in full view. Reaching an analytical perspective on the data is acquired by creating thick descriptions of actual practices and by getting into a dialogue with the data (Gottweis 2006:7).

In the following section, I will introduce how I engaged with data and Atlas.ti as a software tool to guide the ordering of the abundance of materials gathered. But before I turn to the actual analytical strategy, I will explain my strategy of generating data to set up a textual corpus for the analysis. The data generated had to meet the requirement of providing rich, detailed data – in order to be able to articulate and to name the logics, we need to pass through the self-interpretations of social actors (Glynnos and Howarth 2007:139). In the

following, I will introduce case studies, interviews and document analysis as a means of generating thick descriptions.

2.2.3.1 Case studies

As causal mechanistic ideas do not lie at the heart of this study, the question arises which role country-cases play in a poststructuralist study and how thick descriptions of singular cases can be compared. The idea of comparative research in political sciences is rooted in positivist ideas. As it is not possible to 'test' political systems in experimental settings, comparing cases, so the rationale, is seen as a means to measure the relations between interdependent and dependent variables (Peters 1998:1). These variable-oriented researchers classically take, as a point of departure, cases in which the dependent variable varies, which they then want to explain (Ragin 2004:127). For example, if country x has introduced nano-specific regulations and country y has not; such a study would identify possible independent variables and analyse their impact in the two different settings. In contrast to variable-oriented research, the need for case studies in poststructuralism derives from the problematisation: cases mean context. They are means to demarcate the area in which we look at problematised phenomena and means to deliver thick descriptions. To analyse Germany and the UK as cases is thus an important element of my research strategy because it allows me to put my ontological and epistemological premises into practice: it considers context and it focuses on the critical explanation of subject-mediated, problematised phenomena (Glynos & Howarth 2007:202).

The point of comparison, then, is introduced by articulating contingent elements together with theoretical resources (Glynos & Howarth 2007:207). For exemplifying contingency, we can think of narratives that are only temporarily stable and context-dependent – which is why, for instance, American interpretations of genetic engineering could not be transferred directly to European risk governance (Gottweis 1998:106). Discourse theorists thus can, according to Howarth (2000), make use of the comparative method if the cases are initially understood in their own terms and the point of comparison is only introduced in a second step to "further our understanding and explanation of different logics of hegemonic practice in different historical conjunctures, and not to construct generally applicable laws of social and political behaviour" (Howarth 2000:138).

My study is based on a similar-cases study-design because this is best suited to show the governance-change that I assume occurred from GMO to nanotechnology. Whereas the variable-oriented research strategy wants to explain variances in the outcome, my qualitative case-study approach is attentive to commonalities (Ragin 2004:127) that indicate that something is an instance of a certain logic. Within the country-cases, I conducted interviews with policy-makers and consultants or advisors for policy-making, and I analysed documents dealing with nanotechnology policies in the widest sense. I will now turn to explaining my approach to interviewing and textual analysis.

2.2.3.2 Interviews and documents

For reasons of rigor and traceability, I will, in the following, recount how I identified documents and actors, how I conducted interviews, and how I analysed texts. At the same time, I want to reflect on three issues in my methodological procedure: order and chaos, ignorance, and naming logics.

Identifying policy documents and policy actors

As said in the section on genealogy, a first step in my research on nanotechnology governance was obviously to research what the status-quo of nanotechnology regulations was. From a first review of secondary literature on accounts of nanotechnology in social sciences, I learned that contributions to nanotechnology regulations mostly referred to the Royal Society and Royal Academy of Engineering Report (RS/RAEng) on nanotechnologies published in the year 2004. From this, my initial focus on the country-case United Kingdom followed. Here we see that the research subject and its context – in this case that I started my work in 2006 – influence the research process. Guided by ideas of rhetorical policy analysis, the initial document analysis that I conducted was informed by the aim to find out how, in policy documents such as the RS/RAEng Report, nanotechnology, politics and society are articulated in relation to each other. In addition, I analysed on a random basis how different actors who submitted evidence to the RS/RAEng working group in the course of drafting the report positioned themselves towards nanotechnology: how was nanotechnology defined, which topics were important in different statements, which differences can be identified among various actors, and what arguments concerning risks, uncertainty and regulations can I identify? But my research interest implied indeed more fundamental questions about

nanotechnology governance: who are actually actors in the field, where is nanotechnology debated? In other words, I was interested in exploring the political space articulated by nanotechnology and the political spaces *into which* nanotechnology was articulated, as well as the actor identities shaped in relation to nanotechnology. In first paper drafts, my approach was more anchored in Hajer's discourse coalition approach. I approached the document analysis with the methodological idea to identify regularly dispersed (Laclau and Mouffe 1991:142) concepts and terms in order to identify story-lines. I consulted much secondary literature in the beginning, and the primary materials rotated around the RS/RAEng Report, its review and comments. Later my research became more comprehensive and systematic.

In both country-cases, I analysed policy documents, and I conducted narrative interviews. In contrast to the chaotic procedure marking my approach to the UK case, I established a relatively clear course of action in the German case. In general, I started with an internet research on key words such as 'nanotechnology governance' + Germany/UK, or 'nanotechnology politics' + Germany/UK. On the websites, generated by this (google)-search, I looked for policy reports, guidelines, minutes of meetings, reports about events, groups that were formed and so forth. If I found a relevant policy document (briefing, statement, report, recommendation, press release ...) I looked for the institutions who issued the report and for the contact persons in the document's imprint.

In parallel, I started to write a word-document titled "Actors, Positions, Demands." In this document, each identified social actor was ascribed a short description of his nano-related work and a preliminary evaluation of his stance in the political system. In addition, I listed which documents were published on nanotechnologies by this actor. At the same time, I entered an entry of the identified, potential contact persons in a table. This table helped to retain an oversight over contacted interview partners and their responses. The table contained name, institution, contact date, answer to contact, and date of interview appointment. I contacted all respondents via email and received an answer by most of them, although some refused an interview due to a limited time schedule or because their field of activity has moved. Some offered a telephone interview instead, which I postponed and finally did not follow-up on because I felt it impossible to conduct a narrative interview on the phone.

Regarding the document collection, I established another table in addition to the contact-person table, in which all materials I found (statements, reports, studies, press releases, minutes of meetings, newspaper articles ...) were listed. In this non-exhaustive list, I attempted to gather the texts produced in nanotechnology policy-making in each country in a chronological order. Out of this research strategy (to identify actors from documents), interviewees or their institutions were often part of writing up a document. Hence, the interview material contributed to contextualising the written text of the documents within the social practices of writing it and with the institutional context. Finally, interview partners were also identified via "snowball-sampling" (Weiss 1995: 25, Torfing 2007:31). That is, most interviews included a question on whether the interview partner could recommend other contact persons to me.

I do not intend to give a comprehensive list of all documents analysed here, but as an overview, one could say that the English debate concerned early funding and foresighting policies, the RS/RAEng Report, subsequent government responses to the RS/RAEng Report, the review of the RS/RAEng Report, documents of new governmental bodies dealing with nanotechnologies (such as the Nanotechnology Issue Dialogue Group), the Royal Environmental Commission on Pollution (ERCP) report on new materials, parliamentary discussions and regulatory reviews. In the decade of nanotechnology governance leading up to the RS/RAEng Report, I analysed, for example, a report by the Parliamentary Office for Science and Technology (POST), a report by the UK Foresight Materials panel and a 2002 report by Science Minister John Taylor on nanotechnologies. The German case does not so clearly revolve around one report, such as the RS/RAEng Report – even though the Office for Technology Assessment (TAB) published a comprehensive report on nanotechnology in the same year as the RS/RAEng Report – but the debate is centralised insofar as there exists a parliamentary discussion and, from 2006 onwards, the NanoCommission. In addition, the German debate covered the drafting of a research strategy for three governmental agencies, public engagement activities and risk research projects, industry initiatives, a media debate around the Magic Nano case, and a government report on the status-quo of nanotechnology research in Germany.

As for my interviews, I conducted narrative interviews in each country with ca. 15 policy-makers (in its widest sense: civil servants, parliamentarians, scientists, toxicologists, consultants). In-depths-interviews, also called narrative interviews, are not standardised, and

they do not deliver data for a quantitative evaluation (Bogner & Menz 2005:17). Interviews with – whatever kind of – experts in the field of analysis often operate as in-depth-interviews. That is, the aim is to generate thick descriptions of the field, and the interview-modus operates similarly to normal conversation (ibid: 18). The boundaries between different open interview forms are floating. Meuser and Nagel (2005) see differences between narrative and expert because only a particular, professional segment of the interview subject is relevant for expert interviews, not the interviewee himself as a person (Meuser & Nagel 2005:91). I nevertheless consider interviewing experts in a narrative way as narrative interviews. My interviews lasted on average approximately one hour and 20 minutes. This is slightly below the one and a half to two hours we can expect on average according to Weiss (1995:56). I think this is due to my interviews operating as expert interviews, often with people at their workplace: all of my interviewees had a tight time schedule. In addition, I am impatient, and I have a strong wish not be undesirable towards others, and thus I do not want to steal anybody's time. Most of the interviews took place at the workplace of the interviewees, a few were conducted in cafeterias and one took place at the interviewee's home. The cafeteria ones were a disadvantage for transcribing due to the background noise. Apart from that, I could not discern that the setting made a difference to the course of the interviews.

Conducting interviews

My fieldwork started in May 2008 with a first round of three interviews in London, while my actual year of fieldwork was 2009, when I spent four months in England from March to June 2009 and three months in Germany from October to December 2009. I initiated the initial three interviews in London because my first presentation at a conference was approaching, and two months before I was worried that I had nothing to talk about. This might not have been true as I easily could have focused on my theoretical framework in the presentation. Nevertheless, it made me jump into empirical research, which eventually brought me much further in the conceptualisation of my study.

Even if not planned deliberately, this first round of interviews functioned as *pilot interviews*. Weiss (1995) praises pilot interviews as tools for identifying problems with interview guides (Weiss 1995:52). Indeed, I experienced that the benefits of pilot interviews can be even more encompassing, although a refinement of the interview guide was also an issue because it

happened that I did not know how to proceed during these first pilot interviews; they went slowly and I was insecure. But I identified gaps in knowledge about the research field in the pilot interviews. What I read about nanotechnology governance in the UK before the interviews, I concentrated on the Royal Society and Royal Academy of Engineering Report and onwards; the policy stories about everything that was going on before 2004 came as a surprise. Apart from that, I learned the hard way that pilot interviews can make the interviewee aware of pitfalls in the interview preparations. After a one-and-a-half-hour-long interview with civil servants who participated centrally in nanotechnology governance (an interview which was particularly difficult because I faced three highly knowledgeable and informative interviewees instead of the expected one interviewee), I saw, when I wanted to switch off the tape recorder at the end of the session, that it had turned off by itself three minutes after the interview had started because the battery had run out. This had never happened during my journalistic work. I do not know whether my interviewees realised that I turned pale in this moment. I said goodbye, left the building, entered the next pub and wrote down everything from my short-term memory in detail based on the interview notes. Needless to say that loading the battery of the voice recorder became an essential step of interview preparation from then onwards.

I would like to take the opportunity now to say some words about the recorder. Recording an interview can have disadvantages because interviewees could find it worrying that everything they say is recorded, and thus can be pinpointed, reproduced and distributed. Weiss, for instance, recommends note taking instead of recording (Weiss 1995:53f). My impression was that most interviewees forgot about the recording or trusted my promises of anonymity. About five or six times, I experienced that interviewees said during an interview that this should actually be "off the record." In such situations I repeated that nobody would listen to these records anyway, and the interviewees continued talking. Indeed, these comments might function as declarative markers, indicating that what will be said next will be important, rather than as imperatives which ask to switch the device off. In the beginning of the interviews, I always asked whether it was okay to use the recorder. This question also has the function of establishing a collaborative relationship with the interviewee (Weiss 1995:61). Only once did an interviewee refuse the recorder, and he also stopped me from taking notes some minutes after the start of the interview. This was surprising, especially since the interview did not contain any new content anyway. I was just told what I could

have read in the position papers of the organisation. This repulsive stance also told me something, although not much.

One problem with researching on nanotechnology from a social sciences perspective arose from not being a trained scientist. I lack an advanced understanding of biology, physics or chemistry. This is problematic in evaluating and interpreting information on nanotechnology, and interviewees could often just claim whatever they wanted. At the same time, this is not a problem but an advantage. To be able to "learn from strangers," an open-minded attitude is required that allows the interviewer to be attentive to what the respondent is saying (Weiss 1995). In a way, interviewees can feel free to claim whatever they want, because the aim of my research is to learn something about their self-interpretations, how they understand nanotechnology and what they consider important about nanotechnology. If an interviewed industry representative – taking a stereotypical, imagined example – would go on for hours about how great nanotechnology is, that it does not imply risks and that it is anyways covered by existing legislation – that is fine. It reveals the policy story he wants to put through. According to John Law, blindness need not be a loss, but it can also be a gain if it makes us perceptive and sensitive to things others pass by (Law 2004:10). In this respect, the methodological problem that the interviewee could lie (Meuser & Nagel 2005:91) was also not an issue.

In this context, my status as a layperson when it comes to nanotechnology, together with the fact that I am quite young and that I am a woman – maybe even looked at as a girl in some of the interviews – were good conditions for making people talk. Gender and age differences, as well as other context conditions like sympathy or asympathy, influence the interview situation and cannot be contained or controlled (Meuser & Nagel 2005:79-80, Weiss 1995:136-141). I do of course have no reference point, but I had the impression that my appearance and the narrative way of interviewing was often not taken too seriously, and that this made some interviewees more talkative. Most of them tried to help me with my study even more, some of them had a patronising tone. But it was particularly the latter who then were especially open and who delivered provoking thoughts that made me think further or who gave me great direct interview quotes, such as the one about Jurassic park on page 145. Still it was often frustrating to not be able to evaluate scientific results, procedures or characteristics of nanotechnology. It does make a tremendous difference for this study on regulations whether the behaviour of matter really changes on the nanoscale or not. Some

interviewees claim that it is humbug that nanotechnology operates on a level where we can talk about quantum physics. Then again, I found myself in good company when it comes to difficulties in understanding nanotechnology. In addition to the general knowledge gaps pervading the field, I met many policy actors, for example at nanotechnology conferences, but some as well in my interviews, who had been moved to the topic of nanotechnology – often civil servants, sometimes politicians – and who had no more opportunity to learn about nanotechnology than I had. In contrast to me, they, however, are involved in decision-making on nanotechnologies.

A crucial preparation before the interviews is to be clear about the "substantive frame of the study," that is, "the set of topics the study explores" (Weiss 1995: 15). These ideas guiding the interviews (informed by my theoretical problematisation) were fundamental for choosing interviewees. I had to have an idea of what I needed to know from them. When I started the actual interviewing, these ideas were explicated in interview guides. Some interpretative researchers reject interview guides because the guidelines could restrict the openness and flexibility of the study, but as Meuser and Nagel rightly say, interview guides can paradoxically actually guarantee the openness of an interview (Meuser & Nagel 2005:78). The reason is that the researcher familiarises herself with the research field and the interviewee and her institution by preparing the interview guide. This familiarity is a precondition for being able to conduct a loose, non-bureaucratic interview (ibid.). So, I prepared myself for the interviews. I knew which reports the interviewee or his institution had been working on, which meetings were organised or attended, etc., and if these topics would not be mentioned by my interviewees themselves, I had them for getting the interview going. Of course a balance had to be struck so as not to restrict the themes to my prepared knowledge, but to generate new knowledge which I could not access via the internet. The open style of question should guarantee this research aim. My questions would typically be formulated similar to the following examples:

My line of questioning

- Intro: can you please give me as an introduction a short biographical sketch on who you are, how you came to work with nanotechnologies, ...?/ What was the first time there was any kind of consciousness in your department/organisation/group that nanotechnologies might be worth a second thought?
- Out of which context did the work of xxx on nanotechnology develop? What was the first thing to do to establish it?

- Could you please describe the work on nanotechnologies of your department/organisation/group in detail?
- If they mention meetings: can you walk me through such a meeting?
- If they mention certain instances, practices, goals: Could you give me a concrete instance of/a time that actually happened with as much detail as you can?/Could you tell me the most recent time that happened?
- What happened then?
- Which problems did you face in your work on nanotechnologies?/Can you think of what has been the thing that has been most troubling of all the things that you've had to do while you've worked on nano-issues?
- There were (many reports) published by xxx. Can you give me a vivid picture of the debates surrounding the drafting of these guidelines/the report?
- What are your thoughts on the concept of risks related to nanotechnologies? How do experience the work of regulatory agencies?

These interview questions orient themselves toward or are directly adopted from Robert Weiss's book "Learning from Strangers." One aim of these questions is to direct the respondents to give descriptions of specific incidences (Weiss 1995:71). After all, these interviews shall enable us access to social practices via the self-interpretations of actors. In addition, let us remember that the open style of the interview questions is based on the premise that what we first and foremost want to generate by in-depth interviewing is surprise. We want to learn something new, and with a set of interview questions formulated on the basis of hypotheses informing the study, new findings would be shut off (Weiss 1995). Weiss (1995) writes that he was "thrilled by the surprise of things turning out different from my expectations" in virtually every study he conducted (52). Indeed, such moments of surprise also tell us, as the researchers, much about our own stereotypes and expectations. I start a paper, which I published in the course of writing up this thesis, with problematizing an interview quote (Åm 2011) because I had not expected that a member of a civil society organisation would not give me insight into nanotechnology governance networks because of the relationship of trust that was built up among actors of these governance networks.

As concerns transcription, I transcribed most interviews almost entirely, but I did not follow strict transcription rules. In contrast to critical discourse analysis, political discourse analysis – even if it analyses texts – operates higher. Voice and conversation analytical analysis are unnecessary (Meuser & Nagel 2005:83). For comparison, critical discourse analysis – as conducted by Fairclough, Wodak or Reisigl – looks at text genres, argumentation schemes, causal topoi, specific semiotic types, nominations, predications, or perspectifications in the textual material (Reisigl 2008). Such a linguistically anchored type of analysis clearly

requires accurate transcripts which follow clear rules. This is not required in my form of analysis. In the end, how much is transcribed and what is paraphrased depends on the research question (Meuser & Nagl 2005:83). The notes taken during the interviews can be a good index for the tape on what to transcribe (Weiss 1995:56). Still, I tend toward perfectionism and there was little I did not transcribe. Nevertheless, it is a time-consuming, tedious work. I tried to do most of it when travelling to other interviews by train because then I felt that at least something is moving on (the train). Still, performing the transcribing myself was also necessary for starting the analysis and for incorporating and remembering the interviews. This turned out to be good research practice, as I got feedback about the quality of what I was doing before the next interviews started.

One of the above-mentioned interview questions, the one on problems and challenges, had the aim to identify moments where the actors felt "all is not quite right." These are markers that hint at potential dislocatory moments but also to moments where existing social practices (old regime) were not fit to cope with nanotechnologies. In this respect, I disagree with Bogner and Menz (2005) who claim that in-depth interviews with experts are not methodologically and theoretically informed, but open and descriptive in order to generate new theories (Bogner & Menz 2005:18). First of all, it is simply wrong to assert that a researcher could set aside his theoretical expertise; it is truer to assume that any kind of *a priori knowledge* will always be present in the researcher's activities. Second, in-depth-research is tightly anchored in, broadly speaking, phenomenological and hermeneutical theories and not stripped of theory. To apply narrative interviews implies that the negotiation of meaning in social interactions, the respondent's interpretations of their actions and of the events they have been involved in, is ascribed importance (Charmaz 1990:1161). In contrast to claiming that in-depth interviews start without theoretical assumptions, it would be truer to point out that such research does not approach the interview subject and the research field with a set of hypotheses about the research problem at hand. Rather, such research approaches get into a dialogue with the data and articulate categories and connections among categories out of the material (ibid: 1162). I have now already introduced issues of document and interview texts, which will follow below.

2.2.3.3 Analysis

A good question guiding the analysis of material is to ask oneself: *What is this an instance of* (Weiss 1995:155)? Or, as Charmaz suggests: "Of what larger process is this action a part?" By doing so, the data is analysed and lifted onto a more generalisable level, beyond mere empirical description. My goal of analysing textual materials (interview transcripts, policy documents) is to carve out logics informing social practices across interviewing partners, to generate information about tacit knowledge in technology governance, to learn about priorities and constructions of realities, and to learn about patterns of interpretation (Meuser & Nagel 2005:80). I do so by engaging with and thinking about the material. While doing so, I ascribe codes to textual passages. These codes are "developed and defined through interaction with the data" (Weiss 1995:156).

While codes are triggered by observations in the data (Charmaz 1990:1162), the "researcher's school of thought" (ibid.:1165) and his perspective provide the "conceptual roots for the categories to grow" (ibid.). I had, for example, a particular interest in naming nanotechnologies and in chains of equivalences and differences (as delimitations and demarcations). And I looked for demands, arguments, or metaphors. I conducted this actual analysis and the data management using the scientific software Atlas.ti.

As a first step in the analysis, Meuser and Nagel (2005) recommend to group the topics of each interview according to their occurrence (84). Indeed, it came naturally to explicate the structure of each interview and document by means of key words for gaining an oversight and a summary. These key words make me easily remember the content of the interview. I created these key-word-summaries in the primary document manager of the software Atlas.ti. In the "primary document manager" the empirical materials which I analysed were saved. Here I could add comments for each document. Comments on interview transcripts would normally include a short note on why I contacted this person, the structure of the interview, as well as general field notes that influenced the interview situations (i.e. "unfriendly beginning, the respondent feels nanotechnology is not his main area and he would have preferred a phone interview, challenges the first questions ('be more specific!') but starts chatting after a while"). Examples of the structure of interviews are as follows:

I)

- work of working group RSRAEng Report
- example nanosilver advertisement in the train station - not regulated, environmental pollution
- cosmetic industry – event where he challenged them
- government ambiguous definition precautionary principle
- lack of risk research funding
- comparison media attention aviation, GM, nano

II)

- starts off with Royal Society (RS) and nanotechnology
- he Science & Society background
- RS task after report: a) workshops, b) watchdog government, c) responsible nanocode
- ad report: next review Council of Science and Technology but meanwhile RCEP report
- Stakeholder forum (NSF)
- demand government action: targeted funding (centre), mandatory scheme
- EU vs BERR; cosmetic regulation inadequate - moral issue
- experiences different governance (stakeholder forum, NT potential, acknowledgement uncertainty)
- Responsible nanocode; problematic industry
- soft governance vs hard regulation

While these examples of key-word interview structures might not provide any insights for an outsider, they allow me to remember the entire content and course of the interviews in an instant.

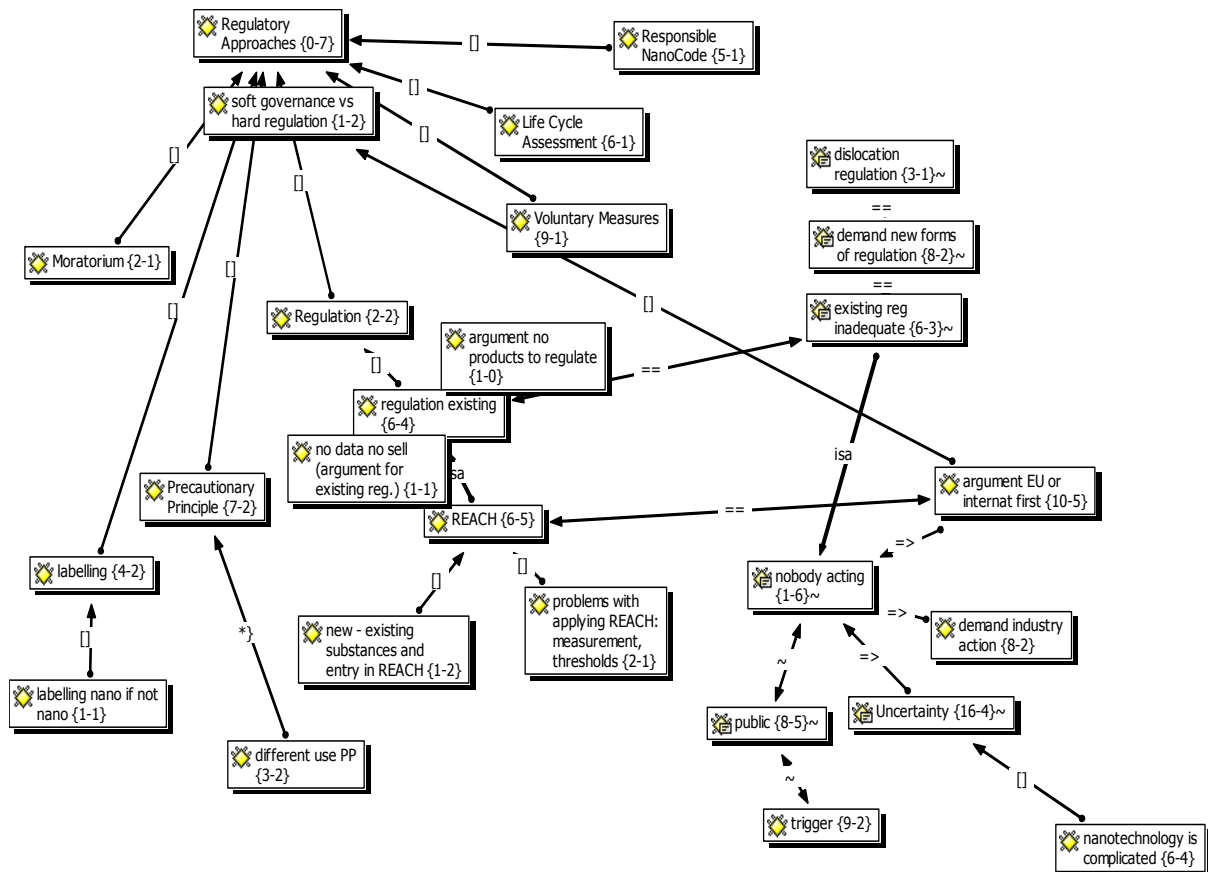
The next step of analysis can be to collect the primary analysis across interviews under subheadings (Meuser & Nagel 2005:84-85). Others refer to this process as sorting and integration (Weiss 1995) or memo-writing (Charmaz 1990). By means of memo writing, we start the analysis of the materials and at the same time the process of writing-up the research report. According to Charmaz (1990), memo writing contains thinking and rethinking categories. It is like talking to oneself. Memos can be ordered and re-ordered; and they can be linked with quotes and quotations which is particularly easy in Atlas.ti. Memo writing is about forming an archive of ideas which then can be rethought for new memos, for a new organisation of the material, and so forth (Charmaz 1990:1169). My first three interviews, for example, were overwhelming as any information, topic or argument was new. Themes I identified ranged from defining nanotechnology, over issues such as complexity, uncertainty and labelling, to demands, like the need to coordinate activities, to foster dialogue and to keep pace with international developments. I collected and sorted quotes and paraphrases of

all three interviews according to these subheadings in a word-document which I called "memo1." Later on, during the process of coding, I wrote memos directly into the programme Atlas.ti whenever a thought struck me. Most of these memos were dismissed, while out of others, the critical explanations that are brought forward in this study were developed. For example, while analysing the German interviews, I once wrote the memo "keeping the process open to avoid polarisations:" It says

Example memo

NanoCommission instead of regulation: Regulations are not discussed in the phase I, they would not reach consensus, the discussion is kept open. At the same time, conflict is avoided. This is connected with the code "precaution", "pragmatics", and "avoid polarisation." It also has something to do with the memo "dialogue, performance and trust."

In the referenced memo on "dialogue, performance and trust" I wrote that new stakeholder forums build trust and new identities – a new consensual political style is established among partners which make protests less likely. What we see in these memos is how I started to develop the idea of a *logic of pre-emption*, which – as we will see – features centrally in the final work. The example shows that coding and categorising is more about developing ideas than about describing topics (Charmaz 1990:1167). This process of coding and memo writing essentially functions to link thoughts, analyses and materials. Sorting and bringing materials dealing with the same issue together is a crucial process in analysis (Weiss 1995:168). In this respect, I also preferred to code the texts on the computer and not on paper, because the software Atlas.ti provided me with tools, such as 'networks' and 'families,' in which I could visualise and order the materials. For example,



When I click on these fields (that are codes), I get a list of quotations which were coded by this code. I developed many networks about different themes.

The example memo above and how the *logic of pre-emption* developed out of it also reveal something about identifying and naming logics. One thing in identifying logics is that the textual analysis is guided by theoretical assumptions. Others, for example, would have identified a narrative in these memos and codes, but here it turned into a logic due to the conceptual framework. Another issue is *naming* logics, which is a question of differentiating among social, political and fantasmatic logics, as well as a problem of giving the logic a name. Later on in the study, I characterise, for instance, a certain kind of practice in nanotechnology governance as being informed by a *logic of scientification*. I could as well have called this logic a *logic of rationality* or a *logic of factualisation*. It comprises a shift in the nanotechnology debate away from a fantastic realm into science discourses and a strong *demand for reason* as opposed to – what was perceived as – an emotional, irrational debate on GM. This logic is part of the process of explaining why the horror fantasies did not grip. Nanotechnology was kept as a technical field. In this respect *the logic of scientification* operates as political logics because it demarcates nanotechnologies from horrific

imaginings and it stabilises an existing regulatory regime. At the same time, the logic of scientification is a social logic as it characterises the governing of daily practices in risk regulations. Risk regulation is marked by being tied into evidence-based policy-making, which is about data collection (risk assessment) and about making informed decisions. Hence, it operates as political logics when it excludes other ways of being, like excluding Prince Charles or E. Drexler by demarcating their perspectives as non-scientific, fictional. But, it is intertwined with social logics characterising an existing regime of regulation, which is based on a belief of statistics as scientific means of knowledge generation. The example shows that naming and identifying logics entail judgements (Glynos and Howarth 2007:187). This constitutive role of the researcher was also problematised in the discussion on articulation earlier on in this chapter.

I intend to conclude my methodological chapter herewith. The rest of this thesis is composed of my empirical analysis – a research report illustrated with interview quotes which demonstrate my analysis and present events in the respondents' words (Weiss 1995:10). The interview quotes can be problematic because my interviewees were promised anonymity and confidentiality. As there are not an abundance of actors involved in nanotechnology politics and due to the strong networking in the field, people might still be identified by what they said, even if their name is not mentioned. Indeed, respondents expressed this worry. For this reason, I further alienated the quotes from the interviewees by giving the respondents different labels. Thus, the same person's quote can be tagged as consultant, civil servant, member of the stakeholder forum and so forth, according to the respective context of their utterance. This is necessary for confidentiality reasons, but I mention it here to avoid giving the wrong impression that I interviewed more people than I did.

2.3 Conclusion

In this chapter, I explained how I approach hegemony empirically in the analysis of nanotechnology regulatory policy-making. I build on Glynos' and Howarth's logics of critical explanation and I complement them with concepts from rhetorical policy analysis. Political logics with their focus on demarcation, exclusion, and inclusions are in the centre of my research on hegemony.

My research strategy is composed of several steps and layers: First, problematization: I identified the aspects of reality that I want to explain; second, genealogy of how the problem at hand emerged; third, data generation and articulation, as well as contextualisation. For the data generation, for developing thick descriptions, I require case studies (context), and a corpus of texts generated by document research and interviews. In these texts, I articulate what I see in the self-interpretations of actors from the perspective of political discourse theory informing my study. In this process of articulation, I tie theory and data together. This practice of analysis is facilitated by asking the question "what is this an instance of;" and by constantly ordering and reordering materials in memos, families, and networks. Various concepts from rhetorical policy analysis inform this analysis, such as different types of arguments, analogies or rhetorical shifts. From the next chapter onwards, I present the results of such an empirical analysis.

3 Period I: Nanotechnology for the Future of the Nation – Visions and Economic Appeals

This and the following chapter address the emergence of nanotechnology as a regulatory object. While traditional approaches to policy-making take the regulatory object as given, I explain how nanotechnology was constructed as a specific field of policy, arguing that this contingent articulation of nanotechnology in early nanotechnology governance formed the conditions of possibilities for a soft mode regulation characterised by the logic of pre-emption to emerge. As such, I bring to the fore the contingency of how nanotechnology was constructed and re-constructed in a particular way. Existing studies on nanotechnology regulations consider the lack of clear nanotechnology definitions as a problem (see Chau, Wu & Yen 2007, Reynolds 2003) and that definitions of nanotechnology have serious policy implications (i.e., Francis 2010:140). But their focus on the technical⁴ misses the political in defining nanotechnology⁵.

Against this background, I elicit the politics of naming in the constitution of the field of nanotechnology. I start with a problematisation in a genealogical vein of how nanotechnology was constituted as a technological field and how it was shifted to the attention of policy-makers. I will bring out the role of strategically placed individuals, scientific networks, laboratories, and consultants in constructing and driving the emerging technology; and how they were gripped by nanotechnology's fantasmatic appeals and how policy-makers reproduced these appeals. Scientists and policy-makers began to re-order science policies by drawing together different fields and aligning them under the umbrella 'nanotechnology.' I show that, in the constant reconstitution of the concept, 'nanotechnology' amassed an extended amount of elements in its signifying chains, and fantasies played a crucial role in this new constitution of nanotechnology.

In fact, the chapter demonstrates that for the first 15 years of nanotechnology governance, policy-makers and scientists increasingly articulated nanotechnology as bringing wealth for

⁴ E.g., should the nanodefinition depend on functionality, or on scale, and if on scale does it range from 1nm to 100nm or to 300nm, ...?

⁵ With the notable exception of Joscha Wullweber (2010), who interestingly claims that nanotechnology is an empty signifier (without, however, asking what the implications of this is for the emerging regulatory regime). And with the exception of Lindquist, Mosher-Howe and Liu who analyse how nanotechnology is defined over time and who address the issue of linking the "nanotechnology-solution" to various problems (in contrast to their promising aim, they stop short, however, at showing that there are different definitions).

the nation and a higher quality of life. Nanotechnology became closely linked to economic growth and the future well-being of the nation. I thus argue that in both countries the rise of nanotechnology is characterised by its articulation within a discourse of the commoditisation of the sciences and practices of forecasting. In addition, I will suggest that in both states nanotechnology governance was part of a meta-narrative of modernization: the politics of catch-up in the UK and of ecological modernisation in Germany. Once gripped by powerful fantasies, nobody would want to risk that nanotechnology's promises would not come true because nanotechnology's development were restrained by regulation or because lay publics were against it. At the same time, nanotechnology politics in both states was accompanied by an extension of the term 'nanotechnology' and by a powerful fantasy of a glorious nanotechnology-future, a fantasy that emerged and circulated internationally.

The chapter begins by addressing the 'discursive economy'⁶ in which early nanotechnology funding emerged. In detail, I explore the UK's science policy-making at the early 1990s, demonstrating that a scientific network at the British National Physical Laboratory successfully introduced nanotechnology as a solution to the problem of international competition and to the problem of exploitation of research results (both elements of the commoditisation of research). I will explain that British policy-making incorporated nanotechnology into its 'politics of catch-up.' Based on a story of delay, UK politics assumed that Britain as a nation was behind in international developments and that it has to catch-up in order to maintain a wealthy nation. Nanotechnology should help the UK to escape this unfortunate situation. In the context of the German case, I will, then, show how practices of forecasting contributed to construct nanotechnology. The VDI Technology Centre, who conducted such forecasting reports for the German Federal Ministry of Research and Education, is introduced as an important German governance actor. Regarding the discursive economy of the rise of nanotechnology in Germany, the forecasting reports contributed to articulating nanotechnology, which was constructed as an environmentally beneficial technology, within a discourse of 'ecological modernisation.'

The chapter will conclude that the extension of the signifying chain 'nanotechnology,' ironically, made it possible that nanotechnology came under threat. When more and more elements and imaginaries were integrated in the chain of equivalences of the signifier

⁶The term 'discursive economy' captures that discourses "should be seen as a practice of production that can be characterized as material, intertextual, and complex, [and] always inscribed in relation to other discourses" (Gottweis 1998:36).

nanotechnology, its omnipresence and power opened up for horror fantasies. What these horror fantasies consisted of and how regulatory efforts on nanotechnology were raised to pre-empt this new threat, will be the topic of the subsequent, fourth chapter.

3.1 UK: The rise of nanotechnology within discourse of commoditisation

When scientists first started to use the label 'nanotechnology' for their research in laboratories in the UK in the late 1980s, Britain was experiencing the death throes of the premiership of Margaret Thatcher. She had pursued a neoliberal agenda which manifested itself, for example, in economic liberalisation and in the privatisation of the public sector. In this political climate, the Conservative government under John Major, who replaced Thatcher in November 1990, developed a reform of British science and technology policy. The reform aimed at organising science and technology policy as instrument for improving the economic performance of, and quality of life, in the nation. The change manifested itself in the 1993 White Paper on Science and Technology, which redefined British science and technology policy as innovation policy. The increased importance of science and technology policy was also institutionalised in a new Office of Science and Technology (Chancellor of the Duchy of Lancaster 1993:2). As I show in my analysis below, with this redescription of science and technology as innovation policy, research funding became governed by a logic of commoditisation. The logic of commoditisation comprises demands of exploitation and efficiency addressed at the sciences and research institutions and the suggestion that sciences shall contribute to the creation of wealth and quality of life by exploiting scientific knowledge into tradable products. The institutionalisation of this reform was gripped by the fantasmatic narrative of a race between nations. The 1993 White Paper thus privileged the threat of global economic competition and the role of science and technology in leading economic change, stating:

2.1 The major challenge facing the United Kingdom today is an economic one. The nation's first priority must be to improve the performance of the economy to meet the competitive challenge of meeting the goods and providing the services which others, at home and abroad, choose to buy. [...]

2.3 Firms which are skilful at innovation – the successful exploitation of new ideas – will secure competitive advantage in rapidly-changing world markets; those which are not will be overtaken. Although just one of the large number of interdependent factors which bear upon industry's competitiveness, the capacity to put science and technology to commercial use through innovation policy plays a significant part in successful modern industry.
(Chancellor of the Duchy of Lancaster 1993: 11)

In general, a main concern of the text was the perceived weaknesses of exploitation of scientific research to economic advantage: the exploitation of new markets, of new ideas, and of funding. The government told a story of scarce resources, due to which the majority of funding and support could go only to those areas which the government had decided would contribute to generating national prosperity and improving the quality of life (Chancellor of the Duchy of Lancaster 1993: 12). At the same time, in the 1993 White Paper, the government repeatedly assumed that the exploitation of results did not take place due to a lack of diffusion of ideas. The main solution of the problem of exploitation was formulated as coordination.

These twin developments set the stage for scientists' efforts to acquire funding in the following years to come, and it thus forms the crucial background for nanotechnology funding. According to the policy goals, it was beneficial for successful research proposals to inscribe themselves within the general aim to generate national prosperity and to improve the quality of life. In this context, the visionary promises of nanotechnology came in handy. Nanotechnology – as we will see below – became increasingly defined as key technology, as cross-cutting technology, which would be the base for innovation in all scientific fields. Accordingly, nanotechnology as a funding strategy allowed many disciplines to hop on board and to participate in the funding share. A main point put forward in the 1993 White Paper was that the government assumed that the exploitation of results did not take place due to a lack of diffusion of ideas. The main solution of the problem of exploitation was formulated as coordination. Here again, nanotechnology could be formulated as solution in policy documents to come, because as an interdisciplinary, cross-cutting technology, it connects scientific and engineering communities.

However, the 1993 White Paper was part of the earlier policies of the Conservative government, which aimed to foster the translation of research into products, such as the LINK-programme. LINK has been a governmental research funding programme for collaborative research projects among industry, universities, and the public sector since 1986. Coordinated by the Department of Trade and Industry, it originally aimed at supporting pre-competitive research partnerships with a focus on bringing together industry and universities (Diederer 1999:37). Among the five initial projects that received funding within the LINK-scheme in the year 1988, were molecular electronics, new materials and

production measures for microchips, industrial measuring instruments, genetic engineering, and – nanotechnology (The Guardian 1988). How did nanotechnology get there?

Albert Franks

Finding nanotechnology within initial projects of the government LINK programme in the 1980s means that somebody has managed to inscribe nanotechnology as a solution to the problems defined by government: nanotechnology was constructed as a LINK issue and thus as an area that could fulfil the demands to exploit scientific knowledge, to foster industry investments in R&D, and to raise efficiency, in terms of translating research results into products. An important player in the LINK programme was the National Physical Laboratory (NPL), the UK's National Measurement Institute and research centre in Teddington, a small town in the south of London. The National Physical Laboratory ran the secretariat of the LINK programme at their institution.

At this laboratory, the scientist Albert Franks worked on surface preparations of substances in the 1980s, and his work moved towards the nanoscale. According to an interviewee, Albert Franks, who himself collaborated closely with research groups in Japan, suggested to the Scientific Directorate of the NPL that going into nanotechnology was a beneficial strategic move. The head of the NPL reacted to this suggestion by initiating efforts that turned out to be successful to convince the UK government to launch a nanotechnology initiative (NION); it was then supported by the Department of Trade and Industry (DTI). The two initiatives within NION were a Nanotechnology Forum and a Nanotechnology Strategy Committee. The Forum aimed at representing academia, industry, and government. One of its main functions was to disseminate information about nanotechnology in the UK in order to raise awareness about the subject (see POST Report summary 1996:3). An important rhetorical strategy in the persuasion of government was to refer to Japan, echoing the fears of global competition. As one interviewee points out:

We had at that time a close link with the Japanese ... nanotechnologies were being considered in Japan and one of our high grade researchers was strongly involved with the Japanese. He used to come and to talk with me and to say that his group wants to do more on nanotechnology. Nanotechnology was something that people had not heard of in many technical areas.

So, the NPL from that actually persuaded the government to have a programme called the nanotechnology initiative. If I remember it correctly this was a programme partly funded by the government and partly funded by industry. It was certainly one of the first programmes where government put money into nanotechnology.

(Interview material: Scientific Director of a Research Institution)

The focus on Japan was also reflected in the first newspaper article on nanotechnology in the UK, issued by the Sunday Times on January 3, 1988, titled: "Polishing off the Japanese – A machine tool than can almost cut away single atoms could allow Britain to leapfrog the Japanese in large-scale silicon wafers." The article dealt with a new machine tool that had been installed at the NPL. The new machine was so precise that it allowed for the analysis of matter at the nanoscale. Hence, nanotechnology was constructed as an opportunity to scoop the Japanese by scientists drawing equivalences between early nanotechnology investments and taking a lead in technology development. This rationality derives from "science-push-theories" (Gottweis 1998:252) encompassing the premise that scientific development and economic growth are intrinsically linked. To link nanotechnologies with this approach matches with a general change in research and development politics since the 1970s, which is expressed by an application-oriented style of subsidizing research results orientated towards management and a language based on innovation (Webster 2004: 9). Sheila Jasanoff (2004) speaks in this respect of the development of knowledge societies, where knowledge has become the first source for well-being of a nation, and hence has lead to stronger connections among politics, science and economy in the last decades.

In sum, the first UK nanotechnology funding was made available within the government's LINK programme, a funding line governed by a logic of commoditisation, which had institutionalised demands that research be efficient and exploitable. At the same time, the scientific community experienced a relocation of resources and the privatisation of governmental-owned research institutes. In this political and economic context, nanotechnology was inscribed as one area where cooperation between industry and academia could be reached, and thus as one area in which commercialisation of research could be enhanced, potentially giving Britain an advantage over Japan. The first nanotechnology initiative called NION was institutionalised as Institute of Nanotechnology (IoN), which, until today, functions as an information source, especially by organising conferences for businesses, and as a cooperation partner in EU project funding recruitment. Significantly, it holds an annual Albert Franks Memorial Lecture.

However, in 1994, just a few months after the White Paper, LINK funding ran out, based on the expectation that industry would continue advancing the field without government support from then on. From the angle of scientific research, funding expired after too short a period

for scientific developments. A scientist in one interview expressed the grievance that the initial efforts were not followed up:

After five years, the funding programme ran out: the government did a review and did not renew the programme. So, nanotechnology almost STOPPED. When every other country was doing nano, especially nanochemistry, our departments and ministries took the view that we have done nanotechnology for five years, so that's it. That was quite interesting.
(Interview material: Scientific Director of a Research Institute)

These grievances were also expressed publicly (POST 1996). Paradoxically, while the LINKS programme and the White Paper had firmly placed nanotechnology research on the policy agenda, its future was under threat and eventually a policy story caught on: one – as I will show below – that brought forward the demand for nanospecific funding supported by a story of delay, which argued that the UK had to catch up with international nanotechnology developments. In the following, I will explore these developments.

3.2 Background: The British politics of catch-up

Characteristic for UK nanotechnology politics has been the grip of the dreadful fantasy that Britain as a nation could fall completely behind in economical and technological development, expressed as the 'decline of Britain' as a meta-narrative and in a story of delay on the nanotechnology policy level. According to Deborah Stone (2002), such stories of decline are classical in policy politics (138); they establish a sense of urgency: if we do not do something now, we will lose ground. In the following, I will show the emergence of this policy story of delay in nanotechnology governance by looking at three documents: a report by the Parliament Office of Science and Technology published in 1996, a report by the Foresight Materials panel published in 1999, and the Taylor Report "New Dimensions for Manufacturing – A UK Strategy for Nanotechnology" published by the UK Advisory Group on Nanotechnology Applications within the DTI in 2002. These reports can be seen as milestones that exemplify how nanotechnology increasingly was considered as object of political intervention by various actors.

When the first nanotechnology funding initiatives ran out in the middle of the 1990s, requests that the UK had 'to catch up' with international nanotechnology developments were publicly articulated and taken up in a report of the House of Common's Parliament Office of Science and Technology (POST) in November 1996. POST's declared aim was to raise

awareness among parliamentarians about the potential of nanotechnology for the future of the UK and to provide them with an understanding of the field, so that they could "gauge the potential for the future of nanotechnology in the UK" (POST 1996:4). The report (titled "Making it a miniature – Nanotechnology, UK Science and its applications") situated nanotechnology within a general trend towards miniaturisation and, therewith, within the success of microelectronics and computing. And it highlighted the widespread economic impact nanotechnologies would have:

The full report reviews the many potential applications of nanotechnology which have yet to be realised commercially, ranging from future improvements to existing technologies (such as sensors and computer chips), to entirely new applications which can only be realised using nanotechnology. Predictions of future markets in this area range from 20BECU to over 100BECU by the year 2000.
(POST 1996: 3)

In the quote we see an important discursive shift linking nanotechnology to the future in a chain of equivalences which was a necessary condition for a discussion about catching-up. The problem, that nanotechnology did not receive enough funding and awareness in the UK at that time, was established in the POST report by the arguments that nanotechnology was a promising, interdisciplinary field with a wide range of applications and that there were international efforts and investments in the field in contrast to the non-existing UK strategy. The report compared international and national initiatives in nanotechnology development against the activities in the UK and concluded that the main issue was whether the UK was keeping pace.

The main issue addressed in the full report is whether the UK is keeping pace. One international 'league table' of 'technological supremacy' prepared for the German Ministry of Research and Technology [...] shows Japan and the USA in a clear lead, with the UK lagging behind Germany in Europe.
(POST 1996: 3, my emphasis)

The current situation was articulated as a watershed moment, where government would have to decide whether it wanted the UK to be strong in nanotechnologies (POST 1996:4). Particularly critical attention was drawn to the UK's Technology Foresight Project which had not considered nanotechnology to be a research priority.

The Foresighting Project reacted to the critique by publishing its first report on nanotechnologies, titled "Opportunities for Industry in the Application of Nanotechnologies," through the Foresight Materials panel in January 1999. Their report

made an important step towards linking nanotechnology with discourses of competition in the global economy:

If investment in nanotechnology in America, Japan and Europe as stated at the end of this report is a yardstick of potential, it is reasonable to accept that nanotechnology will be of major importance to all industrial nations in the near future.
(Foresight Materials panel 1999: 1)

The report drafted very distinct promises of nanotechnologies for economic prosperity and cost effectiveness that would lead the UK out of economic decline. In the foreword, for instance, the report articulated three broad reasons justifying the importance of nanotechnologies. First, the impact of nanotechnology was stressed with the claim that nanotechnology would lead to the creation of many new technologies. Such an articulation of nanotechnology as enabling multiplier fitted well into presenting a solution to demands such as coordination, efficiency, and modernisation. Second, nanotechnology would trigger a cascade of disruptive technologies that would change the way industry worked and new products were made. Nanotechnology would become the new "industrial revolution." Third, investments by the US and Japan were stressed; referring to the story of an economic race between nations.

In the year 2002, the – by then established – UK Advisory Group on Nanotechnology Application of the DTI came to a similar conclusion in a report submitted to then Science Minister John M. Taylor. The main message of what was called the Taylor Report (titled "New Dimensions for Manufacturing – A UK Strategy for Nanotechnology") was the demand for taking strategic action on nanotechnology in order to keep pace. Like earlier reports, the report reviewed the state of nanotechnology applications in industry in the UK. It proposed a series of actions to accelerate and support increased industrial investment. Out of this review it formulated the demand that:

This report makes it quite clear that in order to keep pace with competitor nations we need to recast the scale and nature of our nanotechnology activities. We need to raise awareness in industry of the enormous potential impact that nanotechnology could have and ensure that investment and action by Government, industry and researchers is fully aligned to maximise the benefit for the UK.
(Taylor Report 2002:3)

This quote again shows how the request for nanotechnology funding was linked into a broader demand to "catch-up," which linked technological development and taking a leadership in this development as a solution for reaching economic growth. In detail, the

Taylor Report proposed a coordinated strategy on nanotechnology, including nanotechnology centres, roadmaps, education, awareness campaigns, and international cooperation.

A member of the Advisory Board who participated in drafting the Taylor Report recounted in an interview:

When starting our work on Nanotechnology we made some visits overseas, went to the US, Germany, Japan and others. What we learnt was that all had the same problems: it's a diverse field, there is some goldrush feeling and everybody had some sort of pressure to catch-up. But catch-up with whom? Mainly it was about catching-up with the US but then also the US talked about catching-up.
(Interview material: Member of the DTI Advisory Group on Nanotechnology Applications)

In this example, the subject faced the radical contingency of social relations, but instead of contesting the growth- and benefit-based fantasies that inform the governance of nanotechnologies, he stayed complicit in concealing the fantasy. Rhetorically, "to catch up" is a metaphor that creates the image of others who are leading nanotechnology development and of the UK who is behind and has to follow. The personal response of the interviewee to the experience was not to question the imperative of "catching up," namely, a story of delay underpinned by the threat of losing out in the race between nations, but to feel relieved – relieved that the others were not as far as expected. This did not change the premise of his social practices or those of the innovation group.

In sum, the governing discourse constituted by these actors and texts between the 1990s and 2002 was 'to catch-up.' 'Catching up' can be defined as a governing discourse because it links the demand for nanotechnology funding in Britain (a – demand) to a story of British decline (b – problem definition) and eventually, to the appeal that nanotechnologies can enable the upturn of economic development (c – solution). Whether it was referred to as 'catching up,' 'keeping pace,' 'key to success' or 'taking a leading role' – from the 1990s onwards, the story that nanotechnology would bring benefits and growth and the subsequent demand for investment were prevalent in research policy, putting in place, as I shall discuss below, a path dependency in the field of nanotechnology research policy until 2009. Frequently, the government was also accused by other actors of taking action "too little, too late" (e.g. House of Commons Science and Technology Committee 2004 after Clift 2006). Such a discourse on 'delay' was also prevalent in the molecular biology debate of the 1970s/80s in Europe and is a complex policy narrative on the need to create national support policies for science

(Gottweis 1998: 51). It appears as necessary political rhetoric in order to establish a sense of urgency.

At the same time, "to catch up" as governing discourse in nanotechnology politics was part of a more universal demand which had a predominant stance in UK politics in the 1990s, forming the context of early nanotechnology governance, namely New Labour's 'modernising agenda.' A hegemonic discourse in Britain in the 1980s and 1990s was the 'decline of Britain' which referred to the broader history of Britain's loss of imperial power and to its economic decline in relation to the economic kick-off by the United States starting in 1914, a development in contrast to the severe British budget deficits. It was the time when the Labour party changed towards New Labour, a change characterised by the political scientist Colin Hay as implementing a "politics of catch-up," which signifies, according to Hay (1994: 701/704), a reactive political style based on the assumption that states only catch up with global economic developments without steering them. Indeed, New Labour articulated a discourse of 'modernisation.' This discourse assumes that others drive progressive developments, and the UK (Finlayson 2003: 70) is required to react to these external forces in order to catch-up. Inscribing nanotechnology into New Labour's New Britain can consequently be considered as a mutually reinforcing process. On the one hand, nanotechnology was articulated into discourses that provided the conditions for what was desirable and for what was the current national programme. A new project that wanted to gain success had to be situated within these hegemonic discourses and would not have the chance to grow otherwise. On the other hand, New Labour's modernisation was deeply intertwined with technological development, and nanotechnology (defined as generic, enabling, interdisciplinary technology) appeared to fulfil promises and necessities of reaching the goals of New Labour's agenda. This can be exemplified by the metaphor of the third industrial revolution that nanotechnology would bring, as I will show below. But first, I will turn to the emergence of nanotechnology in German policy-making.

3.3 Germany: Nanotechnology and the logic of forecasting

In Germany we can discern a similar move to situating science policy practices within a regime of commoditisation, which is an important context for the construction of nanotechnology as a regulatory object. In 1993, the biannually published governmental research report on public research funding articulated the policy story that innovation-

oriented research was weak in Germany, especially in the food industry, in chemistry, microelectronics, and information technology. Just a few years later, nanotechnology, which was defined as innovation-oriented research, would become an important development in all of these mentioned research fields. Generally, the governmental report ascribed increasing importance to application-focused research and demanded that efficiency had to increase in Germany's research landscape (FAZ 21/07/1993:6). Again, nanotechnology was not only innovation-oriented but fulfilled also requirements for application-oriented research and met thus this demand for efficiency in research policy. I will show later on that nanotechnology as a term came to stand in for efficiency in the German context. According to the FAZ article, the 1993 research report also suggested cutting funding for big infrastructure programmes, such as space missions or nuclear techniques (in this context, it is also important to consider the big changes in world politics after the end of the Cold War). As a replacement to the focus on infrastructure funding, the government report suggested that research policy should increase funding for strategically important technologies which allow for a 'growth of intelligence' (FAZ 21/07/1993:6), such as functional matter, nanotechnology, and bioinformatics. We see, thus, that nanotechnology in Germany, as in the UK, was embedded within the commoditisation of research.

Scientific advisors at the Federal Ministry of Education and Research (BMBF), located at the VDI Technology Centre, were particularly important in creating nanotechnology as a field in Germany and in initiating policies for nanotechnology research funding. The VDI Technology Centre is a company of the Association of German Engineers (VDI – Verein Deutscher Ingenieure). Despite its affiliation to the VDI, the Technology Centre undertakes independent consultancy work at the interface between science, politics, and economy. It evaluates, for instance, research projects, mainly for the BMBF. Its leitmotif is to accelerate innovation by fostering the translation of scientific results into technology development⁷. Thus, the institution was sustained by the expression of discourses of commoditisation, as described above. Such is the institutional-political context in which nanotechnology was pushed in the 1990s in Germany. A key figure in promoting nanotechnology was Gerd Bachmann, a senior researcher at the VDI TZ. Supposedly, he had met Albert Franks, the scientist of the UK National Physical Laboratory who was a driver in persuading the UK government to fund nanotechnology, during a chance discussion in a railway station in the mid-1980s – a talk that is believed to have inspired Gerd Bachmann (Nano Magazine Issue

⁷ See <http://www.vditz.de/>

14). He published an innovation analysis on nanotechnology in the year 1994 and an updated version in the year 1998. In the following, I analyse the 1998 report from the perspective of how promises were made of what was to come.

Reconstituting discourses of commoditisation, the innovation analysis on nanotechnology issued in the year 1998 by Gerd Bachmann examined nanotechnology from an economic perspective. Analysing the structure of the innovation analysis along its headlines, we can carve out a series of assumptions informing the report. The first section identifies the benefits of being able to identify and use the individual character of molecules. The second chapter concludes that, because of these benefits, international competition around these developments has started and Germany is positioned relatively well. In general, nanotechnology products are assumed to have an enormous market potential. In chapter four, Bachmann evaluates the German research landscape and the amount of nanotechnology patents positively. Out of this status-quo he recommends that policy-making has to ensure that positive developments are sustained and potential weaknesses improved.

Innovation analyses assume linearity in the development of technologies.. Indeed, Gerd Bachmann rearticulated dominant metaphors of race and competition when he wrote in his innovation analysis in the year 1998:

Industry's and funding agencies' interest in nanotechnology is increasing dynamically not only in Germany but worldwide. Although we can only guess at the moment what the applications of this new technology will be [...], a global race for the best starting position into the market has begun.
(Bachmann 1998: V)

Such practices of forecasting ignore their own role in producing the technologies to come. Both in the UK and in Germany, foresighting reports were important sites for the creation of nanotechnology as a field. In the UK, the UK Foresight Material panel published a report in January 1999, titled "Opportunities for Industry in the Application of Nanotechnologies," which drafted distinct promises of nanotechnologies' economic prosperity and cost effectiveness that would lead Britain out of economic decline. In Germany, the VDI-TZ innovation analysis by Gerd Bachmann, which was a consulting report for the Research Ministry, made substantial effort to represent the field of nanotechnology in numbers – the promise of what was to come should be expressed in a calculable form. Miller and Rose (2010) pointed out how government, in order to act as a centre, has to accumulate facts, particularly in the form of statistics, about the field which is to be governed. Calculations are

in "itself a way of acting upon the real," and government depends on "calculations in one place about how to affect things in another" (Miller & Rose 2010:66). This function of calculation, that reality is formed in a particular way by conducting statistics, might be particularly true for foresight exercises such as this innovation analysis, which did not try to grasp the status-quo, but to estimate how nanotechnology-related marketing numbers would develop in the future. In chapter 5, titled "Market Potential of Nanotechnologies," Bachmann evaluated, for example, five potential areas for the application of nanotechnology (ultra-fine layers, nanostructures, molecular architecture, ultra-precise modelled surfaces, analysis of nanostructures), and he tried to estimate, in numbers, which products these nanotechnology applications would bring in five different branches (medicine, optics, chemistry, electronics, cars). For example, the study assumed that ultra-fine layers would be employed, for instance, in glasses, sensors, chips, solar cells or colours, and that the sales of these products would circa double from the year 1996 to the year 2001 (from 22.900 DM to 45.400 DM). After estimating the developments in all five application areas, Gerd Bachmann concluded that the turnover of these products would be around 100.000 DM by the year 2001 (Bachmann 1998: 129-140).

Bachmann's report significantly contributed in Germany to the constitution of the entity 'nanotechnology,' to extending its signifying chain, and to rendering the relations among distinct nanotechnology-phenomena stable. Applying Miller and Rose's analysis of statistics, one can say, the figures themselves enable relations to be established between the different elements of the signifying chain, rendering 'nanotechnology' into thought as a calculable entity "with a solidity and a density" that appears all its own (Miller and Rose 2010:66).

Methodologically, Bachmann's innovation analysis drew on expert interviews and on an earlier report by the consulting company Gewiplan from the year 1991. Many rely on the information of such companies, and the more one is quoted, the more one's analysis is considered legitimate (Ebeling 2008⁸). Referring to Callon's (1998) assertion that economists do not merely describe economies, but bring them into being, Mary Ebeling also concluded (as I want to show here) that the foresighting into the nanomarket essentially contributed to creating the field.

⁸ In her article, "Mediating Uncertainty: Communicating the Financial Risks of Nanotechnology," Ebeling provides a trenchant analysis of how nanotechnology as a market was formed and communicated and looks at the role of consulting firms in the building of the market.

In the effort to build a new technological market out of nanotechnologies, actors make a multiplicity into a singularity - nanotechnologies become 'nanotechnology' - and a widely dispersed marketing potential becomes a single market.
(Ebeling 2008: 346)

A basic assumption of such practices of forecasting is linearity with regard to the application of scientific research into tradable products. The thought that we can soon employ commercially what can be done in the laboratory is rather naïve and disregards that the scientific results might only be valid within the experimental conditions of the laboratory. Further below, I will discuss the emptying of the term nanotechnology and the fantasies underpinning the constitution of the field, which are intrinsically connected to how forecasting works. But first, I will contextualise early nanotechnology policy-making within the "discursive economy" (Gottweis 1998) of the German case.

3.4 Background Germany: Nanotechnology articulated into "Ecological Modernisation"

In this section, I show how, in Germany, nanotechnology was constructed as a new technology for reaching the goals of 'sustainable development.' In the 1990s, sustainable development had become an overarching goal in global (United Nations Rio de Janeiro Conference) and supra-national (EU preamble of the Amsterdam treaty) politics. Subsequently, the problem arose of how to translate these policy goals on a local level. In Germany, for instance, a large, interdisciplinary research project called "Global future-oriented development – perspectives for Germany" aimed at creating criteria, guidelines, and implementation strategies for sustainable development in research and development.⁹ Nanotechnology was one research field considered by the study. The appearance of nanotechnology in the 'sustainable development' study shows that nanotechnology was articulated as one area to push a 'sustainable Germany.' Thus it was linked with the hegemonic sustainability discourse in the 1990s.

Significant in the constitution of nanotechnology in Germany were efforts to consider nanotechnology from the perspective of a beneficial environmental technology. Gerd Bachmann's innovation analysis, for instance, considered advantages of nanotechnology for reducing energy use and for energy creation with effective photo-voltaic cells or compact

⁹ See project-webpage <http://www.itas.fzk.de/zukunftsfaehigkeit>

light batteries with big inner surfaces (Bachmann 1998:12). It also considered the advantages of nanotechnological solutions for environmental protection, for example, by enabling the segregation of harmful substances by nano-membranes, filters, and catalysers; by the replacement of toxicological substances with nanomaterials; and by providing improved indicators for detecting harmful substances (ibid: 13). Following Bachmann's analysis, the first Research Ministry report on nanotechnology, published in the year 2002, had three subheadings: "Ecological Importance" as one, next to "Economic Importance" and "Scientific Importance." The BMBF articulated nanotechnology as a per se sustainable technology:

An essential characteristic of nanotechnology is that it is based on the idea to realise certain functionalities required by technical applications with a minimum of material. For this reason, nanotechnology is in its conceptualisation primarily and principally resource- and energy-saving. (BMBF 2002a: 11)

In the following years, this discourse on nanotechnologies' potential for the environment sedimented in German nanotechnology politics. It was invoked particularly by the Federal Environment Ministry. For example, the Environment Ministry's website search, conducted in the year 2009, provides only a few documents on the topic nanotechnology, and these documents primarily talk about guaranteeing nanotechnologies' benefits for the future. Also, its press releases (e.g. UbA 2009) or information text on nanotechnology (e.g. Federal Environment Ministry 2008) present nanotechnology as contributing to environmental protection and as bringing a number of products with a positive influence on the environment and economy. Importantly, my point here is not that nanotechnology's benefits for the environment were merely a strategy for acquiring funding. Rather, I assume that 'nanotechnology for the environment' had a similar function for establishing nanotechnology as a field in Germany as 'to catch-up' had in Britain. The challenges Germany's government faced in the 1990s were economic ones induced mainly by the reunification of Western and Eastern Germany, as well as new political demands of environmental protection and equity, which had become prominent topics from the end of the 1970s onwards, expressed for example in the anti-GMO movement and the rise of the Green Party. In 1998, when Gerd Bachmann published the update of his innovation analysis, a historical change occurred in German politics: the red-green project. This new coalition government composed of the Social Democratic Party (red) and the Greens was considered to be a historical change because the latter were in the government for the first time. In addition, the government was,

for the first time, built by parties neither of which had been part of the government in the previous legislative period (Egle, Ostheim & Zohlh fer 2003:9).

According to Egle, Ostheim and Zohlh fer (2003), the red-green project tried to stitch together diverse demands, ranging from unemployment to environmental protection, through the discourse of? 'ecological modernisation' (11). The concept had been developed by the social scientist Martin J nicke (i.e. J nicke 1993). The term was taken up by the governing parties of 1998 – an entire chapter of the coalition agreement was titled 'ecological modernisation' (ibid.). It was the discursive economy of the time into which any project had to be linked to be successful, similar to Britain's demand for modernisation which was expressed as the imperative 'to catch-up'. In Germany, the demand to fund nanotechnology also became linked to a more universal demand: to develop, but sustainably; to progress, but without doing harm.

An important element of the overarching concept 'ecological modernisation' is the discourse's integrating aspect: it appears as solution to urgent problems of the time. Technology plays a key role in 'ecological modernisation.' An example is the effort to create policy instruments that support environmental technologies which increase the number of employees at the same time ("besch ftigungswirksame Umweltinnovationen"). In a way, this 'ecological modernisation' seems to be gripped by a fantasy of getting it all, which we will also see in the concept of responsible development later on. Responsible development does not steal enjoyment by stopping development, but it promises a win-win-situation for the environment and the economy. The philosopher Astrid Schwarz (2009) refers to these fantasmatic appeals in 'green nanotechnology' as 'green dreams of reason.' Schwarz elicits the common ground between the nanotechnology and the sustainability discourse, both of which allocate visions of excess and control at the same time. In this respect, the 'logic of getting it all' is a fantasmatic logic gripping science policy. There are strong fantasmatic appeals at play in this demand for a 'green efficiency revolution,' which is a slogan applied to nanotechnology by the Social Democratic Party. On May 6, 2004, the SPD parliamentarian Ulla Burchardt used the phrase, for example, in a speech on nanotechnology in the parliament:

Experts prognosticate: Nanotechnology will bring the next industrial revolution in the next ten to twenty years and nanotechnology will change our life more than microelectronics, which brought us the computer, internet and many other things. This gets plausible if you imagine that a million of bits on information can be saved on a needle head by means of nanotechnology or that significant savings

of commodities, weight and resources will be possible in products, which will bring the ecological efficiency revolution closer.
(Burchardt, Ulla - 6. Mai 2006, see Deutscher Bundestag 15/108: 9793)

We see that the then governing party, the SPD approached nanotechnology with a focus on the advantages of nanotechnologies, which were defined as bringing life quality, health, a better environment and growth through nanotechnology's potential for efficiency, which would bring about a reduction in the use of resources and costs. What is excluded in this fantasy of a 'green efficiency revolution' is the possibility of protecting the environment by means of restriction, i.e. by reducing consumption or trafficking. Such restrictions would steal enjoyment, while an ecological modernisation promises extension of economic growth and environmental benefits by technological development. That is 'sustainable development' masks potential pitfalls in technology developments. So there are good reasons for characterising it as a fantasmatic logic. Still, it operates as well in social practices if we see 'sustainable development' as a hegemonic political regime in which all social practices are aligned to the overarching goal of sustainability.

So far we saw that the rise of nanotechnology was accompanied in both states by appeals to economic growth and technological advance. In this respect, the role of policy entrepreneurs such as Albert Frank and Gerd Bachmann, who were gripped by these ideas and reproduced them, offer interesting points for comparison. We saw that elements of scientific research and technology development became articulated as moments of a nanotechnology discourse. Research institutions and research consultancy were important sites for constituting the nanotechnology field. At the same time, the comparison shows that the research field could only grow if it was contextualised within the discursive economy of the time. Nanotechnology had to be articulated as solution to pressing issues of the time, i.e. the 'decline of Britain' or the environmental movements in Germany. In order to define nanotechnology as solution to problems of our time, the promises of what nanotechnology would bring in the future had to be convincingly presented and constituted, as it was done in social practices of forecasting. In addition, both countries were governed by a neoliberal discourse which suggested that a general solution to a set of problems was to increase efficiency in terms of improved use of resources by adopting an economic rationality on every string of life. I call this marketization a logic of commoditisation. At the same time, we can also see in these developments in science policy that neoliberal discourse conceptualises society as governed by competition. According to Foucault, German

neoliberalism in particular presumes that "competition as an essential economic logic will only appear and produce its effects under certain conditions which have to be carefully and artificially constructed" (Foucault 2008:121); we can see this legacy in German science and technology policy.

In both states, we can also track tendencies of emptying meaning surrounding the creation of the field of nanotechnology. I will turn to these now.

3.5 Emptying the meaning of nanotechnology

Above, I demonstrated the importance of the political context into which discourses of 'nanotechnology' were articulated and indeed constructed. I have been building up the argument that once linked with modernization, economic growth, and well-being, a regulation of nanotechnology becomes less desirable. I have yet to detail the construction of the meaning of the regulatory object. Thus, I will, in the following, present an analysis of how the term was used. I will point out the contingency in its construction by illustrating how the concept was extended and emptied in both countries. I will do so mostly through an analysis of early reports, many of which I have already drawn upon (such as the research ministry's report and the innovation analyses in Germany, or the POST-Report or the foresighting report in the UK). I will first present the analysis of the German context in which 'nanotechnology' was increasingly conceptualised as cross-sectional technology and key technology. I will also show how the boundaries of non-living and living materials were blurred, so that nanomaterials came to signify almost everything at a small scale. In particular, German reports constructed the future regulatory object nanotechnology as inherently new and omnipresent. Then, I will continue with analysing the use of the term in early UK policies. I will show how the initial references to 'nano' as scale were increasingly left behind. UK policy-makers stressed nanotechnology's promises to come: To redraw the boundaries by defining 'nanotechnology' as generic, enabling, interdisciplinary technology was the rhetorical basis for claiming that nanotechnology would bring a new industrial revolution. Let me start with Germany.

In Germany, one of the first to coin the term 'nanotechnology' was the Institute for Systems and Innovations Research (ISI) who did this cautiously in a report on "Technologies of the 21st Century," published in 1993:

Nanotechnology has a key function in the technology development of the 1990s and in the first decade of the 21st century. It enables engineering at the atomic and molecular level. For a full scale stimulation of future innovation processes and a new technology generation by the new basis technology, an interdisciplinary cooperation of electronics, information technology, material sciences, optics, biochemistry, biotechnology, medicine and micromechanics is a precondition. Applications of nanotechnology – as far as this can be evaluated today – span from designed matters to biological-technical systems, mainly applications are, however, seen in electronics [...]. Topics ranking among nanotechnology are attached to their scientific contexts without nanotechnology constituting a homogenous research field yet.
(ISI 1993:65)

The ISI group did not report about 'the' pre-existing field 'nanotechnology,' but they established links among various technological developments from an abstract, observatory, and analysing perspective without claiming that these links were made in the practice of scientific research. By so doing, they put into perspective – that is they brought into view – the ubiquity of nanotechnology in terms of research moving into the direction of characterising and using processes at the nanoscale.

In the subsequent VDI-TZ innovation analyses and in the Research Ministry's reports, reflections on how much nanotechnology constituted a research field were left behind, and the concept 'nanotechnology' was defined as signifying a cross-sectional technology. This articulation as a cross-sectional technology linked sciences or scientific practices (electronic engineering, optics, material sciences, chemistry, or biology) under the label 'nanotechnology' with the rationality of miniaturizing. This definition opened up the possibility of perceiving nanotechnology as ubiquitous, and thus for ascribing nanotechnology the role of a key technology. The move was significant because the red-green government, which was in office from 1998 onwards, had agreed in their coalition contract to restrict technology funding to key technologies and environmental research (Henkes & Kneip 2003:291). According to Henkes and Kneip, this decision was a compromise between the government parties because the Green Party initially demanded to reject research funding for genetic engineering and biotechnology.

The following quotes by Gerd Bachmann and the Research Ministry explicate how research practices in different disciplines were united in the nanotechnology rationality and the term nanotechnology emptied at the same time:

Nanotechnology-related research and development merges knowledge and processes of the living world (bio- and gentechnology) with the non-living world (chemistry, electronic engineering, material

sciences). The goal is to effectively produce products with innovative characteristics and functionalities.
(Bachmann 1998: 7)

Nanotechnology – an innovation space
Nanosciences are today one of the most fruitful sources of new and ground-breaking inventions. Physicists, biologists, chemists and engineers find in nanosciences a field where they come together; a multidisciplinary, motivating challenge.
(BMBF 2002a:1)

The quotes hint at how the economic appeals of nanotechnologies were carved out ("to effectively produce products with innovative characteristics and functionalities"), particularly by arguments of quality that articulate nanotechnology as leading to 'efficiency,' which is an important characteristic within a context marked by discourses of competition. Apart from that, Bachmann postulates the blurring of boundaries between the living and non-living world. This extends the ubiquity of nanotechnology: if nanotechnology concerns the living and non-living world, it is everywhere. In biotechnology governance, an important step towards the commoditisation of life by intellectual property rights for biotechnological inventions was to eliminate the distinctions between the non-living and the living world (see Shelia Jasanoff's analysis of the Chakrabarty's case (2005:48ff)).

Another outstanding feature of defining nanotechnology in the 1990s – in contrast to the regulatory debates from the year 2004 and onwards – is that the policy documents of the 1990s were eager to present nanotechnology as something new. Newness seemed to be an essential condition for justifying demands for investment. Bachmann's 1998 innovation report set the stage for nanotechnology as follows:

Nanotechnology deals with new systems whose new functions and characteristics are only dependent on the nanoscale-effects of its components.
(Bachmann 1998:1)

The smallest elements of materials with a size of only a few hundred atoms or molecules are called nanoparticles; they show clearly changed characteristics in contrast to their behaviour in bulk materials.
(Bachmann 1998: 2)

Thus, Bachmann introduced the report by emphasizing that this innovation analysis was concerned with something very particular and new. In the same vein, the Research Ministry's 2002 Report on nanotechnology, which was written in a language that made information accessible also to a lay public, explained that the nanolevel was the level of atoms and molecules and that, in contrast to matter at the microlevel, matter at the nanolevel did not

show classical physical properties. It highlighted that the characteristics such as colour, conductivity or magnetism change at the nanolevel. Thus, new phenomena could be observed at the nanolevel which could be used in new technical systems.

The controllable manipulation of atoms and molecules at the nanoscale is the new thing which signifies nanotechnology. It will increasingly allow for building functional nanostructures atom for atom and to create matter and elements with up-to-the-present unknown characteristics.
(BMBF 2002a: 5)

In sum, we see in German rhetorical practices of defining nanotechnology that they stressed nanotechnology's ubiquity, newness and cross-sectional impact: because nanotechnology supposedly changes any important technology field, nanotechnology could be ascribed the status of a key technology. The constitution of nanotechnology as a field is, thus, reflected and reproduced in the extension and emptying of the term nanotechnology itself. We can observe a similar politics of naming in the UK.

In the UK, the National Physical Laboratory, which was the first to initiate nanotechnology funding, has been the UK's measurement institute, and accordingly they referred to scale when they talked about nanotechnology. That is, first references to 'nanotechnology' mainly signified precise measurement at the atomic scale based on advances in microscope techniques. In the LINK funding programme, which nanotechnology was a part of, nanotechnology was one technology among others (next to molecular electronics, microchips, measuring instruments, and genetic engineering). Areas of nanoresearch stretched from lasers to thin films and sensors to semiconductors. This concrete application-oriented definition of nanotechnology was set aside in the POST Report in 1996.

POST introduced two crucial shifts in the definition of nanotechnology. First, POST re-inscribed nanotechnology as an umbrella term for "small-scale technologies" which combine trends towards miniaturisation and precision finishing. This definition predicated the legacy of precise measurement, but moves ahead by articulating nanotechnology as an umbrella term, laying the foundation for inscribing nanotechnology as an enabling and generic technology. Second, the declamatory style of the report was strongly rooted in the underlying assumption that the full potential of nanotechnology could only be shown in the future with improvements of existing technologies and "entirely new applications which can only be realised using nanotechnology." There is a fantasmatic appeal in the discursive shift to future. What it does in terms of political logics is that it pushes away evidence. It shifts

contestation away, into the future. It negates opposition and attracts investment. Thus, nanotechnology became articulated as a generic, interdisciplinary, enabling technology that would bring many benefits in the future. In this respect, "[c]onstructing possible futures serves the present today" (Sanz-Menendez & Cabello 2000:229 quoted by Grunwald 2006:61).

Hooking into this articulation, fantasmatic appeals figure even more strongly in the Foresight Report. In the foreword, the report articulates three broad reasons justifying the importance of nanotechnologies in a promotional rhetoric. First, the importance of nanotechnology is constructed by an argument of quality that nanotechnology would lead to the creation of many new technologies. Such an articulation of nanotechnology as enabling multiplier fit well with presenting a solution to demands such as coordination, efficiency, and exploitation. Clearly, nanotechnology was now re-described as something more than the narrow definition of 'precise measurement' that was dominant in the 1980s. Second, the report suggests that nanotechnology will trigger a cascade of disruptive technologies that would affect industrial and manufacturing processes. Our entire life would be changed in the yet unimaginable nanoworld. Nanotechnology would become the new 'industrial revolution.' I will turn to these visions shortly. Considering the prosperous British industry before the economic decline, articulating nanotechnology as the basis for a revitalisation of the UK industry generally is a persuasive argument, and it fit within the broader story established by the 1993 innovation policy:

Solutions to the industrial and social problems of the 21st century will be solved fastest and most effectively by multidisciplinary teams of nanoscientists that have been trained to understand each other's 'language', and future business and education strategies need to take account of the need to develop these teams.
(Foresight Materials panel 1999: 8)

The appeals of this innovation-discourse of nanotechnology must be seen within the UK's official stance that research and technology politics are seen as central to a prosperous economic future for the country (see for example a speech by Tony Blair on Nov 5, 2002). The slogan of the UK's innovation strategy is "hit the world running" (Government Statement on NT 2008:31). Innovative ideas are wanted for fulfilling this. In this vein, the Taylor Report talked about nanotechnology as a

[c]ollective term for a set of technologies, techniques and processes – effectively a new way of thinking - rather than a specific area of science or engineering.

(Taylor 2002:6, my emphasis)

The quote shows that nanotechnology even referred to a 'new way of thinking' in the year 2002, which represents an amazing career from its beginning of 'precise measurement.'

By way of summary, the analysis of these UK and German reports shows that nanotechnology came to stand in for a new industrial revolution and for a new way of thinking. The re-inscription of the concept 'nanotechnology' gathered up an extended amount of elements in its signifying chain. While nanotechnology was mentioned as one element in a row, together with molecular electronics, genetic engineering or measurement, when it became part of the LINK programme in the 1980s, the term comprised many diverse research fields after the turn of the 21st century. Schummer (2007) suggests that "the meaning of 'nanotechnology' has continuously grown such that discipline after discipline defined their own nanotechnologies" (Schummer 2007:684). I think that the term not only amassed disciplines, but that the articulation of these elements as moments of a nanotechnology discourse changed the identity of nanotechnology and the enrolled disciplines such that the link between nanotechnology and economic success, well-being and leadership became hegemonic.

In so doing, fantasies became an integral part of the extended but emptied conception of nanotechnology. Even if someone intended to talk about precise measurement as nanotechnology today, fantasies of, for example, creating nanotechnology robots co-vibrate when using the term. In the next section, I will explore this imaginative side of the nanotechnology term which deals with the fantasies that played a crucial role in this new constitution of nanotechnology.

3.6 The fantastic nanotechnology-future

Imagine a technology so powerful that it will allow such feats as desktop manufacturing, cellular repair, artificial intelligence, inexpensive space travel, clean and abundant energy, and environmental restoration; a technology so portable that everyone can reap its benefits; a technology so fundamental that it will radically change our economic and political systems; a technology so imminent that most of us will see its impact within our lifetimes. Such is the promise of Nanotechnology'. (Kai Wu)
(Foresight Material panel 1999: 4)

This quote from the UK foresighting report on nanotechnologies, as well as those already discussed, show how imaginations, visions and promises about the nanotechnology-future to

come (to which I refer to as fantasies) played a crucial role in the first nanotechnology reports in the country-cases, be it references to the likes of 'industrial revolution,' 'saving information on the head of a needle,' 'engineering at the atomic level' or 'creating matter atom by atom,' as well as the blurring between the living and the non-living world. These rhetorical tropes have a history. In this section I would like to show the interplay of the developments in my cases with international discourses on nanotechnology. Key visions underpinning nanotechnology deliver important historical resources for later discussions (Kearnes & MacNaghten 2006:282-283). Here I thus discuss the international circulation of ideas which crucially form the policy environment for my concrete empirical material. I will start with how the visionary character of nanotechnology took shape over time.

One significant rhetorical strategy to constitute nanotechnology as technological artefact is to formulate a canon of the research field's historical emergence. Milburn (2002) identifies as a part of this substantiating narrative in nanotechnology the "Feynman origin myth" (276). Similarly the philosopher of sciences Peter Janich considers Feynman as an icon of nanotechnologies' public relations – an icon which is necessary for constructing a common ground of the discipline (Janich 2006:2). On 29 December 1959, Richard Feynman held a speech at the Californian Technology Institute with the title "There's Plenty Room at the Bottom." In this speech, the famous physicist and Noble Prize winner suggested engineering on a molecular level:

Principles of physics, as far as I can see, do not speak against the possibility of manoeuvring things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done. (Feynman 1959 after Milburn 2002:276¹⁰)

With his speech, Feynman became the first to formulate the idea of manipulating single atoms in order to produce new matter (Boeing 2004:14). One of Feynman's examples of potential applications of the intervention on the nanoscale was to write the entire 24 volumes of the Encyclopedia Britannica on the head of a needle (ibid: 28). Feynman, however, did not use the word nanotechnology. This term was first introduced in 1974 by Norio Taniguchi from the University of Tokyo (ibid: 16). Many see nanotechnology as a consequence of

¹⁰ I refer to Milburn here directly. As he rightly states, the influence of the speech can be seen in the frequent incarnations in the web. When I googled the direct quote in the year 2011, I got amazing 7100 hits. As Milburn (2002) also mentions, this is an ethos-based argumentation granting the nanotechnology discourse authority by referencing the Noble-Prize winner (277). Feynman's talk became a truism in and by the research community transforming his speculative statements into descriptions of reality (ibid.). In contrast, Milburn shows how Feynman's talk itself again is rooted in Heinlein's science fiction novel "Waldo" (284).

innovative developments in microscopy techniques in the 1980s. In 1981, Gerd Binnig and Heinrich Rohrer developed the scanning tunneling microscopy at an IBM laboratory in Zurich, which was capable of imagining and manipulating at an atomic level (Baird & Shew 2004). Binnig and Rohrer created an important icon in nanotechnology by writing the letters 'IBM' with 35 atoms that were positioned and visualised by the new microscope (Boeing 2004:51). The picture illustrated how one of the leading visions guiding the rise of nanotechnology since the 1980s is the idea came true: building new matter, atom by atom; the promotion of which can be credited to Erich Drexler.

In 1986, the American engineer Eric Drexler published the book "Engines of Creation," in which he conceptualised nanomachines and nanofactories – visions without which nanotechnology could not have been articulated later in the policy process as the next industrial revolution. In his speculative book, which has been often accused of transgressing the line between science and science fiction, Drexler talks about nanofactories in which microscopic tiny machines build macroscopic materials, atom by atom, with the help of self-organising assemblers, that is self-replicating robots. As Hayles (2004) points out, Drexler's rhetoric was informed by industrial production. This can be exemplified by the gears, pulleys and conveyor belts he imagined on the nanoscale – devices that were characteristic for the industrial revolution. Drexler even used mechanical metaphors for the description of biological processes which enabled him to construct nanotechnology as something that can be engineered, built, and controlled like mechanical machines (Hayles 2004:12). In the following, I want to dig deeper into two discourses inherent in Drexler's ideas: discourses of control and discourses of life.

First, Matthew Kearnes (2007) identifies discourses of "the control of the structure of matter" as the most important discourses in nanotechnology. Drexler's argument was that the ability to systematically control matter at the nanoscale would lead to a technological and industrial revolution (Berube 2006:16). This premise implied the argument that nanotechnology means the "ultimate mastery over nature" (Woods-Bennett 2008:155). Kearnes discerns that visions of control operate twofold. The more passive version of nanoscale control deals with the direct physical manipulation of matter (i.e. nanomachines, factories, and replicators that would create objects 'atom by atom') (Kearnes 2007:148). The more active version is represented in the self-replicating aspect of Drexler's ideas. In this respect, nanodevices would be produced by using existing self-replicating systems or

chemical synthesis as a template, that is, they would be actually grown (ibid: 149). This leads to the redefined relation among life, nature, and human beings in Drexler's nanoworld.

Second, one of Drexler's basic ideas and arguments was that if cells manage to replicate, human-made engineered molecules should be able to do so as well. In Drexler's materialistic perspective on the world, organic matter, inclusive human beings, are seen as lumps of coal (Johansson 2008:82). In nanotechnology, life is physical, material, and mechanic, and nanomachines are envisioned as copies of "biological machines," such as an enzyme or ribosome (Milburn 2002:288, Hayles 2004). Johansson's anthropological study of a nanotechnology laboratory shows how this perspective is even taught to students of nanosciences, that humans are self-organized molecular systems and that nature uses a bottom-up approach for constructing them (91). This perspective on life is part of the comprehensive scientist stance towards nature as inanimate, predictable, and governed by universal laws (ibid: 83). Thus, Drexler's visions also included a blurring of the boundary between the living and nonliving.

Drexler, who also funded the first nanotechnology institute, was engaged in promoting his ideas. Equipped with good networks, he was successful in persuading individual "scientist and governmental funding boards about the inevitable nanofuture" (Milburn 2002:208). The process leading up to the first U.S. National Nanotechnology Initiative were multifaceted and included also other important figures, such as Richard Smalley or Mihai Roco¹¹. In addition, the impact of techno-futurism, inclusive transhumanism, is considered to be relatively high (Coenen 2004, Coenen 2009:8). On 21 January 2000, President Bill Clinton announced the National Initiative on Nanotechnology at a speech at the Californian Institute for Technology (Caltech). The initiative's aim was to coordinate nanotechnology across agencies by an R&D programme. When announcing it, Bill Clinton declared:

My budget supports a major new National Nanotechnology Initiative, worth \$500 million. [...] the ability to manipulate matter at the atomic and molecular level. Imagine the possibilities: materials with ten times the strength of steel and only a small fraction of the weight -- shrinking all the information housed at the Library of Congress into a device the size of a sugar cube -- detecting cancerous tumours when they are only a few cells in size. Some of our research goals may take 20 or more years to achieve, but that is precisely why there is an important role for the federal government. (Bill Clinton 2000 see <http://www.ostp.gov/galleries/NSTC%20Reports/NNI2000.pdf>)

In so doing, President Clinton referred to many visions brought forward by Feynman and Drexler.

¹¹ for a detailed, journalistic record of events and actors I suggest Berube's book from 2006

In 2001, the U.S. National Science Foundation (NSF) and the U.S. Department of Commerce (DoC) started to develop another document, which would become influential in promoting nanotechnology, at the workshop "Nanotechnology, Biotechnology, Information technology and Cognitive science (NBIC): Converging Technologies for Improving Human Performance." At the workshop, an important shift in the extension of the term nanotechnology was constituted. As Wolbring (2007) pointed out, bio-interventions or biomedicine would not have been perceived as nanoresearch before the workshop, but afterwards, the nanoscale became the classifying parameter. In the aftermath of the workshop, the NBIC Report was published by Mihail Roco and William Bainbridge. Mihail Roco was a senior advisor for nanotechnology at the NSF and the US government's voice on nanotechnology (Berube 2006:86). He is known for promoting the idea that nanotechnology would change the entire world. His colleague, the NSF employee and sociologist William Bainbridge actively networked with the movement of transhumanism (Coenen 2009:9) which is a movement that, for instance, wants to eliminate ageing and to enhance the intellectual properties of human kind with the help of technology. This utopian perspective is prevalent in the report. The NBIC Report is a crucial reference point in nanotechnology forecasting reports. For example, it is frequently quoted in UK and German policy documents that nanotechnology's business will rise to 1 trillion \$ by 2015. According to Ebeling (2008), this number derives from the NBIC Report. The figure has become a symbol to justify the claims that nanotechnology is "the next big thing," and the figure is constantly recycled by financial journalists, marketers, company owners, and entrepreneurs (Ebeling 2008:341).

Secondary analyses of the NBIC Report and its impact suggest that convergence and nanotechnology contain visions of a rebellion against the given and the conquest of matter. In the NBIC Report Roco and Bainbridge propose a list of almost endless opportunities that nanotechnology – as part of the converging technologies – offers. Examples listed in the report are prolonged human health, an extended life-span, or anti-ageing. In addition, the report considers converging technologies as the ultimate strategy to boost national defence, to explore and occupy extra-terrestrial space, or as a way to eliminate world hunger, for example, by introducing a system of biosensors that would monitor the health of any cattle or by planting biosensors in the soil to tell farmers when it is time to water (NBIC Report 2002). Through such listings, nanotechnology became intertwined with expectations and was

constituted as the panacea for all pressing problems of our time (Kearnes & MacNaghten 2006:281-282). As Grunwald points out, the report is written in a constative future, implying that the application of these visions is just around the corner (Grunwald 2006:53). We see in the report significant visions of nanotechnology which Pierre Dupuy (2005) summarises as rebellion against the given. Referring to Hannah Arendt, Dupuy points out how nanotechnology advances ideas of overcoming the free gift of human existence by replacing it with an existence created by humankind itself (Dupuy 2005:9). I identified these ideas that nanotechnology can free humankind from traditional limits in much of the writing on nanosciences, such as a book by Jeffrey H. Matsuura, who himself subscribes to the visions of nanotechnology. He says, for example, that nanotechnology can change some of the physical rules that have traditionally confined us, and that it thus can free us from some of the limitations that have long been placed upon us by size (Matsuura 2006:10-12). Roco and Bainbridge also refer to Moore's law in the NBIC Report, according to which the capabilities of microelectronics improve at an exponential rate. Johansson (2008) considers this "drive toward miniaturization" (Macnaghten & Kearns 2006:283) as a Wild West analogy: whereas in the old days travellers explored new countries, today it seems that only in the sciences, such as physics, is there still land to discover. In this respect, scientists become conquistadores of matter (Johansson 2008). This idea is also linked to taming nature (Johansson 2008) and changing it (hubris attitude) (Bensaude Vincent 2008).

These visions brought forward in nanotechnology can be summarised as fantasies of a fullness to come. The promotional rhetoric of nanotechnology promoters tells a story in which we are living in a world with cancer, pollution, and hunger, but now comes nanotechnology which can solve these problems. Nordmann (2008) suggests that this story implies a moral imperative, that if we and nature can do better, we have to do better! Technology and political control is perfected to allow for an excess of pleasure and consumption (Nordmann 2008). Bernadette Bensaude Vincent (2008) calls this the 'stem-cell paradigm:' everything is possible – 'you can do whatever you want, do it.' Here, stem cell is symbolically used as the icon of techno-science: this basic, primitive unit holds all possibilities – it's the dream of a plastic world that you can shape.

In sum, I have shown that this new technological object, nanotechnology, is made up of encompassing visions. The sociology of expectations articulated in and around the newly constituted research field is thus an important component of nanotechnology. Without these

central nanovisions, research projects and applications on the nanoscale within material sciences and other disciplines would doubtlessly exist, but nanotechnology as an umbrella term, drawing these different lines together, probably could not have caught on (Woyke 2009:53-54). I introduced the relation between rhetorics of nanomachines, factories on the nanoscale, and self-assemblers, and the promises of a new industrial revolution, as well as the consequence of these conceptualisations in blurring the boundary between the living and the non-living.

3.7 Conclusions

By way of conclusion, in this first empirical chapter, I offered a multi-layered explanation how nanotechnology emerged from a genealogical perspective. I first showed how its rise was dependent on articulating nanotechnology into the discursive economy of the time: into the British modernising agenda marked by a politics of catch-up, into the German modernising project with its focus on ecology, and into a regime of the commoditisation of research (which is marked by discourses of efficiency, exploitation, and competition) in both countries. Nanotechnology became constructed as solution to problems of the time, as a panacea which would bring wealth to the nation and increase the quality of life of its citizens. This is an important background for future regulatory discussions on nanotechnology. When nanotechnology symbolically stands in for a better life, restricting nanotechnology development would mean interrupting this beneficial development. Against this context, the emergence of a regulatory regime which aims at stabilising nanotechnology is more likely. Therefore, it is the condition of possibility for a logic of pre-emption to emerge.

Second, I asked how it was possible to articulate nanotechnology as a solution to problems of our time. I analysed its conceptualisation in different contexts in a genealogical vein and concluded that its construction was contingent. Thus, I pointed to the politics of naming in the constitution of a field. Indeed, the meaning of nanotechnology was constantly shifted. First reports referred to a limited amount of scientific techniques that were operating at the nanoscale (e.g., improved lasers) when they talked about nanotechnology. Later, nanotechnology became an umbrella term for various disciplines; nanotechnology was no longer considered as a concrete technology or application but as a way of thinking which enables the development of a set of new technologies. In these rhetorical shifts, a general

tendency was that the reinscriptions of the concept "nanotechnology" accrued an extended amount of elements in its signifying chains. For future regulatory discussions, it makes a tremendous difference whether regulators talk about the regulation of concrete applications or whether it is a 'key technology' or a 'new way of thinking' which is at stake. Thus, this chapter brings into view the political construction of the regulatory object 'nanotechnology' which the existing literature on regulatory policy-making fails to consider.

Third, I showed how fantasies and their international circulation played a crucial role in this new constitution of nanotechnology. In addition, I addressed the role of governance actors who were gripped by these fantasies (particularly Roco and Bainbridge, but as well Franks and Bachmann) and who reproduced these fantasies and moved the agenda forward. I identified the significance of practices of forecasting for perpetuating fantasmatic appeals. Promises of what there was to come became an integral part of the conception of nanotechnology as such. Thus, even if someone intended to talk about precise measurement as nanotechnology today, fantasies of, for example, creating nanotechnology robots is always part of the signifying chain. This extension of the signifier nanotechnology's chain of equivalences opened, ironically, up for the possibility of counter or oppositional fantasies, as I will show in the next chapter – after all, fantasies can be gripping, but they can be unsettling as well.

4 Dislocating a Promising Nanoworld: Prone to Horrors, the Public?

This chapter completes my critical explanation of how nanotechnology emerged as a regulatory object. In the previous chapter, I demonstrated how nanotechnology came to signify a generic, enabling technology and how it was discursively shifted into a chain of equivalences of future well-being, allowing for its articulation into national projects as a panacea for the pressing problems of our time. Such a constitution of nanotechnology negated in part demands for regulation at all. However, progressive extensions of the signifying space of nanotechnology, which I presented in the last chapter, were to facilitate the politicisation of nanotechnology and its constitution as an object of regulation. In this chapter, I thus analyse the shift in problematizing nanotechnology from the year 2000 onwards. The nanotechnology-project came under threat because the appeal to the future promise of nanotechnology opened up the possibility of counter or oppositional narratives. The signifying chain had become over-extended as many various disciplines, images, applications, and ideas were named as 'nanotechnology.' For technology sceptics, nanotechnology seemed to be omnipresent and too powerful. An apocalyptic dimension was added to nanotechnology: horror fantasies of human enhancement and of the destruction of the world by nanoparticles. In the following, I aim to show the interplay between such rising horror fantasies concerning nanotechnologies and their reverberation in the country-cases.

Against this background, the chapter argues that the drive towards regulating nanotechnologies was an internal response by state elites. Traditional approaches to regulatory policy-making often assume that regulation is initiated as response to an external threat, such as market failure, public protests or policy advocates (Hood, Rothstein and Baldwin 2001). On the contrary, I will show in this and the following chapter that regulation was initiated as an internal response as governance actors who had promoted nanotechnology, shifted towards protecting nanotechnology against potential threats. In short, although beatific fantasies of nanotechnology gripped policy-makers, they equally experienced these promises of a 'wonderful future' to come as being under threat as horrific fantasies emerged. I will bring forward the argument in this chapter that these horror fantasies did not grip the public. Nanotechnology did not become an object of public contestation. Rather state elites (including policy-makers, scientists, and the STS community) were gripped by horror fantasies and by their fears of public contestation. This

is the condition of possibility for the logic of pre-emption to emerge. Indeed, this was, I suggest, one of the conditions of possibility for the logic of pre-emption to emerge.

In the second part of this chapter, I therefore contextualise the developments in the nanotechnology discourse within experiences of the BSE-crisis and public protests against GMO. I build up for the argument that policy-makers were alert to horrific claims about nanotechnology because of these experiences. As such, policy-makers' strong reactions to the horror fantasies were amplified by a socio-political context marked by the rise of environmental movements, environmental consciousness, and a 'public phobia' (Arie Rip). In other words, state elites came to be gripped by the fear that nanotechnology would lead to public protests and they aligned all their efforts to avoid another governance failure. As I suggest above, it was this particular horrific fantasy that enabled the articulation of political responses driven by the logic of pre-emption. In Chapter Five, I will go on to demonstrate that the response of state elites in Germany and the United Kingdom was to start to put into place a regulatory regime which sought not to impose stringent regulations on nanotechnology, but to absorb potential opposition and hence protect the continued development of nanotechnology. Here however I now analyse rising fear fantasies in nanotechnology.

4.1 Rising fear fantasies

In the last section of Chapter Three, I examined which 'dreams' would be fulfilled by nanotechnology according to nanotechnology advocates; that is to say, I analysed the fantasmatic appeals of the nanotechnology-future. In this section, I introduce in contrast the Janus face of nanotechnology visions. The philosopher John P. Dupuy (2007) captures this Janus-faced nature of nanotechnology visions in the term 'dreams of reason' (a notion derived from the Spanish artist Goya's painting, "The Sleep/Dreams of Reason Produces Monsters") which can be interpreted as expressing ambiguity in Western thought: claims of mastery contra a disturbing utopia. It is the ambiguity of the Spanish term 'sueno,' as dreams or sleep, which allows for a double reading. Either monsters are produced if reason sleeps, or dreams of reason produce monsters (Dupuy 2007:244). This links to the Janus face of technology, which appears as the primary engine of human progress but also as the bearer of the potential for exceeding "our understanding, capacity, or willingness to use it well, and for the possibility of harmful consequences we did not foresee" (Bennett-Woods 2008:3-4). In

this respect, the debates about nanotechnology can be seen as debate about the future relation between humankind and technology in general (Grunwald 2006:49); and authors such as Christopher Coenen show that nanotechnology visions have a history and context of (see Ferrari and Gammel 2010). That said, I would like to stick to the concrete case of nanotechnology.

In April 2000, the computer engineer and company leader of Sun Microsystems, Bill Joy, published an influential article in the magazine "Wire," entitled "Why the future does not need us." With the publication of this article, Joy added an apocalyptic dimension to nanotechnology (Grunwald 2006:54). He demanded a stop to nanotechnology development before it was in his words to erase humankind. The fear fantasy articulated by Joy was a world where machines have become more intelligent than human beings because of nanotechnologies. His worries were driven by the supposed self-replicating potential of genetic modified organisms and nanotechnologies. Joy articulated in the text a chain of equivalences between nanotechnologies and GMO and other failures in scientific development, for instance, bacteria resistance against antibiotics. The story he told was that everything that could go wrong, would go wrong. Joy sought to disarticulate existing chains of equivalence: He demanded to stop the development of robotics, nanotechnology, genetic engineering, and knowledge-based weapons of mass destruction. In fact, he tried to articulate nanotechnology as a metaphor for broader societal changes, questioning economic growth and the Western belief in happiness. Clearly, Joy tried to generate a political momentum in which resistance emerged based on linking many demands (Joy 2000).

In 2001, the Canadian ETC Group (Action Group on Erosion, Technology and Conservation), known as a vocal NGO in anti-genetic modification protests, picked up on this debate and started to criticise nanotechnology. In one of their first reports on nanotechnology (2001), it demanded a moratorium on nanotechnologies, which would consider nanomaterials as hazardous and thus restrict their use until their safety was proven. In so doing, ETC rearticulated nanotechnology as a safety problem. Indeed, for the ETC Group, nanotechnology did not represent a path into a glorious future, as promoted in the innovation analyses on nanotechnology. Rather, it was portrayed as yet another technology with potential adverse effects, which could, in the worst case scenario, mean the end of humankind (echoing the appeals of Joy). This link to other technologies, which they established, was explicitly expressed in the title of their 2003 report: "The big down.

Atomtech: Technologies converging at the nano-scale. From genomes to atoms." Thus, nanotechnology was first renamed as atomtechnology in a situation in which publics worldwide were hyper-sensitive to nuclear technology (in warfare and after accidents at nuclear power plants, such as Chernobyl). In Germany, for example, protests against nuclear waste deposits or transports were frequently in the news. Second, the ETC Group articulated equivalences between nanotechnology and genetic engineering, arguing that, while genetic engineering was already a severe intervention of humankind into natural processes, nanotechnology's impact could be even more significant because modifying matter could "transform every aspect of work and life" (ETC 2003:5).

In fact, the structure of the report established a narrative that situated nanotechnology chronologically as the next step in a chain of adverse developments from cloning, to epigenetic, to gene manipulation, and on to the construction of living organisms. In another part of the document, equivalences were drawn between the promoted promises of nanotechnology, such as the end of hunger, the end of diseases, and the eradication of water- and air-pollution, and the early unfilled promises of nuclear technology as limitless source of clean energy. By means of weaving nanotechnology into an accelerating chain of technology development, the 2001 ETC Report thus claimed that humankind was not fit for assessing the consequence of their inventions. The ETC Group's warnings were gripped by the horror fantasy of an omnipresent influence of nanotechnology in the context of convergence (see NIBC-report in the last chapter), which is well summarised in their following statement:

Industry and governments promise that the manipulation of matter on the scale of the nanometer (one-billionth of a meter) will deliver wondrous benefits. All matter—living and non-living—originates at the nano-scale. The impacts of technologies controlling this realm cannot be overestimated: control of nano-scale matter is the control of nature's elements (the atoms and molecules that are the building blocks of everything). Biotech (the manipulation of genes), Informatics (the electronic management of information), Cognitive Sciences (the exploration and manipulation of the mind) and Nanotech (the manipulation of elements) will converge to transform both living and non-living matter. When gmos (genetically modified organisms) meet Atomically Modified Matter, life and living will never be the same.
(ETC Group 2003:6)

The quote shows how the imagined impact of nanotechnology is thought of as particularly widespread and unsettling because of a supposed blurring of the boundary between the living and non-living world. In addition, the fantasmatic promises inspiring proponents of nanotechnology (mainly Drexler-informed ideas of nanorobots, nanofactories, and self-replicating nanomachines) undergird the oppositional view of the NGO. For instance, one of the first ETC Group's publications on nanotechnology was a press release in March 2002

reporting on an army of nanoroboters coming soon. Similarly was the focus of a Greenpeace report on nanotechnology published in July 2003, which dealt with artificial intelligence and robotics.

In 2002, the Jurassic-park author Michael Crichton published the novel *Prey*, in which nanoparticles escape from a laboratory and form dust clouds that attack human beings. The book introduces horror fantasies of invisible nanobots that invade the human body and start to control our molecular structure and, therewith, also our thoughts (Silva 2004:28). The story is often fused with a grey goo scenario, coined by E. Drexler himself, in which a 'grey goo' of nanoparticles destroys all organic material on the earth. In my reading, the novel *Prey* actually focuses more on a story about a relationship and a potential affair than on nanoparticles, but because of Crichton's previous successes, the book became articulated as potential public relations disaster for nanotechnology. Nanoscientists, policy-makers, and STS-folks became gripped by the idea that grey goo could become an icon of negative imagination such as Frankenstein food (Berube 2006:40). Grey goo became thought of as a potential technological stigmatization which could lead to public opposition (Wilkinson, Allan, Anderson & Peterson 2007:146f). Indeed, governmental agencies in the U.S. and European Union feared a potential backlash against nanotechnologies if any of these visions were to be popularised in a Hollywood movie, for example, if a movie of Crichton's novel *Prey* were to be made (Berube 2006:40)s.

All these critical accounts – the grey-goo scenario in particular – expressed the possibility of 'lost control.' Indeed, they built on the ambiguity rooted in Drexler's control of matter, on the one hand, and the – actually opposing – self-replication idea on the other for if the system is self-replicating, it is not mastered, it is out of control. In sum, the rising horror fantasies of nanotechnology were based in fears that the technology could go out of control, fears concerning human enhancement, and fears derived from links to other technologies. As I have shown the discussion on convergence, nanotechnology and the Joy-article was picked up by media worldwide (see i.e. Chang 2000, Schirmacher 2000). In the following, I will dig deeper into how these fear fantasies circulated in my country-cases.

In Germany, an important contribution and trigger for the German debate was Frank Schirmacher's book (2001), "The Darwin corporation. How nano-, bio- and computer-technology dream the new human being" (title translated by the author). Frank Schirmacher

is a well-known German journalist and one of the editors of the major newspaper "Frankfurter Allgemeine Zeitung (FAZ)". As the title of his book on nanotechnology indicates, the nanodebate increasingly focuses on questions of human enhancement by technology development. This particular focus originated from the NBIC and transhumanism discussion.

In the UK, Prince Charles caught attention in the British media in April 2003 with statements on the danger of nanotechnology which replicated those international critiques and appeals of the likes of the ETC and others discussed above. According to the BBC article titled "Sainsbury [Science minister, the author] cool on nano-nonsense," Prince Charles talked about a nanotechnology-induced 'grey goo scenario,' in which self-replicating nanoparticles could destroy life on the planet (BBC NEWS, 28 April 2003). He followed this, one year later, with another public intervention on nanotechnology. However, by this time, he had distanced himself from the assertions that he had talked about 'grey goo,' and he defended himself against the accusations that he believed in science fiction. He said he had never used the words 'grey goo,' nor did he believe in these scenarios. But he repeated his concern was that risks of the emerging technology were not being tackled (The Guardian July 2004). In detail, he demanded a precautionary approach and more funding for Environmental, Health and Safety concerns (Nanotechweb July 14, 2004). We will see below that these political practices dealing with Prince Charles's intervention in the year 2003, which presented him as someone who believed in science fiction and, thus, undermined his authority, were part of a logic of scientification. For the moment, I will assess and contextualise Prince Charles's intervention by setting it within its socio-political context.

Prince Charles's appearance in the nanodebate gained the topic an audience it might not have had before. Nevertheless, the attention the Prince garnered is ambiguous because of his particular reputation in British politics. Due to his critical stance towards genetic engineering, he was already ascribed the label 'the precautionary prince.' As Sheila Jasanoff shows in her study on biotechnology politics, all the paradoxes and contradictions of the status of Britain's Royal Family come together well in the figure of Prince Charles. On the one hand, the monarchy is regarded as one of the most important representations of the British nation from the outside, but also from within the nation. On the other hand, it is the most unrepresentative and constitutionally powerless of institutions, and the Royals are

somehow widely perceived as being different from the rest (Jasanoff 2005 [2007]:124). Prince Charles particularly is often regarded as a person who behaves very eccentrically. He is often ridiculed for his romanticizing view of nature, which is expressed in his promotion of organic food and homeopathic medicine, and he is well-known for talking to plants. He scored higher, however, with the British public when it came to GM food in a debate in which he presented himself as advocate for the control of genetic modification. For instance, before the release of GM plants, he laid out ten questions that, according to him, had not been answered satisfactorily about the uncertainties of the consequences and in whose interest this technology was (ibid: 124-125). After this first announcement by the Prince on GM, his demands became more spiritual, juxtaposing nature and God on the one side with science and rationalism on the other. The originally popular stance of the Prince shifted more and more into a fundamentalism about nature and into a patronizing presentation of himself as a steward of the earth (ibid.: 126-127).

Hence, it might well be that critics of nanotechnology unwillingly received special attention because of the Prince's appearance in the debate. In any case, the incident upset proponents of nanotechnology. How it impacted decision-makers can be seen in the following quotes from people I interviewed who said the following about Prince Charles's intervention:

From day one [of the International Standardisation Committee on Nanotechnology] almost, the Americans were concerned that what happened with GM could happen with nanotechnology because you are probably aware that there are comments from Prince Charles about grey goo and all that kind of stuff. The Americans have been sort of watching this very very carefully because they realise that nanotechnology is very powerful and the standards are very important.
(Interview material: Scientific Director of a Research Institute)

Interviewer: How come the Committee dealt with nanotechnology?

Respondent: It was a key subject that was coming out of meetings that we had around with scientists coming to talk about their works. Those of us who are the few scientists in this place talk to scientists from outside to engage them in um ... sort of ... that we can tell whether there need to be done new legislation, or what. And nanotechnology was a subject which sounded good and also because Prince Charles has come out against nanotechnology and everything he said has to be wrong. And he called it goo and this kind of stuff. And we were defending science and saying this is a good area to do their work, whether it is nanotubes or whether it is nanoparticles. And we went and visited various people who worked in this field and in universities. And the government was interested. Lord Drayson run some meetings before he was minister of science and spoke about our report. We also had an agreement with the Royal Society who did a report about the same time.
(Interview material Member of the House of Commons Office for Science and Technology)

Below I will show that Prince Charles's appearance in the debate – even if it was slightly stultified in public – and the presence of critical NGOs, in combination with the media attention for utopian and dystopian visions of nanotechnology, changed nanotechnology

governance. But first I will introduce the context which explains why the rising critique fell on fertile ground among state elites. In the following section, I thus show how nanotechnology governance was embedded within a broader change of a governance of science and society relations that began in the 1990s onwards and a socio-political context of strong mobilisation against genetically modified organisms and a perceived lack of trust in political institutions after incidents like BSE.

4.2 After the expert-regime: A public regime of science governance

Nanotechnology policies from the year 2003 onwards were formulated within a socio-political context marked by the legacy of the controversy of science, technology and risk, in particular in GMO and BSE (Pidgeon & Rogers-Hayden 2007:194). Part of this policy legacy of the GMO and BSE experience was that a public regime of science governance was institutionalised (as opposed to the previous expert regime of governing sciences), compromising practices of public participation and the almost obligatory consideration of ethical, legal and social aspects (ELSA) in science development. Originally, the social practices of doing science and steering science funding were characterised by closed expert circles. In the wake of protests against the release of genetically modified organisms, environmental movements grew and became new, important political factors; and the protests strengthened the rise of the Green Parties (particularly in Germany where they were voted into Parliament for the first time in the 1980s). Such protests challenged the existing regime of governing sciences in closed circles; they transformed the social practice of science policy, in as much as the societal dimension became an integral part of science governance. In social sciences, this shift is often reflected in the discussion of the "Public Understanding of Science" to dialogical "Science and Society" relations.

In the 1980s, increasing the public understanding of science (PUS) became an important goal in science policy. However, PUS, it was alleged, did not consider the complexities of science and society relations, such as the creation of order around science and technology, cultural values implicit in the recognition of scientific facts or moral narratives expressed in the direction of scientific research (Jasanoff 2007:251). Its critics (i.e. Wynne & Irwin 1996) took issue with its casting of lay individuals as empty bottles which had to be filled with information, embodied as this was in policy programmes aiming to increase science

communication and thus the public understanding of science (Jasanoff 2005:252).

Indeed, the term 'deficit model' was coined by social scientists such as Wynne in order to criticise a set of beliefs consisting first of the assumption that lay people are sceptical towards scientific developments because they do not know enough about science and second that – if they would only know enough – their attitudes would change towards a general approval of science and technology. Criticisms of the limits of this deficit model articulated demands for more democratic science and society relations. The Royal Society in its 1999 report represents these demands had caught on; titled "Science and Society," the report recommends a careful monitoring of public attitudes on science. It focuses on the sources of information shaping public attitudes and mechanisms for facilitating dialogue between the public and the science community. Thus, a regime of science and society relations that – at least rhetorically – acknowledges their mutual interdependencies and the need for dialogue, openness, and transparency informs governing practices began to emerge. Well-known pioneer projects were the ELSA research accompanying the Human Genome Project (3-5% of the annual HGP budget was devoted to the study of the ethical, legal and social issues of studying the human genome) (Bennett-Woods 2008:62) and the British public debate, "GM nation?" which consisted of over 600 public dialogue meetings (Jasanoff 2007:127ff).

These developments were subsequently given further impetus by scandals. In several European countries, controversies over biotechnology emerged and scepticism arose toward the governance of scientific applications. Genetically modified foods in particular stirred up European politics in the 1990s because in many European countries, anti-GM movements developed (Cooper 2009:563). These intense public controversies led to aversive biotechnology policies by national governments and at the EU level (Seifert 2006). In the following, I will recapitulate these developments with a particular focus on the anti-GM movement in my case-studies.

When genetic modification became possible in the 1970s, concerned scientists triggered a discussion on the safety aspect of this novel development and they indeed imposed a voluntary restriction on their activities (Wright 1993:79). At the same time, scientific institutions formed committees to address the issue (the BERG committee in the U.S. and the Ashby committee in Britain). In 1975, these committees organised an international conference in Asilomar, California. (ibid: 89). As a result, policies were adopted to contain

laboratory hazards (ibid.). The first political reaction to genetic manipulation in laboratories was strict in Britain, even stricter than the U.S. Asilomar conference discussions, in which policy efforts were also taken to contain manipulated genes within the laboratory (Jasanoff 2005:55). Britain's initially strict regulations on genetic manipulation were anchored in the Health and Safety at Work Act of 1974 (ibid.). At this time, the Health and Safety at Work Act was an outstanding exception in Britain's otherwise liberal regulatory regime due to the power of the trade unions (Wright 1993:91). Jasanoff (2005:55) and Wright (1992) point out how the first British advisory committees on genetic manipulation were carefully composed in a tripartite structure representing industry, labour and government. We see that genetic manipulation as an occupational theme was an important element in the early politicisation of GMO, as it was in nanotechnology later on.

But starting in the early 1980s, these initially strict regulations on genetic engineering were loosened. According to Wright (1992), this was due to economic interests in the U.S. lobbying for deregulation. In the UK, the responsible committees were marked by the decreasing importance of trade unions due to Thatcherism. The committees articulated an urge to follow these tendencies toward deregulation so as not to "miss out on a revolution in biotechnology" (Wright 1993:97). Indeed, when the technique of genetic manipulation had progressed to the stage of broader experiments and deliberate releases into the environment (of e.g. certain insect-resistant plant seeds), the UK government was reluctant to take up the deeper questions posed by these tests. The government effectively let sciences continue despite uncertainties (Jasanoff 2005:102). This reluctance was due in part to the fact that in the 1980s and early 1990s the regulation of genetic engineering was not a hot topic worldwide, with the exception of Germany. In Germany, the Federal Ministry for Research and Technology (BMFT) had been ascribed the responsibility of adopting the rules on genetic manipulation discussed at Asilomar in the 1970s (Jasanoff 2005:58). In the 1980s, the Green Party came into Parliament and decided to position themselves in the field of genetic engineering. Herbert Gottweis (1998) gives a detailed account of how the Greens funded a working group on biotechnology and genetic engineering, and how they were important drivers in the German Parliament's Enquete Commission on Biotechnology, founded in the late 1980s (266ff). The writing of a German Genetic Engineering Act turned out to be a long and complicated process, marked by much opposition and disagreement (ibid: 286f). While the German government was reworking their legislative suggestions in

the early 1990s, the crisis deepened because court decisions supported citizen protests against deliberate releases of genetically modified plants (ibid.).

In 1998, the situation escalated in many European states. As Franz Seifert (2006) shows, public protests against GM foods and crops arose simultaneously in most European states, with Germany among the forerunners (Hampel & Renn 2000). Seifert identifies as common trigger-events food scares (in the aftermath of the BSE crisis), media reports on the first cloned sheep Dolly, first field trials, the arrival of non-labelled U.S. imports of GM crops, and the affair around the scientist Arpad Pusztai (Seifert 2006:8ff). Pusztai claimed that he had found adverse effects on rats' immune systems caused by genetically modified plants. The rising debates were also accompanied by symbol neologism, such as Frankenstein food (ibid.). According to Jasanoff (2005), this news in the British media enabled panic over GM to spread in the UK (123). In fact, anti-GM movements in various countries which brought together environmental and consumer NGOs and small farmers were successful in organising a consumer boycott on GM food, in which retailers and the food processing industry joined, thus wielding pressure on the agribusiness (Cooper 2009).

However, this peak of resistance toward GM foods came only two years after a severe misconduct in the handling of BSE was disclosed in Britain. Sheila Jasanoff titled one section in her book, "Designs on Nature," "Britain: GM in the Shadow of BSE" because the story of protests against GM food in Britain can hardly be disentangled from the BSE incident. Regarding BSE, British health and safety experts had claimed for years that the cattle disease could not be transferred to human beings. In March 1996, however, they had to admit that the disease caused a new and fatal form of Creutzfeldt-Jakob Disease in human beings. This governance failure led to a severe loss of trust in government (see Barnett, Carr & Clift 2006; Szerzynski 1999). Indeed, an inquiry commission on BSE concluded in the year 2000 "that British health and safety experts had acted as a narrow and secretive community: they were complacent about empirically unverifiable risks yet unwilling to commission new research to improve on available knowledge, and profoundly reluctant to display any uncertainty to a public they saw as irrational and prone to panic" (Jasanoff 2005:122). Germany had its own BSE scandal, in the year 2000, when it was disclosed that there had been several cases of BSE, while officials had insisted for years that German cattle were BSE-free (ibid:139).

As a reaction to street demonstrations, disruptions of field trials, and consumer boycotts against GM foods, European governments and the EU initiated restrictive biotechnology regulations and public participation. At the European level, new labelling rules under the Novel Food Regulations and a revised Deliberate Release directive were introduced (Seifert 2006:12). This amended Directive on Deliberate Releases of GMO into the Environment, issued in spring 2001, reproduced the Commission's commitment to the Precautionary Principle, which was published in 2000. In addition, the de facto moratorium on the cultivation of GM crops imposed on the EU by recalcitrant member states such as Austria was continued (ibid.). In the UK, as I have suggested above, the government started a large-scale participatory exercise: GM Nation? (Gregory & Lock 2008:1258-1259). It was an innovative exercise, although its outcome was subsequently criticised because its debates were alleged to be highly polarised and captured by interest groups (ibid: 1259) and not methodologically sound (Horlick-Jones, Walls, Rowe, Pidgeon, Poortinga & O'Riordan 2006). In Germany, public outcry was not so sharp, according to Jasanoff (2005), but then again the nation state had GM-free labelling already in place since 1998, supported economic farming, and was engaged in European policy-making on the issue (Jasanoff 2005:140ff.).

Overall, therefore, it is important to recognise that rising fear-visions in the nanotechnology field were drawn into a particular socio-political environment in which science and the role of expertise was increasingly challenged. The fear fantasies began to circulate some two years after the UK and Germany experienced severe public protests against GM foods and consequently had to adapt restrictive regulations on biotechnology. This experience with the regulatory regime on biotechnology forms an important background for the upcoming nanotechnology regulatory regime and the grip exercised over state elites of such rising fear-visions.

4.3 The grip of a fantasmatic wow-yuck logic: Nanophobia-phobia

Against the context of the recent protests against GM, Prince Charles' appearance in the nanotechnology debate confirmed policy-makers' fears of a public contestation internationally, as we saw in the quotes above. While GM stood in the shadow of BSE, nanotechnology stood in the shadow of both: BSE and GM. However, it was not lay publics drawing such equivalences. The rise of dystopian visions (grey goo, nanorobots) confirmed

the beliefs of concerned scientists and policy-makers who were actually waiting for this to happen; in short, they were gripped by a fantasmatic wow-yuck logic. As Arie Rip (2006) points out, this line of reasoning (which he called one of the folk theories informing nanotechnology governance) assumes that fascination factors prevail in perceptions of new technology in the beginning, but this early 'wow-phase' of embracing a technology is inevitably followed by a 'yuck-phase' in which societal fears, worries and ethical, moral questions about the technology development prevail. The wow-yuck logic implies the assumption that the yuck-phase could have been avoided by better science communication with the public. Both simplified, underlying assumptions – that GMO were first embraced and then rejected, and second that this could have been avoided by taking the public understanding of science development in consideration early – go unquestioned (Rip 2006:351) in this fantasmatic logic. This generalised fear of a public rejection of technologies is projected onto nanotechnology by nanotechnology insiders, so that we can even talk about a nanophobia-phobia as a fantasy gripping policy-makers:

In other words, there is a general presumption that publics are passive and susceptible to fearful interpretations – here, after reading a science fiction novel. Specifically, scientists and technologists (and other promoters of nanotechnology) are prone to project nano-phobia, and this projection can become a phobia in itself, a nanophobia-phobia.
(Rip 2006: 358)

This nanophobia-phobia has to be seen against the context of a public regime of science governance as introduced above. We must consider that ELSA in science development has become an obligatory part of policy documents, a part of the conventions which draw the boundary of what is appropriate in science governance. Public dialogue on science-based policy-making became increasingly commonplace in Europe and a legitimate and expected feature in policy-making of technology governance. Conceived as a necessary condition for the political acceptance of emerging technologies, policy-makers often implicitly assume that greater public consultation can eliminate opposition to technical change by creating social consensus (Gottweis 1998:276, Irwin 2006:299). In the U.S., for instance, the National Nanotechnology Initiative (NNI) devoted 8% of its budget from its beginning to the societal and ethical implications of nanotechnology (SEIN) (Berube 2008:63f.). This context amplifies the nanophobia-phobia: The STS community themselves play a crucial part in articulating the need for engaging the public by reproducing the wow-yuck-logic themselves. For example, participants in open internet discussions about 'grey goo' and nanotechnology are often mainly actors within nanosciences and people who work professionally with

possible public reactions on nanotechnologies (Rip 2006:358). Another example, in the field of nanotechnology and society, is the oft-quoted philosopher John Dupuy who postulates an obligation to expect the catastrophe in order to prevent it (Grunwald 2006:68).

Indeed, the connection between nanotechnology and GMO or BSE experiences is actually not obvious¹². Even if we would take it as given that nanotechnology bears new risks that are not covered by regulations, public phobia is not an inevitable consequence. Safety problems occur in many areas without agitating publics, for example, in food additives (even the adding of so-called pro-biotic bacteria into yogurt seems to be healthy only in limited amounts), new chemicals or chemicals in general (the amount of toxic materials in cleaning agents or insecticides is often pushed hard to the limit for guaranteeing a better effect of the product); and many people still smoke and only a few are willing to drive less in order to reduce car emission.

In the next chapter, I will show in the context of my case studies that the politicisation of the concept nanotechnology, of all things, is intertwined with the established link first to previous technology protests such as against GM, as we saw in the rhetorics of Joy and the NGOs, and second to the rise of horror fantasies connected with nanotechnologies. Nanotechnology was considered a big issue on a small scale and biotechnology had been a big issue on a molecular scale too. In the face of a lack of information about an unclear object, a metaphorical thinking was employed that treated nanotechnology as if it were GM, as I will show in the next chapter. To perceive nanotechnology like GM gave way to a distinct manner of grasping nanotechnology that emphasised certain features over others. For example, that nanotechnology attempts to control life and the danger of public protest was highlighted whereas nanotechnologies' mundane (in relation to its huge promises) applications in, for instance, semi-conductors were excluded. This channelled thoughts and action into a certain direction that is – as I characterise it – marked by a logic of pre-emption, which is expressed, for example, in the demand for public engagement, as we will see in the next chapter.

Definitely, there has been a change in nanotechnology governance. I characterize the promotional period, which I dealt with in Chapter 3, as period 1 in nanotechnology governance. The shift, which I problematized in this chapter, introduces period 2 in

¹² For a critique on the GMO-Nanotech analogy see also Sandler & Kay (2006).

nanotechnology governance. The following quote from the empirical material of the German case exemplifies the change (about which we will learn much more in the next chapter) how nanotechnology governance is differently conceptualized once policy-makers were gripped by the fear of a public contestation. The quote hints at how alert political actors were to negative perspectives on nanotechnologies and that they showed a strong will and openness to include concerns. We also see a major change in how nanotechnology is talked about compared to the promotional reports in period I.

Nanotechnology is discussed in public very intensively and partly controversial. Pragmatists, visionaries and utopians are facing each other. There are different evaluations about the potential of possible applications and their consequences. But there is also a controversy concerning the definition of nanotechnology and how it is demarcated towards other established technologies.
(BMBF 2002b: 1)

The quote is taken from the introductory paragraph of the German Research Ministry's report titled "Strategic realignment of nanotechnology" published in May 2002, which was part of efforts to develop a nanotechnology strategy. While earlier strategic efforts had focused only on the development of market potential and a qualified workforce, this text added the requirement "to initiate societal discourse about chances, perspectives, and risks of nanotechnology" (BMBF 2002b). We can see a similar change in the UK, where industry representatives, for instance, interpreted the mere presence of NGOs in the field as indicative of negative public perception of nanotechnologies (see Industry representatives' meeting minutes – 3 March 2004). How this changed context, in detail, caught on in the case studies is the topic of the next chapter.

In this chapter I showed that it cannot be said that the rise of a few actors pronouncing counter-narratives, articulating nanotechnology with horror fantasies, can solely explain the change of the problem definition of nanotechnology from 'ensuring economic growth by staying competitive in the nanomarket' towards a societal issue and to an issue of safety concerns. But the changed regime of science society relationship, as introduced above, has to be taken into account as well. Only against this background were policy-makers gripped by fear fantasies concerning a public contestation of nanotechnologies.

4.4 Conclusion

By way of conclusion, I explained in this chapter how nanotechnology became a potential regulatory object. In this construction of nanotechnology, logics of equivalences played a crucial role in the construction of a new hegemonic articulation: that nanotechnology was under threat. First, actors such as the computer engineer Bill Joy, NGOs, the science fiction author Michael Crichton, and Prince Charles established equivalences between nanotechnology, biotechnology, atomtechnology, asbestos, and other negatively perceived or failed scientific developments. To draw these equivalences connected nanotechnology with risks. However, such horror fantasies could only emerge because of the extension of nanotechnology's signifying chain which I traced in the previous chapter. Nanotechnology was presented as potentially out of control, as yet another technology of which humankind cannot foresee the consequences. In fact gripped by a fear of public contestation, state elites started to protect nanotechnology. They wanted to prevent the 'yuck-phase' which they believed was about to emerge. Therefore, I assert that the new hegemonic articulation was that nanotechnology was under threat (in contrast to claiming that nanotechnology became a threat).

Importantly, I pointed to the role of emotional, affective responses in the development of regulation. State elites (policy-makers, STS community, scientists) came to be gripped by the fantasmatic appeal that 'the' public was prone to horror fantasies, when, in fact, they themselves were prone to public phobia, which Arie Rip characterised as nanophobia-phobia. It was because of the state elites' response that the articulation of dystopian nanotechnology visions was successful. This does not mean that policy-makers reacted irrationally. Rather it brings to the fore the affective dimension of policy and how fantasmatic appeals can impact on the dynamics of policy-making. In a climate of a European-wide upheaval against GMO, it became legitimate to imagine a similar conflict in the nanotechnology-field; not least if an NGO, Prince Charles, and a well-known science fiction author take up the issue. In addition, science governance had changed from the experiences with GMO and BSE, and public engagement had become a necessary element of science governance. Therefore, nanotechnology was articulated into discourse of ethical, legal, and social aspects. My analysis brings to the fore that the move towards regulation, confirming a connection between nanotechnologies and risks, emerged from the

processes of internalized policy-making as nanotechnology actors decided to set out to preempt potential threats. This chapter showed the shift of the context of nanotechnology governance which occurred from Bill Joy's article onwards. In the following chapter, I will explore in detail this discursive shift from nanotechnology innovation project towards the responsible development of nanotechnologies, analyzing how this shift gripped across policies in Germany and the United Kingdom.

5 A new period in nanotechnology governance: Towards a risk regime

In this chapter, I examine how policy-makers put place a regulatory regime in order to stabilise nanotechnology development, opening a new period of nanotechnology governance in which a risk regime on nanotechnologies was developed. The move, as I argued in the previous chapter, was a response to perceiving nanotechnology as under threat. It has to be understood in the context of the dystopian visions which were received within a public regime of science governance. In period I nanotechnology as an innovation (Chapter Three), nanotechnology was articulated as innovation project in both case-studies and this articulation was underpinned by powerful fantasies. From 2002 onwards, however, raising fear fantasies were interpreted as potential dislocation of the innovation discourse. Policy-makers were gripped by the imagination that nanotechnology could be the next field to encounter public contestation. Therefore, they started to pre-empt a potential conflict about the development of nanotechnology by implementing a regulatory regime. As I will show in this chapter, the "responsible development of nanotechnologies" became the hegemonic regime governing nanotechnologies. I will explain how this new regulatory regime caught on and how it gripped across policies. The theoretical tools that I bring into play to explain hegemony are political logics: I focus on the demarcation and definition of the new regime towards the outside, how it absorbs opposition, and how it presents as the only possible alternative.

In fact, in this chapter I will show how state elites saw a risk regime on nanotechnology increasingly as necessity for stabilising nanotechnology. I will argue that, in this process, the visionary debate was left behind and nanotechnology was articulated as a technical matter. That is, the social practices of the governance actors in Germany and the UK who dealt with the challenge of nanotechnology were marked by demands for reason, evidence, and factuality. I conceptualize this as a social logic of scientification as the practices of governance actors were marked by such a strong belief and wish for scientific procedures – in Germany, for example the link between nanotechnology and fine particulate was fore grounded –, when nanotechnology was articulated as a risk issue, while the visionary debate was excluded. This was a process of depoliticisation.

In Germany, I will demonstrate how acknowledging risk gradually shifted from being considered as a threat to technology development to its enabler. Technology consultants of

the VDI TZ had been promoting a pre-emptive approach to nanotechnology governance already in period I, which can be exemplified with their forecasting studies. However, I will illustrate that their idea of implementing a radar system, which identifies and addresses potentially upcoming hurdles to the development of innovations, could only catch on within the changed context of nanotechnology politics, once horror fantasies had gripped policy-makers. In response to the debate of utopian and dystopian nanotechnology visions, also the Parliamentary Office for Technology Assessment commissioned a report on nanotechnologies in the year 2003 (TAB-report). Also industry responded to the perceived threat to technology development by initiating stakeholder meetings on the 'responsible development of nanotechnologies;' their aim was to 'apply lessons learned.'

Similarly, in response to emerging horror fantasies, the British government commissioned the Royal Society (RS) and the Royal Academy of Engineering (RAEng) to undertake a study on nanotechnology. This report problematized nanotechnology within risk governance and within a discourse of ethical, legal, and social aspects of technology development. That is, the document represents and introduces how nanotechnology – in contrast to the previous reports that focused only on innovation, growth, and competition – was differently approached from the publication of the RS/RAEng report onwards. Similar to the German case, I discern how that this new problematization of nanotechnology governance was embedded in social practices of scientification. That is, governance actors demanded reason and rationality. They wanted to avoid what was perceived as an emotional, unreasonable, polarised GMO-debate. The GMO-debate became the 'dismissed other.' That is, the content of the new hegemonic regime of the "responsible development of nanotechnologies" was defined by its negative outside, by the demarcation to the experience with public protests against GMO. In short, the GM-debate was considered as full of emotions – nanotechnology should be different. Policy-makers imagined that public protests could become a barrier to nanotechnology development and their efforts, united in the 'responsible development of nanotechnologies,' should pre-empt this threat.

I now turn to the analysis of the regulatory developments in Germany, demonstrating the shifting politics and discursive shifts that occurred in nanotechnology governance as the regime of 'responsible development of nanotechnologies' became hegemonic.

5.1 Germany: Articulating nanotechnology within a risk regime

In Germany, I discern two phases of risk governance and nanotechnology: a first phase where risk was seen as a threat to technology and a second phase where the hegemonic discourse was that risk was enabling further technology development. Both phases are overlapping and represent the view of different actors. An analysis of the politics of this discursive shift, how risk became part of what was defined as the policy problem of nanotechnology, is exciting because we saw in the previous chapter what seemed to have sedimented first and foremost were imaginaries about the promising future nanotechnology would bring, and how necessary therefore it was to foster developments in nanotechnology research. In the following, I will show that in the wake of the dislocatory moments, when nanotechnology was linked to GM-protest and to negative and unexpected consequences of scientific inventions (asbestos, BSE, nuclear technology), a discursive shift took place. Risk went from being a threat to technology towards being rhetorically re-inscribed as the only means of ensuring nanotechnology. This shift was driven by a logic of pre-emption. In the context of negative experiences with the contestation of technologies, the absence of a risk regime for nanotechnology was recast as a danger. Establishing a risk regime became a necessity for securing nanotechnology and potentially evading opposition. In the following, I will illustrate these developments.

5.1.1 TAB Report: Efficiency and the delicacy of talking about risks

One of the first moves of a governmental body in reaction to the dislocatory moments of linking nanotechnology to GMO and to the visions debate in German feuilleton was to commission a holistic study on nanotechnologies. In the year 2003, the Office for Technology Assessment of the German Bundestag (TAB - Büro für Technologie-Abschätzung beim Deutschen Bundestag) was commissioned to conduct a study on nanotechnology for the German Bundestag. The TAB Report, which was published in November 2003, became a key document for nanotechnology governance in Germany. It was a study on the state of the art of nanotechnology research in Germany.¹³

¹³ The TAB is a scientific institution which has the mandate to advise the German Bundestag and its committees on questions of science and technology. TAB is operated by the Institute of Technology Assessment (ITAS), which is located at the Karlsruhe Institute of Technology, and which cooperates with the Fraunhofer Institute for Systems and Innovation Research (ISI). Its nanotechnology study had been commissioned by the research committee of the Bundestag (lower house of the German parliament). In general,

An outstanding feature of the TAB Report was how it dealt with the prevalent nanotechnology discourses at the time. On the one hand, it critically incorporated visionary discourses and it questioned their functions. On the other hand, the report took certain visionary narratives as true and reproduced them (self-organisation phenomena, dimensions of nanotechnology established by the NBIC Report or DNA computing). An important narrative constituted and taken for true in the TAB Report concerned the potential of nanotechnology for the future of the German nation. When commissioning the nanotechnology report, it was made clear to the reports editors that:

The focus of the study should be on the sectors relevant to Germany's economy and thus on branches such as the car industry, energy, the building industry (new materials), and the life sciences.
(Interview Material: ITAS employee)

The quote exemplifies how the report was written on the premise that Germany had a leading position in nanotechnology, and that this position had to be maintained. Therefore, the TAB had to walk a tightrope in its study as regards nanotechnology and risks. While the mandate provides that the TAB works independently from the Bundestag, research institutions working on nanotechnology made it clear to the authors that nanotechnology must not be criticized too much. The researchers at the TAB analysed existing documents on nanotechnologies and they interviewed scientists. Various concerned scientists had, independently from one another, experienced severe critique against their work in previous years – when they were working on GM, when they used animals in experiments or when they conducted nuclear research. Thus, the scientific community expressed grievances about – what they perceived as – a generalised negative perception of scientific research in society. Their fear that the next growing sector would be discredited publicly was big. Thus, writing about risks in nanotechnologies was a tricky topic which demanded sensitivity. This can be seen in the structure of the narrative provided in the TAB Report: risks and nanoparticles were dealt with only after establishing the argument of nanotechnology's efficiency, the promises about what was to come, and how the German economy could benefit, after a chapter on visions, and after considering potential positive effects for human health and the environment. Studies about the toxicology of nanomaterials were not available at that time. If risk was problematized it was because links were made to fine particulate. As the TAB Report said:

the topics of technology assessment conducted by the TAB are chosen by the parliamentary parties or committees of the German Bundestag.

Assumptions about the potentially negative consequences of nanoparticles are until now based on arguments of analogy to research results about the consequences of ultra-fine particulate.

It is proven that ultra-fine particulate can cause chemical reactions in the body. The up-take of ultra-fine particulate in cells can trigger reactions of the immune system.

(TAB Report 2004, Executive Summary)

VDI TZ was another actor who experienced that talking about risks and nanotechnologies was like walking a tightrope and that part of the scientific community strongly opposed using the two terms in the same sentence.

5.1.2 A logic of pre-emption starts to work: Of radar systems and innovation hurdles

In this section, I will illustrate how the logic of pre-emption started to characterise nanotechnology politics. I will exemplify this development with a focus on the VDI TZ as a policy entrepreneur. In the course of the innovation analysis led by the VDI TZ in the 1990s, some of the experts who were interviewed by the VDI TZ mentioned toxicological issues concerning nanomaterials. They argued that nanomaterials constitute general fine particulate and, at that time, the media debate focused strongly on health and environmental risks of fine particulate. Consequently, there were some discussions on risks at the early expert workshops convened by the VDI TZ. According to an interviewee, the scientists were divided into two camps:

Some scientists thought it was necessary to talk about nanotechnology and risks but there were others who did not want to forge any links between nanotechnology and risks.

(Interview material: Technology Consultant)

According to the interviewee, both camps within the science community – those who argued against linking nanotechnology with risks and those who considered reflections on nanotechnology and risk necessary – justified their stance by referring to public protests against emerging technologies in the past. Thus, nobody put risk on the agenda because they saw a 'real' threat by a certain product on the market or in a particular stream of research development, but nanotechnology got linked with risks by drawing equivalences to diesel particulate and against the background of a regime of public governance of science. Those scientists in the above-mentioned VDI TZ workshop and interviews, who were opposed to linking nanotechnology with risk, feared that shedding light onto nanotechnology from the perspective of risk might frame nanotechnology in the wrong angle and invite opposition

against the its development. This line of reasoning is also reflected in the following statement of a politician from the Free Democratic Party (FDP), Ulrike Flach, in a plenary debate on nanotechnology in 2004:

Those people who slow down the development of technologies must not gain prominence in the discussions in this country again. Such elements were our problem in genetic engineering and in the nuclear debate. Many people worried and raised their words which did not bring us further.

My worry is that those people will prevail again and nanotechnology will be bureaucratized. I am sure: a series of regulation is coming. I fear that there will be endless discussions at so called citizen conferences which will lead to similar negative results as we experience with Green genetic engineering every day.

(Flach, Ulrike (FDP) – 6. Mai 2004, see Deutscher Bundestag 15/108: 9800)

The FDP politician expressed grievances about technology debates in Germany and feared that recognizing nanotechnology-risks might open up the opportunity for a counter-hegemonic movement. In this question, there was a clear cleavage in the parliament between red and green (Social Democratic Party SPD and the Green Party), proposing ELSI research on the one hand, and black and yellow (Christain Union Party CDU and FDP) who wanted to consider nanotechnology first and foremost from the perspective of chances, on the other hand.

The VDI TZ people working on nanotechnologies were, from the beginning, advocates of the position that nanotechnology offers an opportunity for 'applying lessons learnt.' In regards to the rising debate about threats to human health by fine particulate – and against the background of horror fantasies of nanotechnologies and a public regime of science governance – their stance could slowly gain ground. In the light of the GM debate, among others, the consultants of the VDI TZ, such as Gerd Bachmann and Norbert Malanowski, had from the beginning tried to set out an entirely new way of 'doing technology.' This can be exemplified by calling their first studies on nanotechnologies "Innovation analysis." As my interviewee from the VDI TZ explained:

We developed a new concept with the Federal Ministry of Education and Research in the late 1990s that demarcated the old technology assessment from what we called an innovation analysis. It focused more on innovation research and that we should come in earlier, like a radar system, where you see issues approaching in the future. The earlier you deal with such issues the more space of action you have. When we know much and the technology is already established, the space of action is smaller.

(Interview material: VDI TZ representative)

The radar system of the VDI TZ also included that NGOs be consulted. NGOs were approached as early as the year 2000 in the course of the expert interviews for another

innovation study to get their expert opinion about nanotechnologies. Indeed, no organisation had considered the topic at this time by themselves. Instead, the topic was brought to the NGOs by a consulting agency of the Ministry for Education and Research. We can interpret this as an attempt to stop opposition by recognizing the possibility of opposition. Instead of waiting for them to come, they were invited in because of the experiences with the past. It was here that a logic of pre-emption started to work. Their suggestions were informed by the biotechnology protests, while at the same time the VDI TZ tried to interrupt the course of history going in the same direction. Thus, the link to biotechnology had to be established and interrupted simultaneously. This tension can be seen in the following interview quote:

We had to take care in our first expert interviews not to slide into old technology assessment discussions about biotechnology. Even today it is often referred to enormous mistakes made in the past which contributed to the formation of irreconcilable camps concerning biotechnology. Some say even today that we are also too late with nanotechnology but I think this is nonsense. I would say we were very very early.

(Interview material: VDI TZ representative)

This quote is an example of how, by means of linking nanotechnology with biotechnology, a demand to interrupt this link arose, and a demand for a new techno culture was formulated. What might seem paradoxical in the first place indicates in fact the formation of a hegemonic project: the 'responsible development of nanotechnology,' namely a risk regime of nanotechnology, driven by a logic of pre-emption. If we recall, what is said in the theory section, a hegemonic project is a complex discursive-material web of relations that is successful in producing particular patterns of thought or action as the only alternative (Moebius 2008: 166). Here we see that the link between nanotechnology and biotechnology was not obvious. Nevertheless, industry perceived it as the only alternative to prevent a dislocation of nanotechnology by avoiding another biotechnology-like conflict. Central for the stabilisation of a hegemonic project is to demarcate it from the outside (ibid: 167). Genetic modification became 'the dismissed other' that consolidated nanotechnology. When nanotechnology and risk actually was debated as a technical matter, such as fine particulate, industry was gripped by fears that nanotechnology could be the next biotechnology despite the fact that fine particulate does not stir up the public such as genetic modification.

Nevertheless, the topic of fine particulate cannot be disregard in the German context; it is a specificity of the German case that the nanotechnology-risk discussion entered via this path. In the following, I will explore the function of the fine particulate debate in the nanotechnology context.

5.1.3 *Logic of scientification*

We saw in the TAB Report quoted above and in the recount of the VDI TZ interview above that scientists who were interviewed on nanotechnologies in the beginning of the 2000s mentioned nanotechnology and risks – if they made this connection at all – by referring to nanoparticles as fine particulate, and thus referring to the fine particulate debate. The debate about fine particulate (German: Feinstaubproblematik) is a sump as deep and complicated as the nanotechnology debate. For this reason, it cannot be illustrated here in-depth. Briefly summarized, the debate deals with airborne pollutants of very small size or fine particulate; the word-by-word translation from German would be fine dust. These small particulates are caused by emissions from cars, industry, and airplanes. The smaller the particulate the further it can be breathed in by human beings and cause health risks, like diseases of the respiratory tract as well as cardiovascular diseases. It is unknown and debated which kind of particulate is most risky. This depends on characteristics of the particulate, such as size, character or surface condition. Politics is trying to define thresholds for emissions. Policy measures taken are focusing on traffic, such as supporting vehicles low in harmful substances, setting speed-limits or forbidding heavy vehicle traffic in town, and on industry, for example, by emission schemes.

The fine particulate debate is far away from the horror visions around nanotechnology that I introduced above as an essential part of a potential dislocation of the rise of nanotechnology as a field. This raises the question of what happened to the vision debate. I suggest, what was implied with a discussion on nanotechnology and risks in the context of fine particulate was an articulation of nanotechnology as technical matter, a shift of nanotechnologies away from the fantastic realm.

Although the TAB Report explicitly took up the visionary debate, I argue that it substantially contributed to disentangling nanotechnology applications from these visions and to restoring its technical character. The TAB Report authors faced the question in the year 2003 of how to deal with visions á la Drexler, Joy, and Crichton. Hence, the TAB decided to devote a chapter to visions. Similar to their separation into top-down and bottom-up approaches of nanotechnology in the definition section, the authors introduced a rationalisation of nanotechnology visions by drawing a boundary between two visionary discourses: short-

term visions within research politics focusing on the (economic) potential of nanotechnologies and long-term, futuristic visions which postulated far-reaching, in-depth changes of the conditions of human existence. The authors discussed how the function of such visions might be to hype technologies but how visions could cause fears or – at least – disappointed expectations (and thus trigger the expected yuck-phase). To deal with visionary discourses in a study which was supposed to provide an overview of the state of the art in technological development was innovative, and this holistic view was received with positive attention after its publication. During my interviews, several actors in Germany mentioned that they thought the TAB report would have gotten the same acknowledgement worldwide as the Royal Society and Royal Academy of Engineering report published in the UK (to which we will turn to in the following section), had it been written in English. My argument is that by talking about visions in a separate section, they were disentangled from nanotechnology applications. In addition, the separation into long-term and short-term visions drew a chain of differences which allowed for subsequently introducing a hierarchy and which contributed to dismissing far-reaching visions that came to be seen as fictional accounts.

Apart from the TAB Report in spite of Frank Schirrmacher's book – no actor in Germany picked up on the dystopias and utopias of nanotechnology. Interviewees recall:

In Germany, nobody succeeded in turning the debate into an ideology debate a la grey goo, Michael Crichton, self-replicating robots who turn into grey goo, etc. ... This was an issue in Germany briefly when Prince Charles made his utterances in the UK and Ray Kurzweil had a comment in the newspaper called Frankfurter Allgemeine Zeitung (FAZ). After that there was a short debate in the FAZ, but then never again. You can see this in the media analysis. In this media analysis, it was assessed how much this topic – these dystopias and utopias – played a small role in the beginning ... but never such a significant role as in the US. It did also not work out to load the topic religiously. Nanotechnology really stayed in the technical realm of materials. Nanoparticles do not look like anything. Nobody cooked up the topic although there would have been a potential for this.
(Interview material: Civil Servant BfR)

Once articulated as a technical matter, it was in the context of the rising debate on fine particulate that a discussion on nanotechnology and risks were triggered.

When the problem of fine particulate was raised in the public, the group of nanotechnologists gained dominance which was in favour of heading towards the direction of toxicological tests.
(Interview material: VDI TZ representative)

The social logic informing these practices is a social logic of scientification, which includes a shift of the nanotechnology debate away from a fantastic realm into science discourses.

This shift was underpinned by a strong demand for reason as opposed to – what was perceived as – an emotional, irrational debate on GMO. Horror fantasies did not grip because nanotechnology was kept as a technical field. In the course of the following chapters, we will see how the logic of scientification characterised many social practices of governing nanotechnologies. For the moment, we will stick with the fine particulate debate.

Nanotechnology also got on the agenda of the NGO, the BUND (Friends of the Earth Germany), within the context of discussions on emissions and fine particulate. According to its own definition, the BUND is Germany's biggest environmental association and it represents the German branch of Friends of the Earth. From its self-presentation on its website, it can be seen that the NGO, who has almost half a million members, does not aim to position itself as a social movement, which is against something, but their self-representation focuses on constructive suggestions. I mention this because I consider it as part of this hegemonic demand for reason at the beginning of the 21st century that ideally NGOs should also be balanced, rational, and constructive. We can see the same in the UK consumer organisation "Which." The BUND's website says that they promote ecological agriculture, organic food, environmental protection, and the development of renewable energy. As an organisation, the BUND is federally structured, which means there is the federal umbrella organisation with its headquarters in Berlin, and there are headquarters on the state level, in addition to about 2000 local or federal thematic groups composed of volunteers. Nanotechnology became an issue in one of these small BUND thematic groups of volunteers which was concerned with emissions. My interviewee from the BUND implicitly challenged any assumption that the NGO represents the lay public (as opposed to experts in science and government) by stressing at the beginning of the interview that these thematic groups were often joint or set up by concerned experts, who, based on their job experience with a certain topic, feel the necessity to engage with it critically in their private life. The self-interpretation of the BUND, deployed in this interview, was that the NGO serves as a platform or site where concerned experts find a space for raising critical issues that are silenced in the expert's daily work on these issues:

These are in fact experts, who intend to volunteer additionally to their work, because they think ... I don't know, in energy questions or concerning chemicals or emissions ... that environmental protection should be further considered and who bring their expert knowledge into these thematic groups. The BUND's concern with nanotechnology came out of such a structure.
(Interview material: BUND)

Nanotechnology got onto the agenda of the BUND through a thematic group working on emissions concerned with fine particulate. The BUND was not present in a public debate on nanotechnology in 2003/2004, nor was nanotechnology a hot issue within the organisation. Only when the group organised a first workshop on nanotechnologies together with the Protestant Academy Iserlohn in 2005 and when the Federal Environment Ministry started the Nanodialogue, did the significance of the topic and of the organisation rise, as we will see below. For the moment, it is enough to take with us that also at an NGO, nanotechnology risk came on the agenda in the context of a debate on emissions and fine particulate.

Thus far, I have established the argument that in the aftermath of the visionary debate on nanotechnologies, a relocation of nanotechnology in science discourse occurred, which I characterised as a social logic of scientification. Moreover, within the context of the fine particulate debate and driven by a political logic of pre-emption, the VDI TZ's idea of a radar system – which evolved, as we will see, into the 'responsible development of nanotechnology' – was able to catch on. Nanotechnology and risk slowly shifted from a 'no go area' towards an acceptable way of talking about nanotechnology with regards to the debate about threats to human health by fine particulate. While it was initially inferred from the experiences in the past regarding protests against genetic engineering and nuclear power that nanotechnology should – under no circumstance – be articulated as risk, these same experiences from the past were now re-defined as opportunities to apply the lessons learned so as to avoid such a contestation of a new technology as well as a polarisation among the public. An interviewee said:

Slowly scientists became prudent. They understood that they had to deal with the nanoparticles issue proactively to avoid a backlash later in time. Besides, they saw the potential funding for risk research. (Interview material: Technology Consultant)

Political practices of 'doing it right the first time' developed mainly at sites of the industry: as said earlier, at the VDI TZ, but also at the Society for Chemical Engineering and Biotechnology (DECHEMA) and at the Association of Chemical Engineers (VCI). The DECHEMA and VCI were within the circles that had inscribed nanotechnology into Germany's future development in the 1990s. Until the year 2003, they had dealt with nanotechnology from the perspective of innovation. A respondent from one of the institutions described the urgently felt demand for pre-emption in the interview as such:

We had much too many negative experiences with acceptance debates in Germany. Actually this time we only wanted to do it right, right?
(Interview material: Industry representative)

Where earlier efforts were made by industry to discursively create the field of nanotechnology and its potential, a risk regime was now developed to secure the discursive formation and the development of nanotechnology. An interviewee from the Association of Chemical Engineers recalled the social practices of how they took strategic action on nanotechnology:

I am department leader here for research and development and we had nanotechnology as a marginal topic from the perspective of innovations. We wanted to use the innovation potential of nanotechnology. That nanotechnology got a big issue in the VCI originated from the communication department who drew our attention to reports in the media occurring now and then in the year 2004 reporting that nanomaterials might be dangerous. The communication department pointed out that we might again have such a technology ... like a cascade: nuclear technology, biotechnology, nanotechnology. So, the research department of the VCI said we had to take care that we would not get the next debate like with genetic engineering.

So, we decided in the presidium that nanotechnology was an important topic and we said all departments had to work together: occupational health, the environment department, communication, research funding and ... also the legal department ... so, everybody. Nobody would only work with nanotechnology but everybody had to integrate the topic in his daily work. We would coordinate the work, attend stakeholder dialogues, participate in citizen conferences and we decided to initiate regular roundtables to which we invited the press.

This came along because we wanted to do it right this time with nanotechnology.
(Interview material: VCI representative)

After the VCI decided to tackle nanotechnologies "the right way," it developed a plan of action at various levels in order to prevent a dislocation of nanotechnology. A core contribution of the VCI to nanotechnology governance was to develop guidelines on the "Responsible Production and Use of Nanomaterials." When producing the guidelines for "Responsible Nanomaterials," the VCI worked together closely with the Society for Chemical Engineering and Biotechnology (DECHEMA). DECHEMA is a registered society for chemical and biotechnology engineers and companies, which positions itself as crossing point of science, industry, state, and the public. The organisation played a crucial role for biotechnology governance in Germany in the 1970s and 1980s. According to an analysis by Herbert Gottweis (1998), their report on biotechnology, published in 1974, defined the narrative of biotechnology in Germany for at least a decade. It linked biotechnology to Germany's future success in economic development and postulated a promising future that could be reached through the appropriate research funding (Gottweis 1998: 184ff). In nanotechnology, DECHEMA gathered an interdisciplinary working group called "Chemical

Nanotechnologies" in the year 2000 with the aim of identifying necessary funding and creating a network. Furthermore, a working group on the "Responsible Production and Use of Nanomaterials" was established, originating the idea, which we also saw in the VDI TZ, that we have to deal with nanotechnology because of genetic engineering, especially because nanotechnology is not like biotechnology:

First discussions about nanotechnology and risks developed in the working group on Chemical Nanomaterials – and here you see the function as a nucleus that our working groups have. We suggested establishing another working group which should deal with risks and chances of nanomaterials. This working group exists now and it is called Responsible Production and Use of Nanomaterials. In this group, we defined what we had to look at concerning risks of nanomaterials in order to avoid such a situation with genetic engineering, particularly against the background that nanotechnology and genetic engineering are very different. They are different because according to the status quo of the technology nanotechnology it is not harmful, while the concerns of people regarding biotechnology were justified if you think about Monsanto.
(Interview material: DECHEMA representative)

As a result of the VCI and DECHEMA's efforts, a Code of Conduct on the "Responsible Production and Use of Nanomaterials" was published in 2008. The function of such moves as to write a responsible code of conduct is to initiate self-governance instead of taking the risk of becoming governed by others; it is thus also driven by a logic of pre-emption.

By way of conclusion, between the year 2000 and 2005, a risk regime on nanotechnology, 'the responsible development of nanotechnology,' was implemented – one that would enable innovation. Therefore, scientists and industry would buy into this idea. At the same time, the responsible development opened up an avenue for safety concerns. Initially, the camp in the scientific community was stronger, those who believed that accepting risks would validate NGOs. This perspective, adopted by concerned scientists and by the right fraction of the parliament, did not consider that accepting risks would not only validate NGOs, but at the same time negate them. If industry recognized risks proactively, it neutered oppositional forces: there was nothing left to be against. This logic of pre-emption was also a driving logic in the establishment of the NanoCommission later.

In sum, the debates of nanotechnology visions contributed to the emergence of nanotechnology as a topic for policy-making. The rising agenda of 'nanotechnology and risk' must be seen in the context of former experiences with GMO protests and a fear that permeates the system that a similar opposition to nanotechnology could emerge. Former experiences allowed for different perceptions of developments, such as the vision-debate in the German feuilleton. The different events and discourses have to be considered as mutually

reinforcing. Apart from that, experiences with technology accidents, such as GMO and the BSE crisis, led to the establishment of new institutions, such as the Federal Institute of Risk Assessment, Bundesinstitut für Risikobewertung (BfR), which became part of a institutional constellation tackling new questions of nanotechnologies, as we will see below. First, we will, however, turn to the UK reaction to the appearance of Prince Charles in the debate.

5.2 UK: Channelling nanotechnology into a regulatory debate

In this section on UK nanotechnology governance, I will analyse the Royal Society and Royal Academy Report, published in the year 2004 as the official reaction to rising concerns about nanotechnology, as well as the subsequent government responses, and will elicit how they rearticulated the policy problem of nanotechnologies. I will argue that they drew the boundaries of the problem definition of nanotechnologies within risk regulation. As a consequence, wider and more universal socio-economic and political demands related to technology development, such as questions of human enhancement or surveillance, were excluded from the debate or at least shifted to the edge. Demands for control and precaution, which NGOs and Prince Charles had articulated, had the potential to disrupt the development of nanotechnology. The government neither agreed to the worst case scenarios of Prince Charles, nor rejected demands for regulation. Rather, the social practice of conducting a holistic scoping study (Royal Society and Royal Academy of Engineering Report) and the subsequent actions taken (institutionalising public engagement, risk assessment, and regulatory overview) pre-emptively absorbed dislocations, "preventing them from becoming the source of a political practice" (Glynos & Howarth 2007: 216-217).

After the rise of horror fantasies about the consequences of nanotechnology, the first step of pre-empting potential conflicts, taken by the reports on nanotechnology from the RS/RAEng and from government, relocated the nanotechnology discourse into the scientific realm. This logic of scientification unfolded in a threefold manner, as I will show below: first, dystopian visions were articulated as 'science fiction' and the ability to make authoritarian claims was withdrawn from those who had been disseminating these visions. Second, the main demands on nanotechnology governance became the demand for trust and the demand for reason, which were both answered by fostering public engagement in nanotechnologies. As I said above, this demand for reason is a part of the logic of scientification. It dismisses – what is said to be – emotional, irrational (and maybe even 'unjustified') responses to genetically

modified organisms, and assumes that people have to be engaged in early dialogues about technology development. I consider the demand for results of the nanotechnologies' toxicology and risk assessment as the third part of the unfolding logic of scientification. I turn now to these three moves of scientification.

5.2.1 *The Royal Society and Royal Academy of Engineering Report*

Similar to Germany, the first move of governmental bodies was to commission a holistic study in the UK in the aftermath of Prince Charles's intervention. While it was the parliament in Germany who initiated the TAB Report, it was the science minister in the UK who announced the creation of an inquiry into nanotechnology, for which the Royal Society and Royal Academy of Engineering was commissioned.¹⁴ For the task of conducting the RS/RAEng nanostudy, a working group was composed which consisted of 14 members with various backgrounds, from technical engineers and natural scientists to a philosopher, a social scientist, a consumer representative and an environmentalist. The chair of the study was Ann Dowling, a professor of mechanical engineering at the University of Cambridge. The final report with the title "Nanoscience and Nanotechnologies: Opportunities and Uncertainties" was published in July 2004. In the two or three following years, debates within the UK (and internationally) focused on the report concerning the possible benefits afforded by nanotechnology and its concomitant risks. The following quote is, thus, not only a self-praise, but it expresses the significance of the 2004 RS/RAEng Report well:

In commissioning our 2004 report on nanotechnologies the UK Government was recognised internationally as having taken the lead in encouraging the responsible development of nanotechnologies.
(RS/RAEng 35/06 2006:1)

The significant feature of the report was that it recognized that a mere evaluation of the benefits would frame the technology development too narrowly. Thus, it expressed the need to assess the concerns about the transformative potential of the technology along with evaluating its economic potential. The aim of the study ranged from defining nanotechnologies to assessing the status quo of the nanotechnology research landscape inclusive current and future applications, to identifying EHS (environmental, health, and

¹⁴ In the same year, a report by the Better Regulation Task Force – Scientific Research: Innovation with Controls" considered nanotechnologies among other technologies, but I will focus on RS/RAEng report here because it solely dealt with nanotechnology.

safety) aspects, as well as ELSA (ethical, legal, and social aspects) (RS/RAEng 2004:1). The report was hailed for this holistic approach. As my interviewees said:

The RS review was probably the first time somebody looked holistically at nanotechnology. The then DTI minister had asked to carry it out. The Royal Society spent a lot of time on this work. Admittedly, they had a broad work stream: There was need for more information but nobody was gathering it so far.

(Interview material: Member of the DIUS Innovation Group)

Governments handle that entire thing differently. Uhm, I think that's a reasonable claim to make. But also the Royal Society, for instance, handles nanotechnology different than the way it handled GM ... They started an immediate controversial [pre]assessment. So, the Royal Society, in writing the nanoreport, ... if you go back and look at some of the early reports on GM agriculture, you would think that came out of two completely different organizations. The nano-report is much more about a holistic analysis of nanotechnology, [...], there was an effort made to integrate societal issues, while GM in the beginning was just a technical case.

(Interview material: Royal Society)

When I attended a regulatory conference on nanotechnologies at a NanoFair in St. Gallen, Switzerland, in 2006, the RS/RAEng Report was omnipresent. A representative of the Swiss Environmental Agency, for instance, said:

The nanotechnology risk and regulation discussion took off in early summer 2004, when the Royal Society and Swiss Re published their reports on nanotechnologies – "Nanoscience and nanotechnologies: opportunities and uncertainties" and "Small matters, many unknowns." These reports illustrated the fact that nanotechnologies offer many benefits both now and in the future, but that public debate was needed about their development. It was also highlighted the immediate need for research to address uncertainties about the health and environmental effects of nanoparticles.

(Karlagnis 2007, Abstract)

This recognition and attention had put the UK government also in a vulnerable position. At this conference in the year 2006 – two years after the RS/RAEng Report was published – critique was expressed about the inertia of British politics following the publication of the report and it was stated – in a plenary discussion – that the UK might have lost its lead in nanotechnology regulation. But I do not want to anticipate too much; we will see what happened further below. For the moment, I want to follow up on the question of how the report dealt with the dystopian visions (of grey goo, etc.), which played a significant role in initiating the report.

5.2.1.1 'Science Fiction' versus 'Real Science'

In this section, I analyse how the RS/RAEng Report dealt with the horror fantasies because of which it was written. I interpret the report as reaction by the UK government, particularly

the science ministry, to manage the opposing demands that clashed in the year 2003/2004 and that had the potential to lead to a public contestation of nanotechnology. As shown in period I, these demands were supported by very strong fantasmatic appeals on either side. Supporters of nanotechnology presented the field in detail as 'the' way to enter into a good future, as an opportunity to cure cancer or to save us from climate change by nanoparticles cleaning environmental pollution. At the same time, opponents created a scenario where self-replicating nanoparticles could destroy organic materials on the earth or where the same mistakes could occur as with asbestos or thalidomide, and thus they contested nanotechnology policy-making by playing out logics of equivalences.

In contrast to these accounts, the argumentative style of the RS/RAEng Report was very serious and down to earth, compared to the grey goo scenarios constructed before. We see here an attempt to de-politicise by an appeal to science – a logic of scientification, which marked various governance practices and which we know from the German politics introduced above. In detail, the RS/RAEng Report made an argument of place (Finlayson 2007: 555), which situated nanotechnology away from the fantastic realm. We can see this, for example, in the structure of the report. While the rise of dystopian visions, supposedly brought on by Prince Charles, was a trigger for initiating the report, the topic was literally shifted to the edge in the RS/RAEng Report. Only on page 109 (out of 111), in annex D, do we see the topic "mechanical self-replicating nano-robots and 'Grey Goo'." This one page of Annex D tries to answer the question whether 'grey goo' is a real concern or whether it is a distraction from the important issues. By referring to the debate between E. Drexler and R. Smalley, in which the two scientists argued whether building self-replicating nano-robots is a dream that could be fulfilled or not, the RS/RAEng Report adopted the position that "making a mechanical self-assembler is well beyond the current state of knowledge" (RS/RAEng 2004:109), and thus, concerns about uncontrolled self-replication of these assemblers should not be a topic. To emphasize the validity of this conclusion, the text quotes Richard Smalley and Erich Drexler themselves, who both had submitted evidence to the RS/RAEng working group and who both suggested that 'grey goo' was the wrong issue to focus on. Thus, the report suggested that questions of a disruptive potential for nanotechnology were no longer relevant and were a distraction from more pressing concerns.

As part of this line of reasoning, which shifted nanotechnology into a scientific realm, oppositional views like those of Prince Charles were said to be based in science fiction. In an

interview, one member of the Royal Society and Royal Academy of Engineering's working group addressed this strategy of setting nanotechnology remote from horror fears:

The pressure originally came from the Prince of Wales to be honest. He said something he read that book about grey goo, you know, and I think he made some, I think, rather ill-considered remarks in public. And the Royal Society and the Royal Academy were under pressure to respond to that. So, one of the first things we had to do was to point out that this was complete nonsense. It was on the same level with being afraid of dinosaurs because you've read Jurassic park, okay?
(Interview material: Member of the RS/RAEng working group for their 2004 nanotechnology report)

Drawing this boundary between 'real science' and 'science fiction' was similar to discussions about nanotechnologies and the role of Eric Drexler in the U.S. in the 1990s. As a consequence of the successful efforts to discredit the dystopian visions of opponents and to position oneself as a serious actor, the boundaries of what was the problem were able to be reset; the more universal demands (of reconsidering technology development) could be set aside with this move. The horror fantasies came to be seen as fantasies, as science fiction; thus, they no longer had the capacity to grip subjects.

To summarize this section, I explained how the politicization of nanotechnology was met by a governance practices that were characterised by a logic of scientification. Accordingly, factuality and reason was stressed and nanotechnology became articulated as a technical matter. Thus, the question emerges: what was defined as a policy issue, once it was no longer horrific visions? I answer this question in the following twofold. First, nanotechnology became an issue of public engagement: the narrative of the RS/RAEng Report clearly reflects that the social practice of writing and of collecting evidence for such a report was characterised by the public regime of science governance and the same can be said for its results. Second, regulation became a key issue in the RS/RAEng work implying requests for governmentally funded risk research, particularly to initiate life cycle assessment of nanomaterials, and to support the standardisation of measurement at the nanoscale. I will now turn to these two issues in this order.

5.2.1.2 Upstream public engagement: The anticipatory-precautionary talk

In this section, I show how the Royal Society and Royal Academy of Engineering Report articulated nanotechnologies as a policy issue within a public regime of science governance. The Royal Society and Royal Academy of Engineering working group on nanotechnology

started their work with a call for evidence. They received written evidence, they organized oral evidence sessions and they had meetings and workshops in this process.¹⁵ Public engagement was part of their evidence gathering. In their final report, an entire chapter is devoted to 'Stakeholder and public dialogue.' The chapter describes and discusses the results of the public consultation, particularly the low awareness about nanotechnologies in Britain in the year 2003, and it recommends that these exploratory studies conducted in the course of the RS/RAEng study should be followed up on by government (RS/RAEng 2004: 61f). Referring back to the supposed lack of trust in political institutions due to failures in handling the BSE crisis, the report suggests it is important to promote a wider dialogue, namely, a dialogue with a range of stakeholders about risks and uncertainties (ibid: 63f). Because of, first, low public attention, second, the early developmental stage of nanotechnology research and, third, the hypothetical character of nanotechnology's promise, the report defines nanotechnology as an 'upstream issue' and thus, a field where the direction of technology development and public response to it still can be steered. From this, the idea and demand to apply lessons learned could be formulated:

32 Viewing nanotechnologies in upstream terms suggests that lessons can and should be learned from the history of other similar technological innovations. Mayer (Mayer 2002) argues that the development of all major technologies should be viewed as social processes, and that framed in this way there are clear parallels to be drawn between nanotechnologies today and the position that biotechnology faced in the 1980s. Similarities include the levels of excitement and hype, a promise to control the future without critical consideration first of which futures are desirable and who might ultimately control them, and narrowly framed debates about risk issues not encompassing wider social and ethical issues. One can also draw parallels between nanotechnology today and the nuclear energy industry in the 1950s. Wynne (2003) argues that a particular difficulty with the early history of that industry, unanticipated at the time, was that the over-optimistic early claims made for the technology laid the foundations for the deep public skepticism and opposition that was to emerge much later in the 1970s.
(RS/RAEng 2004:64)

I left the quote in a full length because it also shows how the report carefully incorporated STS literature (Wynne) and thus, how this knowledge package of the STS community came to influence how nanotechnology was politically dealt with. In general, social scientists were part of the state elites who internally initiated the development of a regulatory regime because they were influential in linking nanotechnology and biotechnology and in distributing a simplified assumption that protests against biotechnology were fostered by too little dialogue with the public. Next to S. Mayer's text quoted above ("From genetic modification to nanotechnology: the dangers of 'sound science'"), the Canadian M. Mehta

¹⁵ All the evidence, the proceedings, minutes of meetings and their report can be accessed at <http://www.nanotec.org.uk/>

published another well-known, early article (2004) in the field in the *Bulletin of Science, Technology and Society*: "From biotechnology to nanotechnology: what can we learn from earlier technologies?" The quote also indicates how the policy recommendations formulated by the Royal Society and Royal Academy of Engineering were gripped by a fantasmatic wow-yuck logic, which I described above. How sedimented discourses of the public regime of science governance characterized the perspective taken in the RS/RAEng working group can also be seen in the following quote:

Interviewer: The report is known for having public engagement in its focus. How did this develop?

Respondent: Oh, it was right there from the start.

It was there right from the start like a matter of course?

Oh yes, I mean people who ... the members of the working group included some who were uh ... that was THEIR background. Uhm, this has been ... uhm ... the public engagement aspect has been central part of science policy in the UK for quite a long time now. Goes back to perhaps the 1990s. Uhm ... and I suppose one of the influential documents was a report by the Royal Commission on Environmental Pollution on ... it's called setting environmental standards ... but actually it is about public engagement. And I was part of writing that, which is probably another reason why they recruited me on the Royal Society /Royal Academy Engineering Nanotech Working Group.

(Interview material: Member of the RS/RAEng working group for their 2004 nanotechnology report)

The quote refers to the change in attitude in science governance discourses in the 1990s. We see how already the composition of the RS/RAEng working group and the design of the evidence gathering were carefully composed in order to include expertise on science society issues and their lessons.

In sum, a central idea within UK nanotechnology governance became 'getting it right the first time.' On the one hand, the potential for environmental catastrophes shall be prevented with nanotechnologies in contrast to previous failures with asbestos or nuclear plant accidents. On the other hand, the notion of 'getting it right the first time' also refers to avoiding experiences of public resistance against new technologies. With nanotechnologies, the idea was to act pro-actively. For example, public engagement was fostered early. In short, nanotechnology was seen as offering the possibility to apply lessons learned from prior mistakes. A part of this anticipatory-precautionary governance was a demand for reason and rationality, as I want to show with the following interview quotes:

In a sense, we will learn from some of the successes and failures, stem cells was a success, GM a failure - what are the lessons? And I think very clearly that a properly structured debate with good TV programs which people do watch - you know, you got dedicated science channels now - you can try and stop the popular media from um ... like the Daily Mail very unhelpfully ... just um ... um got everyone scared stiff unnecessarily from GM food ... trying to stop that irresponsibility. But you can only do it by engaging in the debate, by telling them the facts. So that intelligent and responsible journalists present a balanced report.

[...]

GM was labeled by the public as Frankenstein food. The thing was out of control then and it was still people who got persuaded that GM um ... soya or maize ... you know, because the whole thing got handled in a way that was emotional and lacked the evidence base which, I think, people would have wanted; the sensible discussion.

[...]

The consumers weren't be worried or weren't be concerned if they don't know anything about it but um ... when they do know something about it, it could be too late. They could find what they did with GM that um ... suddenly um they have been presented by a fait accompli and um ... they react completely ... and then you have to stop it and then it is cracked which may not have been the right answer.

(Interview material: Member of the House of Lords, Science Committee, my emphasis)

The quote first requests a different approach of science communication by the media. In the second part of the quote, the GM debate is articulated as emotional and out of control, which are references to grievances the interviewee clearly wants to avoid concerning nanotechnology. Thus, the anticipatory-precautionary talk was linked to the demand in nanotechnology governance to establish a reasoned debate compared to what was perceived as the passionate, polarized, politicized protests against GM. Such demands for reason were articulated in the frequent call for an informed debate, e.g. in the evidence submitted to the RS/RAEng report or by politicians and civil servants in my interviews. The GM debate was considered to be full of emotion, and such a dialogue was articulated as 'the dismissed other,' as a development that should be avoided in any case.

The stress on avoiding emotions, polarization, and irrationality illustrates that nanotechnology governance is not only about anticipation but about the pre-emption of conflict. To appeal to rationality and factuality marked the argumentative style of first UK nanotechnology policy statements. We see that the social practices of writing such statements were characterized by a logic of scientification. At the same time, to articulate nanotechnology governance as contrary to GM governance means that governance practices should be aligned with the overarching demand to avoid emotions, conflicts, and protest – the logic of pre-emption. This logic explains the institutionalization of practices of scientification which range – as I showed above – from the dismissing of horrific fear fantasies and the demand for public engagement to – what I will turn to now – the shift towards risk assessment and a regulatory debate.

5.2.1.3 Risk governance as a part of the responsible development of nanotechnologies

³⁵ A key issue arising from our discussions with the various stakeholders was how society can control the development and deployment of nanotechnology to maximize desirable outcomes and keep

undesirable outcomes to an acceptable minimum – in other words, how nanotechnology should be regulated.
(RS/RAEng 2004:xi)

In this section, I show how the RS/RAEng report and the following government responses problematized nanotechnology as regulatory issue. The introductory quote of this section (above) indicates how the RS/RAEng rearticulated the policy problem of nanotechnology into one of risk governance. The quote clearly shows that regulation is no longer seen as restriction but as enabler to maximize desirable outcomes. From the recommendations put forward in the RS/RAEng Report, the UK government's policies on nanotechnology developed.¹⁶ The UK government broadly welcomed the recommendations brought forward by the RS/RAEng Report and confirmed its commitment to 'the responsible development of nanotechnologies.' As Lord Sainsbury states in the foreword of this government response:

In June 2003, I asked the Royal Society and the Royal Academy of Engineering to conduct an independent study identifying the opportunities and uncertainties surrounding nanosciences 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. [...]
Our commissioning of this Report demonstrates our commitment to the responsible development of new technologies. These technologies are at an early stage of development. This means that we can concentrate on getting it right – ensuring that developments benefit society and the environment, but do not overburden industry with regulation.
[...] The Government's agenda sets our ambition to work actively in partnership with industry, civil society groups, the research community and the public so that we can move forward together, bringing forward our particular perspectives to ensure that we reap the benefits and avoid the pitfalls.
(Government 2005a:1, emphasis added by the author)

Thus, if we remember the last report considered in period I, the Taylor Report, where nanotechnology was defined as 'a new way of thinking' and as a technology leading us into a glorious future, we see in the above-mentioned quote that progress still is the main demand. But an essential part for enabling the moving-forward became to 'avoid pitfalls.' Potential pitfalls should be pre-emptively met to guarantee the technology development, which was now recast as responsible development. Thus – similar to the developments in Germany – regulation became an essential part to stabilise nanotechnology. The following quote from the RS/RAEng Report (in the chapter "Nanomanufacturing and the industrial application of nanotechnologies," subheading "4.6 Barriers to progress") reflects this:

¹⁶ The government published three reports in the year 2005 following its publication: a response to the RS/RAEng Report in February 2005, a programme for public engagement in August 2005, and a first government risk research report in November 2005.

38 Alongside purely technical barriers to progress are those relating to regulation such as classification and standardisation of nanomaterials and processes, and the management of any health, safety, and environmental risks that may emerge. Appropriate regulation and guidance informed by scientific evidence will help to overcome some of these barriers, and there are already discussions between industry and regulators on the above issues.
(RS/RAEng 2004:33)

We see that – similar to the 'innovation hurdle' in the German context – UK policy-making casts progressing without regulation as a dangerous project which could lead to a disaster, and demarcates it from a responsible development in which regulation stabilises (and guarantees) progress. This move is a part of the hegemonic project, the 'responsible development of nanotechnology,' driven by a logic of pre-emption and informed by an economic rationality. This move was expressed as a demand to keep the balance, to negate the dichotomy between innovation and regulation. It was a very central and stabilising element in the nanotechnology regulatory debate, such that regulation was not to hamper innovation and innovation, in turn, had to happen 'responsibly'. The move towards regulation, or risk governance, was intertwined in the UK with a demand for evidence gathering: this push for research on risk can be seen as a strategy of depoliticisation through recourse to expertise, a part of the social logic of scientification and the political logic of pre-emption. 'To fill the knowledge gap' became a central request in UK nanotechnology politics and was set out in detail for the first time in the RS/RAEng Report.

The RS/RAEng's significant recommendations concerning risk governance were:

41 [...] Therefore, we recommend that factories and research laboratories treat manufacture nanoparticles and nanotubes as if they were hazardous, and seek to reduce or remove them from waste streams.

42 [...] Therefore, we recommend that, as an integral part of the innovation and design process of products and materials containing nanoparticles or Nanotubes, industry should assess the risk of release of these components throughout the life cycle of the product and make this information available to the relevant regulatory authorities.

[...]

44 [...] [...] We recommend that the use of free (that is, not fixed in a matrix) manufactured nanoparticles in environmental applications such as remediation be prohibited until appropriate research has been undertaken and it can be demonstrated that the potential benefits outweigh the potential risks.

(RS/RAEng 2004: 46)

The excerpt shows that the study recommended that nanoparticles should be eliminated from waste streams and that the use of free nanoparticles should be banned. This is a significant move, proposing a widespread precautionary approach which asks for the containment of

nanoparticles produced in research and thus, casts them as risky, as potentially hazardous. Consequently, the problem definition of nanotechnology was rearticulated into one of risk governance, to be precise, into one of potential environmental, health and safety risks of engineered, free nanoparticles. By way of conclusion, the political struggle over nanotechnologies was channelled into regulatory politics in the aftermath of the RS/RAEng Report and the subsequent government reports consolidated the narrow focus on engineered nanoparticles.

5.3 Conclusion

In this chapter, I explained how the discourse of 'the responsible development of nanotechnology' managed to gain hegemony. I demonstrated that policy-makers considered the context of nanotechnology politics as changed after the rise of horror fantasies and how they responded to the perceived threat to nanotechnology with efforts to pre-empt that threat. In detail, I analyzed how the policy-makers' actions (i.e., initiating the TAB Report in Germany and the RS/RAEng Report in the UK; or initiating stakeholder meetings) in relation to their changed discursive context but I as well showed that their practices (i.e., writing the reports, meetings), changed the context for nanotechnology politics and the construction of the policy issue of nanotechnology. In both cases, the core of the problem of nanotechnology was rearticulated within the governing discourse of the responsible development of nanotechnology into a problem of "applying lessons learnt," particularly by risk assessment and public engagement. 'Responsible development' classically is an ambiguous term which is well suited to fill the content of a hegemonic formation. Central for the stabilisation of the hegemonic project was, in addition, the demarcation to the outside – GMO became cast as the dismissed other. Contiguity was established between nanotechnology and biotechnology and to public responses to technology development in general. The fantasmatic appeal of the wow-yuck-narrative enrolled the state elites (i.e., the VDI TZ, the VCI, DECHEMA, and the Research Ministry in Germany; the RS and the RAEng, and the government in the UK). Grippled by the fear of 'the' public's fear, policy-makers produced the 'responsible development of nanotechnologies' as the only alternative. In and through discourse, the governance actors were gripped by nanophobia-phobia and they constructed the emerging conflict between nanotechnology and the public and the need to pre-empt it as a 'fact.' I showed in my analysis how this logic was underpinned by taking equivalences between nanotechnology and biotechnology as true. If these equivalences

would have been questioned, establishing a risk regime might not have been chosen as the necessary course of action.

This chapter also showed how the practices of nanotechnology governance from 2004 onwards were informed by a social logic of scientification compromising the demands for reason, factuality, and rationality, and practices of evidence-gathering. This social logic operated in different ways in my two case studies but it was in both cases installed by a political logic of pre-emption. In Germany, nanotechnology was disentangled from visionary discourses. It became relocated into a science discourse and equated as a technical policy issue similar to fine particulate. In the UK, I showed that the logic of scientification enfolded in a threefold manner in the analysed governance practices. First, critiques of nanotechnology, such as Prince Charles, and fear fantasies, such as grey goo, were discredited because they were considered as science fiction as opposed to science. Second, the anticipatory-precautionary talk strongly appealed to reason and dismissed the emotional GMO-debate. Third, nanotechnology was channeled as a technical matter into a regulatory debate marked by scientific risk assessment. Because of the foregrounding of risks, a deeper debate on the direction of research and desirable innovation was missing in public engagement (Doubleday 2007:220). It was a successful move to depoliticize and negate opposition. What was left after the RS/RAEng Report, instead of the potential bigger struggle of the direction of technological development and who should decide, was a debate about whether nanotechnology should be regulated, and if yes, how.

A parliamentarian of the House of Commons, who had been involved in pushing nanotechnology, expressed grievances about the hegemony of the responsible development in my interview:

When you mention nanotechnology in a meeting here, nobody wants to know. They don't feel it is important. People are scarcely interested in science in this place. They want to talk about science in the streets, and science in the tents ... they don't know about nanotechnology as such. They want to talk more about general scientific things that the public can understand.

(Interview material: Parliamentarian)

The quote is well suited as a concluding remark to this section, as it demonstrates the difference, how the nanotechnology rhetoric had changed from period I to period II. Up until this point, my dissertation showed how demands for pre-emption emerged. Now, I will turn to how the logic of pre-emption was reproduced in practices.

6 Institutionalisation of Nanotechnology Governance

Having in the previous chapter critically explained the emergence of the nanotechnology risk regime in Germany and the United Kingdom, this chapter analyzes how the logic of pre-emption gripped across policies and how it was put into practice. In other words, it examines what actions were taken once a risk regime of nanotechnology had gained hegemony, exploring specifically how this particular 'risk regime' or 'the responsible development of nanotechnology' was reproduced in practice. I will show that the logic of pre-emption gripped across various sites and contributed to the construction of new political spaces dealing with nanotechnologies. For example, it set in place governance practices ranging from scientification to the politics of network governance. In so doing, I will introduce the new nanotechnology governance institutions that were founded in Germany and the UK, such as the UK Nanotechnology Research Coordination Group (NRCG), stakeholder forums or the German 'Nano-Commission'. Approaching these new institutions as 'sedimented' discourses (Howarth 2000:120), I argue that the emergence of these complex institutional arrangements which constituted the nanotechnology regulatory regime were both expressed by and sustained by the empty signifier 'responsible development of nanotechnology.'

The chapter begins with an analysis of the case of Germany in which I first give an overview of the many different sites in which nanotechnology-politics blossomed. I focus in particular on three venues: the German Bundestag, public engagement settings, and governmental agencies. As such, I introduce the many various public engagement activities to exemplify the different governance levels in which nanotechnology politics became embedded. The logic of pre-emption constitutes the condition of possibility that lead to all these practices ranging from evidence-gathering over five percent ELSA-funding to public engagement. Against this background, and by means of contextualising public engagement within the German government's innovation policy, I critically evaluate the limits and function of a public dialogue which is driven by a logic of pre-emption. My argument is that the main aim of all these efforts, particularly of the NanoCommission which was established in 2006, is to avoid polarization.

Turning to the UK, I will subsequently show that, driven by a logic of pre-emption, a regime was set in place that was first and foremost characterised by a logic of evidence-gathering and the 'politics of network governance.' Two governance networks coordinated policy-

makers within government, research councils, and the sciences: the Nanotechnology Issues Dialogue Group (NIDG) and the Nanotechnology Research Coordination Group (NRCG). In order to examine, as in the case of Germany, the translation of the logic of pre-emption into practices of public engagement, I will introduce the central Nanotechnology Stakeholder Forum, offering an oversight over the range of public engagement settings that were otherwise put in place. Similarly, as in the case of Germany, I argue that these practices of engagement contribute to confining conflicts within pre-established frameworks; their aim is to reach consensus not to allow for opposing opinions.

Having set out the primary argument and focus of the chapter, I now analyse the diverse sites of nanotechnology politics in Germany.

6.1 Germany: Nanotechnology-Politics blossoming at different sites

In this section, I show how the logic of pre-emption led to nanotechnology-politics blossoming at different sites in Germany. An important event which marks how the logic of pre-emption caught on in Germany is the *NanoDialogue* which was organised by and held at the Environment Ministry in Bonn in October 2005. It had 162 attendees. If we consult the list of attendees of this huge nanotechnology governance event, the list tells something about the proliferation of nanotechnology politics sites until 2005. One quarter of the attendees (about 40) were from private and public risk assessment, safety or toxicological institutes. Apart from the toxicology-issue, the issue of occupational health was strongly represented by the presence of a trade unionist and a number of insurance representatives. Another big group was composed of industry. A few citizen organisations were present: the BUND, consumer protection, a healthcare organisation, and an attendee from the Evangelical Church. The bulk of participants at the NanoDialogue came from administration, state, and federal ministries.

In the following, I want to focus on three tendencies, which are – according to my interpretation – illustrated in the NanoDialogue's attendee list. The first one is that pre-emption led to the presence of nanotechnology as an environment, health and safety policy issue in government. I will do this by analysing a first parliamentary debate on nanotechnologies. Second, the dialogue event itself gathers many stakeholders and is part of

a bigger move towards pre-empting conflict by avoiding polarization. I will introduce the scope of public participation in nanotechnologies in Germany. Third, the prevalence of actors dealing with risk research and toxicology as well as the title of the event, "Dialogue on the Evaluation of synthetical nanoparticles in occupational and environmental areas," indicate that the risk regime of nanotechnology caught on. I will exemplify this by presenting the joint work on a risk research strategy on nanotechnologies developed by three federal government agencies.

6.1.1 The German parliamentary debate on nanotechnology

In this section, we will see how the logic of pre-emption gripped the governing parties. I explain that it led to the rule that five percent of public nanotechnology funding must go into ELSA-research. As introduced earlier, part of the reaction of the German government to a potential dislocation of the innovation discourse on nanotechnology was the TAB Report. The report was adopted unanimously by all factions, who consented to the idea of nanotechnology being something good and beneficial. Subsequent to the TAB Report, the four main parties represented in the German Bundestag made efforts to position themselves around the topic by bringing forward motions in the parliament. There were small and unsurprising differences between the governing (SPD, the Greens) and the oppositional parties (CDU/CSU, FDP). Nevertheless, similarities prevailed and the overarching demand was that nanotechnology should go on the market, and thus, the exploitation of research results into products should be enforced. This background (the sedimentation and reproduction of the discourse 'nanotechnology is good,' which we know from *period I*) is important because after deciding 'it is good and we do it,' nanotechnology is then difficult to oppose, and actors gripped by the fantastic visions do not really want to restrict the technology development. Thus, restrictive regulation was not really desired if nanotechnology was bound to economic growth and future well-being. Rather a bridge between the competing aims of expansion and regulation was needed.

The only substantial difference between the governing parties and the oppositional parties evolved around the question of whether nanotechnology research should be accompanied by research into the ethical, legal, societal aspects (ELSA) of nanotechnology. The SPD advanced the demands that five percent of the funding for nanotechnology should be devoted to ELSA research and that the existing regulations should be reviewed. When bringing this

demand forward, the Social Democrats employed an identity discourse presenting themselves as distinct from the CDU/CSU, the others whose worldview was defined as focusing on economics compared to the SPD's integration of societal issues. This can be exemplified by the following statement from the SPD member responsible for research matters, Ulla Burchardt, issued during a plenary debate:

A strategy which is only concerned with industry is not sufficient for supporting innovation. Concerning the motions of the opposition I have to say: You get stuck with your innovation funding half way, because you are blind on one eye. For us, citizens are not only economic beings and society is more than economy. We want to use the societal departure into the nanocosmos and the chances of the progress through nanotechnology in the interest of the people – for more quality of life, health, an intact environment and personal freedom. This is a fundamental difference to you.
(Burchardt, Ulla - 6. Mai 2004, see Deutscher Bundestag 15/108:9794)

A parliament member recalled in an interview:

A bone of contestation was the worries that we would put nanotechnology into a bad light if we put a focus on security, ELSA research and risk research. But I consider it more important to learn from the past that it is important to talk openly and transparently about risks from the beginning and to try to avoid them. Then, it will be easier for the technology.
(Interview material: Parliamentarian)

Finally, the Red-Green coalition could celebrate their success (and future bone of contention) in the implementation of their demand for five percent ELSA research funding. The persuasive argument of the SPD and the BÜNDNIS 90/the Greens was, again, that considering adverse consequences of nanotechnology would stabilise the development of the technology. Thus we see the articulation of a *logic of pre-emption*, which is well exemplified in the last quote.

Hence, we see that the responsible development of nanotechnology governance became part of the government programme, for example, in the form of 5% ELSA research. ELSA research again is often conducted by means of gathering citizen conferences, focus groups or by initiating stakeholder meetings. I will now turn to another site of the institutionalisation of nanotechnology politics by introducing the scope of public engagement in German nanotechnology governance.

6.1.2 *Public engagement in nanotechnologies*

As in the UK, the logic of pre-emption manifested in public engagement into nanotechnologies in Germany. From 2004 onwards, circa thirty different kinds of public engagement activities were conducted in Germany on different governance levels and with different target groups (for an illustration see NanoCommission final report p. 18f). For example, the Federal Institute of Risk Assessment (BfR), museums, and the big research consortia "NanoCare"¹⁷ organised independent engagement exercises of lay publics. Another set of public engagement exercises were stakeholder dialogues, independently organised by industry associations, such as the VCI and DECHEMA or the NGO BUND and the Evangelical Academy Iserlohn. I will say something more about the Evangelical Academy below. Another – well-known – policy measure addressing the lay publics was the Nanotruck, which started touring Germany in 2004. I will come back to the Nanotruck below. As concerns governance levels, the above-mentioned public engagement exercises varied in scope. NanoCare, for instance, held citizen dialogues in diverse German cities. VCI and DECHEMA's dialogues did not have a geographical restriction but a thematic one (nanoexperts and scientists). There was a homogenous member profile in the "forumnano," made up of small and medium-sized companies. In addition, German states organised dialogues. Thus, we see that the engagement landscape was variegated and consisted of various streams of activities, which would be collected by the NanoCommission on a federal level, as we will learn later on.

Public engagement was originally anchored in the policies of the SPD and the Green Party. Nevertheless, the succeeding coalition government with the Christian Democratic Union and the Social Democratic Party, led by Chancellor Angela Merkel, had to govern within the public regime of science governance as well. We can track the rhetorics of public engagement of nanotechnologies in their science policies. In 2006, the German government published its Hightech strategy, which covered specific strategies for different knowledge, science and technology areas, and integrated the efforts in these diverse areas into a coherent approach towards innovation politics. The 112-page strategy was accompanied by an additional six billion Euros investment in German science and technology development in the respective legislative period. The overarching aim of the strategy was the translation of

¹⁷ See <http://www.nanopartikel.info/cms> "NanoCare" was the main government-funded project on risk research, which started in 2006 and which was accompanied by a series of citizen dialogues.

research into products: 'to bridge science and economy' in the words of the document, the effect of a *logic of commoditisation* that had characterised science policy since the beginning of the 1990s. The document appealed to self-governance that every individual in education, research, government, administration, industry, civil society and media should feel responsible for innovation and for bringing Germany forward. It demanded enthusiasm for technology in a manner that sometimes almost came across like a threat:

Wherever science and development meets resistances in Germany, we want to eliminate these.
(High-tech strategy 2006:2)

I introduce the Hightech strategy here because a particular goal formulated for nanotechnology in the strategy was government's intentions to lead an intensive dialogue with the public about chances of nanotechnologies. As part of the Hightech strategy, the government adopted the "Nanoinitiative Action Plan 2010." In sum, the government's strategic plan for nanotechnology was mainly to fund the translation of nanoresearch into products, and dialogue processes were initiated as an accompanying measure. I presented this in detail because it shows how the pronouncing of public dialogue was embedded in the demand to guarantee the marketing of products.

Similar to adopting regulation for stabilisation, the function of such public dialogue is to guarantee the development of nanotechnologies. It is part of 'the responsible development of nanotechnologies' driven by a *logic of pre-emption*, and not, for example, by a *logic of democratisation*. Public dialogue in such a context is a policy instrument to delete "wherever science and development meets resistances in Germany" (see quote from the Hightech strategy above). As I have illustrated how public engagement was anchored in nanotechnology governance on a policy level, I will now show how this discourse was translated into actions and reproduced in practices in the German multilevel governance system. For this, I want to elaborate on two of the engagement scenarios: the Nanotruck and the Evangelical Academy Iserlohn.

6.1.2.1 Nanotruck: Demands for skills and for trust

In January 2004, the Federal Ministry for Education and Research started a promotion tour for nanotechnology with a truck that would tour Germany. This so-called Nanotruck¹⁸ would

¹⁸ See <http://www.nanotruck.de/>

inform about nanotechnology and help to bridge the gap between science and the public. The Nanotruck exemplifies how *demands for skills* and *demands for trust* were implemented into practice in nanotechnology governance. Both governments, the Red-Green government until 2005 and the Red-Black government from 2005 onwards, articulated such demands. On the one hand, the youth should be encouraged to pursue a career in nanotechnology research. To achieve this goal, the government provided education materials to the schools like brochures with an accompanying CD introducing the world of the Nanocosmos and they initiated the Nanotruck project. Also, funding schemes for research groups to employ young scientists were established as an instrument to foster the development of skills. On the other hand, the government demanded the generation of trust. I introduce a separation between *demands for skills* and *demands for trust* even if they are overlapping for the following reason. While the demand for skills includes the demand for skilled workers, the education of young people and the provision of qualified employees, the demand for trust addresses the more general public. Both demands are constituted by a *logic of pre-emption*: by means of dialogue with the public, society should be informed about nanotechnologies in order to prevent potential worries and to foster society's interest in the development of nanotechnologies (see for example German Parliament 2006 16/2322: 11). The VDI TZ, who had been a driver in constituting practices of pre-emption, was, in the year 2009, still in close contact with the Nanotruck:

Originally, the Nanotruck was planned to tour for one year, but due to its success it kept going up to now. Meanwhile, the Nanotruck also incorporated an area concerned with risks and nanotechnologies. We are working closely with those responsible for the Nanotruck; we are meeting now and then because they are the ones meeting the citizens and we are discussing issues that arise out of this engagement.

(Interview material: VDI TZ)

While efforts of government (Nanotruck & Co) and of the industry (forumnano, stakeholder dialogues by VCI, DECHEMA) seem to fit with generalised expectations about the governance of emerging technologies, the presence of the Evangelical Academy Iserlohn, an institution of the Protestant church Westphalia shortly mentioned above, might come as a surprise. Therefore, I want to introduce this rather rare actor here.

6.1.2.2 "Preaching nanotechnology"

An active proponent for the 'responsible development of nanotechnologies' is the Protestant Academy Iserlohn. Their general mission is to invite dialogue on critical topics of the time.

As part of these efforts, it has gathered interested people at five conferences on nanotechnologies since the year 2003. Nanotechnology was studied by the Protestant Academy within its working group on "sciences and theology" which has been running since 1971. The Academy continues its efforts, started by the Protestant church after the Second World War, to institutionalise discussions on sciences and theology. Nanotechnology was first considered by them at a meeting in the year 2003 on "Robotics, Artificial Intelligence and Nanotechnology"¹⁹ – an initiating event obviously gripped by the horror fantasies unsettling nanotechnology governance in the beginning of this century and part of the dislocatory moment interrupting the rise of nanotechnology as panacea to the problems of our world. They published a book in the aftermath of this meeting on robotics and nanotechnology, which was followed by another book on nanotechnologies published by the Academy in the year 2007 with the title "Sustainable development of nanotechnologies." A comparison of these two titles is a nice example that reflects the discursive shift from fantasies to the 'responsible development of nanotechnologies.'

The Protestant Academy became an active proponent of the 'responsible development of nanotechnologies' by issuing a manifesto in March 2005, which demanded the responsible development of nano-, bio and information technologies. The manifesto problematized the focus on funding nanotechnologies for economic growth and the striving for speedy applications of nanotechnology into products, against the background of a lack of concerns about risks. It suggested installing an innovation council who would form the basis for a debate among science, industry, and 'the' public about nanotechnology regulations. This council would prepare risk assessments and evaluation criteria for the responsible development of new technologies, for example, strategies on how to deal with uncertainties.

One year later the NanoCommission was institutionalised, which came close to the suggestions of the Protestant Academy. The chair of this commission, Wolf-Michael Catenhusen, is active in the Protestant church and organised, for example, a nanotechnology event within Church Days 2007. I will thematise his role as an organic intellectual further below. At this Church Day, which can be imagined like a huge trade fair, visitors were able to inform themselves about nanotechnologies. For this purpose, talks on nanotechnology and information about nanotechnology were prepared, for example, research centres on

¹⁹ See homepage of the Protestant Academy Iserlohn <http://www.kircheundgesellschaft.de/akademie/aknt-startseite.htm>

nanotechnology (the competence centres) had a stand about nanotechnologies. In a newsletter from the Nanomaterials Network, which is related to one of the competence centres, the administrative office of the network talked very positively about their participation at this stand. They mentioned the strong interests of the visitors in nanotechnologies and highlighted that even three priests informed themselves on nanotechnologies because they intended to talk about this emerging technology to their community. As manifested by the priests' intention to 'preach nano,' the Nanomaterials Network considered their participation in the church day as a public relations success for nanotechnology (see NanoMat 2007).

To summarize, this section on the institutionalisation of nanotechnology governance in Germany has so far introduced nanotechnology policy-making in the German Bundestag and diverse public engagement. I showed how nanotechnology governance practices at diverse sites were institutionalised by a *logic of pre-emption* and sustained an ambiguous notion of the 'responsible development of nanotechnology.' I have not yet examined how much the 'risk regime,' which is the demand for risk assessment as part of adopting nanotechnology regulations, provoked actions and will turn to this now.

6.1.3 Risk research strategy by governmental agencies

While nanotechnology blossomed as a policy issue on sites as unexpected as the Protestant Church, it was also increasingly tackled by the classical institutions of the German state. Generally, at least four ministries were responsible for various facets of nanotechnology politics in Germany: the "Federal Ministry for Education and Research," which deals with funding issues and innovation politics; the "Federal Ministry for Food, Agriculture and Consumer Protection," which tackles, for example, questions of health risks; the "Federal Ministry for the Environment, Nature Conservation and Nuclear Safety," which has authority over environmental issues; and the "Federal Ministry of Labour and Social Affairs," with responsibility for occupational issues. All ministries, apart from the Research Ministry, have subordinated governmental agencies: the "Federal Institute for Occupational Safety and Health" (**BfR**) belonging to the Consumer Protection Ministry, the "Federal Environment Agency" (**UbA**) of the Environment Ministry and the "Federal Institute for Occupational Safety and Health" (**BAuA**) (Labour Ministry).

In the pre-established political and administrative bodies of the state, articulating nanotechnology as a topic of occupational health was central to its emergence as legitimate policy field. It was the Federal Association of Chemical Engineers' (VCI) who first raised the topic of occupational health and nanotechnology. Part of their plan of action to tackle nanotechnologies was to initiate a series of stakeholder dialogues. The topic of the first event, which took place in September 2005, was occupational health: "Nanomaterials at the workplace." In the course of the event preparation, the VCI initiated cooperation with its potential counterpart, the BAuA (Federal Institute for Occupational Safety and Health) – a very concrete practice exemplifying attempts to pre-empt. From then on, the industry association and the governmental agency worked together on the question of nanomaterials in the workplace. They conducted a survey among companies, and they developed a joint guidance paper for handling and using nanomaterials at the workplace. Further activities the BAuA started, once nanomaterials had been inscribed as a topic of occupational health, were to develop measurement techniques and thresholds for nanoparticles. As part of these efforts, the idea to write up a risk research strategy for nanomaterials arose, and the BAuA contacted the two other governmental agencies to join in the development of such a strategy.

The three governmental agencies, UbA, BfR and BAuA, with BAuA taking the lead, became a – not always welcomed – driver of nanotechnology policy in Germany by demanding a coherent strategy as well as funding for risk research on the risks of nanoparticles. The main aim of developing such a strategy was to identify which risk assessment on nanotechnology was needed from the perspective of the agencies. The three civil servants who came together on a regular basis were Bruno Orthen of the BAuA, René Zimmer of the BfR and Marianne Rappolder of the UbA. The three agencies stressed the uncertainties about nanomaterials' behaviour and demanded to close these knowledge gaps. They articulated an urgent need to conduct risk research concerning measurement techniques of nanoparticles, exposure to nanomaterials, toxicology of nanomaterials at oral-intake, and to determine accumulation and persistency of nanomaterials in the environment.

Significantly for the regime of a responsible development of nanotechnologies, the governmental agencies did not adhere to the discourse that a risk regime was necessary for the stabilisation of nanotechnology. Their angle was solely on risks of nanomaterials and the competencies of their agencies: environment, consumer protection, and occupational health. The risk strategy can be read as an argument and demand that funding for risk research was

needed. Their actions are driven by a *logic of scientification*. But at the same time, the risk strategy challenged the demand to guarantee the development of nanotechnology by regulation. It opened up for the consideration that regulation might actually restrict the development of nanotechnology. In contrast to, for instance, the TAB Report which carefully embedded an evaluation of risks in a long narrative of the benefits of nanotechnology, the risk strategy of the government agencies disregarded these conventions of the nanotechnology discourse. Besides, nanotechnology is said to lack nanospecific regulation in the strategy (BAuA, BfR & Uba 2007:7) and thus, the agencies drew a chain of equivalences among different nanomaterials. By so doing the strategy participated in a political regulatory struggle circulating around the question of how new and outstanding nanomaterials are. (I will analyse the logics of this struggle in detail in the following chapter). This caused troubles. A social scientist studying nanotechnology in Germany remembered:

It was interesting to observe how three subordinated government agencies more or less explicitly demanded from the Research Ministry to fund certain aspects more. This led to a virulent conflict in German politics for a long time because those three ministries wanted money for risk research but the Research Ministry did not like to be told what to do with its money. It rejected the demand and asked them to do it themselves.
(Interview material: Social scientist)

To sum up, nanotechnology risk became a policy topic within occupational health. The BAuA joined forces with the Uba and the BfR to put pressure on the Research Ministry for risk research funding. But the Research Ministry rejected the demand. All three civil servants active in this push were moved to other areas after drafting the strategy, not least because they broke hierarchical rules (to which the interview quote refers). Scrambles for responsibility and leadership have a long history in German technology politics. The biotechnology debate in the 1980s and '90s was marked by a rivalry between the Federal Ministry of Research and the Federal Ministry of Environment (Gottweis 1998). In this context, policy-makers made efforts in nanotechnology governance from the beginning for good cooperation on the ministerial level. This indicates that the *demand to avoid polarisation*, driven by a *logic of pre-emption*, addressed not only the science society relations in general, but also the relations among nanotechnology governance actors.

6.1.4 Avoid polarization: Collecting streams of activity in Germany's NanoCommission

In this section, I will build up the argument that the establishment of Germany's NanoCommission can be interpreted as a move to avoid polarization and to integrate the governance landscape. As protests by lay publics and conflicts among political actors accompanied the governance of biotechnology, a pre-emption of disagreements was not only pursued in public engagement but also in governmental relations, for example, by the Research Ministry. When this ministry developed its first nanotechnology strategy around the year 2000, those responsible tried to – as they said – cautiously build up good relations from the start. As one respondent put it:

The Research Ministry wrote in the year 2000, or was it 2002, the first nanotechnology strategy. By then, we were actually already trying to build up the first cautious contacts towards the Environment Ministry but one has to say that the Environment Ministry showed relatively little interest in the topic at that time and we in the Research Ministry did not give rise to any polarisation of the debate within the government. There has not been any polarisation in nanotechnology from the beginning.
(Interview material: Respondent from the Ministry for Education and Research)

The quote hints at the slippery slope on which relations between the Research Ministry and the Environment Ministry were built and indeed, the story of the research strategy of the governmental agencies showed institutionalised opposition against the story which the Research Ministry employee drafted.

While the Research Ministry was a clear policy leader in nanotechnology governance in the first decade, the influence of the Environment Ministry raised during the institutionalisation of the 'responsible development of nanotechnology.' The Environment Ministry set out to make itself a name in the topic in October 2005, when it organised the *Nanodialogue*. The presentation of the event says something about the ministries want to present themselves in the nanotechnology debate. The structure of the narrative of the press releases of the IKU GmbH, the communication agency which organised the NanoDialogue, clearly shows that the Environment Ministry should be presented as the key actor in nanotechnology politics by initiating these events. For example, it was the Environment Ministry that was to hold the welcome speech at the NanoDialogue event, and the press release's headline was that the Environment Minister Sigmund Gabriel initiated a NanoDialogue.

Nevertheless, the Research Ministry and the Environment Ministry made efforts at developing good relations. For instance, Environment Ministry commissioned the

NanoCommission (the central, federal stakeholder dialogue which was institutionalised in the aftermath of the NanoDialogue) but they invited a former state secretary from the Research Ministry as the chair, which was an innovative appointment against the background of former rivalries between these ministries. The chair's name was Wolf-Michael Catenhusen, a member of the German Social Democratic Party and a former state secretary, and I mentioned him briefly in the section on the Evangelic Academy Iserlohn. He has been an important actor in German technology politics for more than two decades. Asked about how to make sense of Catenhusen's initiating nanotechnology discussions at a church day, a respondent said in an interview:

The Evangelic Academy Iserlohn organised many nanotechnology discussions. Wolf-Michael Catenhusen organised also a big nanotechnology event during an Evangelic church day. Such events might provide him a forum where he can develop ideas, try them and where he can – to a certain degree – learn and establish networks.

(Interview material: German ELSA researcher)

As a political actor, Wolf-Michael Catenhusen led the important 'Biotechnology Enquete Commission' in the German Bundestag' in the 1980s. And in the year 2009, he was not only chair of the NanoCommission, having been appointed in the year 2006, but he was also sitting on central ethic committees. Additionally, he was the one who initiated the first nanotechnology strategy of the Research Ministry in the year 2000 when he was a state secretary. I consider him an 'organic intellectual.' Like a gardener who plants seeds which will flower, an organic intellectual has the resources (for example by habitus and networks) to spread his ideas so that they can blossom and be carried on. Asked in my interview for his interpretation as to why he was asked to take over the chair of the NanoCommission, he answered:

This is maybe connected to members of the Ministry of Environment knowing my efforts in other technology politics discourses in Germany. Maybe they trusted that I have good foundations of trust with many stakeholders.

(Wolf-Michael Catenhusen)

From Catenhusen's perspective, his appointment as chair of the NanoCommission can be interpreted as an integrating step between the two ministries to avoid a polarisation as well as a sign to various stakeholders that the debate would be well-balanced – both of which, I argue, are attempts *to pre-empt conflict*. Wolf-Michael Catenhusen was not only an important politician with many contacts in parliament and government, he also knew industry representatives from other technology debates and he was, for example, one of the

few who accepted an invitation from the BUND (Friends of the Earth Germany) when they tried to set up an early workshop on nanotechnology. Since the overall policy narrative situated nanotechnology within the context of former technology debates, my interviewees imagined the two opposing ends of the magnet in nanotechnology governance to be NGOs on the one hand and industry on the other. The chair of the NanoKommission was implemented as a central point to prevent forces, which appeared to have the likelihood of pushing off of each other, of moving away from the centre (Äm 2011:125).

In 2006, the NanoCommission was introduced as the peak within a wide range of dialogue processes in Germany and as a central point where all these activities that had developed could be collected into a governance network defined by the government. I interpret the institutionalisation of the NanoCommission as an attempt to establish a governance network that centralized the fragmented landscape of nanotechnology governance. The NanoCommission is the institutionalised form of the previous two "NanoDialogues;" thus, in terms of analysis, the same can be said for the "NanoDialogues" as for the NanoCommission: it is driven by a *logic of pre-emption* (indicative, for example, in the focus on NGOs) and an attempt to collect diverse streams of activity on a federal level, a *politics of network-governance*.

The NanoCommission took up its work at the end of the year 2006. It was structured as a stakeholder dialogue where representatives of government (ministries, agencies), industry, science, trade unions and civil society organisations met regularly for an exchange on their positions and evaluations of nanotechnology. There were three working groups formed: working group 1, "Chances for the Environment and Health;" working group 2, "Risk and Security Research;" and working group 3, "Guideline for a Responsible Development of Nanotechnologies." Industry outnumbered in the commission itself, as well as in the three working groups, apart from working group number two, where there were mostly government representatives. There were three NGOs present: the BUND (Friends of the Earth Germany), the Federal Consumer Protection Agency (Verbraucherzentrale), and a citizen initiative on environmental protection (Bundesverband Bürgerinitiativen Umweltschutz).

So far, the chapter has shown that from the year 2003 onwards *the logic of pre-emption* led to nanotechnology popping up as a topic at sites as diverse as the Evangelical church,

government agencies or in working groups on chemical toxicology. Nanotechnology was linked to questions of occupational health and environmental pollution, and the establishment of risk governance was one important political practice employed in German nanotechnology politics apart from public engagement, indicating the sedimentation of the 'responsible development of nanotechnology.' In the year 2006 then, policy-makers collected different streams of activity in the NanoCommission, a government commission conceptualised as a federal stakeholder dialogue, which institutionalised two large dialogue events convened by the Federal Environment Ministry. While the NanoCommission was working on finding their way and their destiny, a significant event occurred in Germany that would shake up nanotechnology politics altogether: the "Magic Nano" case. But before getting into this, I will now turn to the institutionalisation of nanotechnology politics in the UK.

6.2 Institutionalisation of nanotechnology politics in the UK

In the following section, I will explore how the 'responsible development of nanotechnology' institutionalised after the RS/RAEng Report. I will identify two main social logics into which the logic of pre-emption was translated in the UK: a *logic (or politics) of network governance* and a *logic of evidence gathering*. Both social logics are gripped by the *political logic of pre-emption*. The *logic of evidence gathering* informs the practice of risk assessment which is constructed by government departments, such as Defra, as the necessary basis for regulation. As concerns the *politics of network governance*, an important implication of hegemony is that it dominates a field but it does not eliminate opposition (Gottweis 1998:264). Rather – to pre-empt a conflict – opposition is integrated. If we consider that the conditions under which governance takes place are characterised by a radical uncertainty encompassing disagreements about means of policies, and the goals of policies, to what the policy problem actually is, it follows that successful governance (successful in a sense that a new regime such as the 'responsible development of nanotechnology' can catch on) must bind at least some of these things together (Finlayson 2007:550). In this section, I argue that the UK government's attempt to integrate opposition into networks instead of excluding them, constituted an essential step of this 'binding together.' I will now turn to how these moves materialised.

6.2.1 *The UK nanotechnology politics of network governance*

In this section, I will show that the logic of pre-emption, which had to integrate opposition, led to the establishment of governance networks within government and across the interface of science, society, and politics, in the UK. After the publication of the RS/RAEng Report in July 2004, government had to respond to the study and its recommendations. But who was government, i.e. in whose area of accountability could nanotechnology be ascribed? The policy issues raised in the report concerned environmental, health and safety aspects, public engagement, and innovation policy. This broad spectrum concerned the Department of Environment, Food and Rural Affairs (Defra) coming from the environmental side; the Depart for Innovation, University and Skills (DIUS) addressing the academic and innovation side like the education of skilled workers or sponsorship over nanotechnologies in companies; the Department for Business, Enterprise and Regulatory Reform (BERR) with its responsibilities for businesses and for promoting UK business, having an interest in nanomarkets exploiting nanoresearch; and the Health Ministry with a human health angle and an interest in new medical technologies. Other big players were the seven research councils who were administrating the research funding for all academic disciplines in the UK. Finally, as nanotechnology was articulated into a risk regime, the Environment Agency, Food Standards Agency (FSA) and Health and Safety Executive (HSE) had stakes in the discussion. As "everybody was supposed to be involved and interested in it" and as – maybe more importantly – individual departments demanded a share in the responsibilities and workload related to nanotechnologies, they increasingly articulated a *demand for coordination*, as exemplified in the following quote by a civil servant from Defra:

So, everybody is involved and interested in it. And the way we have sort of divided the workload between us is that DIUS takes the lead on cross government communication and coordination, so, we have something called the NIDG, it's a dialogue group, so it's placed so that all the different ministries can come together, the various aspects on nanotechnologies and they lead on matching people involved. And for our part, we take the lead on the research in environment and human health and safety aspects, so we lead the NRCG, the research coordination group. So, there is a lot of coordination going on.

(Interview Material: Defra1)

This problematisation of nanotechnology as an issue of coordination resulted in setting up three coordination bodies: the Nanotechnology Research Coordination Group (NRCG) led by the Department of Food, Environment, and Rural Affairs; the Nanotechnology Issues Dialogue Group (NIDG); and the Nanotechnology Stakeholder Forum. Later, a ministerial group on nanotechnologies also convened. I will now first introduce networking within

government, which was mostly driven by a demand of coordination and of sharing responsibilities. Then, I will turn to the institutionalisation of public engagement as another strand in the politics of network government.

6.2.1.1 Government Networks

The aim of this chapter is to shed light on how the new regime, 'responsible development of nanotechnologies,' caught on; how the logic of pre-emption institutionalised and was reproduced in governance practices after 2004. So far, I said that agency had to be assigned and distributed among various governmental actors because nanotechnology invoked a whole range of departments, and a strong demand for coordination arose.

NIDG

Coordination was at the core of the role constructed for the Nanotechnology Issues Dialogue Group (NIDG). The extension of the nanofield, which I tracked in *period I*, turned out to be a challenge once nanotechnology had been shifted from an innovation project to a regime of responsible development. A member of the secretariat of the NIDG, which was located at DIUS, said:

Nanotechnology has the lead in complexity. This was why the NIDG was established.
(Interview material: NIDG, DIUS)

The first task of the NIDG, led by the Government Office for Science (Go Science), was to organize the government response to the Royal Society and Royal Academy of Engineering Report. The interviewee articulated the role of the group as "bringing actors together and kicking them a bit to make sure there is progress." The respondent defined progress as ensuring and enabling the responsible development of nanotechnologies. This was also expressed on DIUS's homepage:

The Nanotechnology Issues Dialogue Group (NIDG), chaired by Go-Science in the Department for Innovation, Universities and Skills (DIUS), is enabling the responsible development of nanotechnologies and co-ordinating the activities described in the Government's response on nanotechnologies across departments, agencies and Research Councils.
(DIUS homepage²⁰)

²⁰ Accessible in the national webarchive:

http://webarchive.nationalarchives.gov.uk/+/http://www.dius.gov.uk/office_for_science/science_in_government/key_issues/nanotechnologies/nidg

Therefore, the NIDG can be interpreted as one part of the institutionalisation of the "responsible development of nanotechnologies." In detail, the NIDG provided a dialogue-platform. The members of the NIDG came from all departments. There were 15-20 people convening every three months, from the year 2004 onwards. As documented in most of the minutes of NIDG meetings, available online, the meetings were "attended by representatives from across Government Departments, Regulatory Agencies and Research Councils."

In the first NIDG meetings, they drafted the government response to the RS/RAEng Report which was published in February 2005. As mentioned on earlier, the government largely embraced all the RS/RAEng recommendations and contributed to articulating nanotechnology into a regime of responsible development. For example, the structure of the narrative of the government's response shows how important the topic of 'science and society' is considered to be. The government's response does not start off with talking about 'economy, benefits or innovation,' but with a commitment "to make substantial and sustained progress towards building a society that is confident about the governance, regulation and use of science and technology" (3).

7. That is why we commissioned the RS/RAEng Report, to look at the possible ethical, social, health, safety and environmental questions that could be raised by nanotechnologies. Failure to address these issues adequately could delay or foreclose opportunities to realise the potential benefits of these new technologies, or mean that we miss chances to avoid or mitigate potential downsides.
(UK Government 2005a:3)

The quote hints at how the government – that is the Government Office of Science located at DIUS – was gripped by the fear fantasy that the wonderful benefits of nanotechnology might be hampered from realisation in the UK, if the ethical, legal, and social aspects of technology development were not considered. This way of thinking is governed by a *logic of pre-emption*, assuming that you must (and can) foresee what can happen in order to avoid it. A certain belief in 'agency' is implied, assuming that you can actually change the course of things. The fear that things go wrong, if government does not act, does not question the premise that the worst case scenario can actually be prevented by action. This – in a way – shows a legacy of the Public Understanding of Science (PUS), which believes that the publics will be positive, if they only know enough about nanotechnology because it forecloses the opportunity that people, once integrated in decision-making, might decide that they do not want to realise the potential benefits.

My analysis of the minutes of NIDG meetings allow for some insight into the messiness of nanotechnology policy-making. For example, at the NIDG's 5th meeting, which took place in June 2005, the Environment Agency demanded to know how to meet the RS/RAEng recommendation on restricting nanoparticles being washed out into waste streams. It follows from the discussion that the government had absolutely no knowledge about who was using nanoparticles in the industry in the UK. They decided to first find out who was dealing with nanoparticles, driven by a *logic of evidence gathering*. For this again, they first had to build up relations with industry. In the end, Defra adopted a "Voluntary Reporting Scheme on Manufactured Nanomaterials," which we will hear more about later. The example indicates the relative helplessness of government's initial nanotechnology policy-making. From the minutes of the first meetings, we can also see how the institutionalisation of nanotechnology governance took form and policy-makers had to negotiate different roles and functions. In the fourth meeting of the NIDG, which was the first meeting after the government's response publication in February 2005, it was said, for example:

Members discussed the new role for NIDG, as defined in paragraph 13 of the Government Response to the Royal Society/Royal Academy of Engineering (RS/RAEng) Report. The Chair also mentioned the role of the new Nanotechnology Research Co-ordination Group (NRCG) and that it would report to the NIDG, holding meetings a few weeks before each NIDG Meeting so that its outputs could be discussed at NIDG.

The meeting heard a report from the Chair of the NRCG on its first meeting on 11 February. This had focussed on the research programme, where a first report was due by autumn 2005. There would also be a landscaping study later in 2005 on the manufacture and import of nanomaterials in the UK.

Members heard about plans for public and stakeholder dialogue. Stakeholder meetings were planned to inform the research agenda setting process. A broader and longer-term programme of nanotechnology public dialogue activities was also under development.
(NIDG 2005)

In the excerpt, we see that the members of the NIDG learned there would be two main government activities going on in 2005: initiating public and stakeholder dialogues and a first risk research report would be drafted.

Indicative for the hyper-politication of nanotechnology and how the logic of pre-emption manifested is the ministerial meeting on nanotechnologies which the NDIG prepared from since late 2007. In December 2007, five UK ministers met for the first time on a special issue: nanotechnology. After that, the ministers from the Department of Environment, Food and Rural Affairs (Defra); the Department of Innovation, University and Skills (DIUS); the

Department of Health; the Department of Business, Enterprise and Regulatory Reform (BERR); and the minister of Health Services convened every three months in the so-called ministerial group on nanotechnologies. Science minister Lord Drayson led the group. The aim of the ministers was to gather a strategic overview of regulatory discussion concerned about the environmental, health, and safety effects of engineered nanomaterials. Only from then onwards did the NIDG seem to have a clear purpose: it could work towards drafting the 'Government statement on nanotechnologies.'

I will now continue with the topic 'networking within government,' by introducing the Nanotechnology Research Co-ordination Group (NRCG) mentioned in the quote, and thus, show how the risk regime was institutionalised. Then I will turn to networking between government and stakeholders, among stakeholders, and with the public.

NRCG

The then Science minister, Lord Sainsbury asked the Royal Society to carry out this study. They spend a lot of time, a lot of effort on it. They made sure, they would write to people and get a really good hand at what was going on.

Then they set out the challenges the government, they think, should be taken forward. We got a kind of broad work stream. So, what, for example, came out was the need for more information about the environment and human health risk of nanotechnologies. And coming from a ... we set up ... I mean it was quite clear that there was not enough information out there in the moment and nobody was gathering it. We were in a bit strange situation where because how nanomaterials were exposed and generated ... it is quite hard to ... how to distinguish them actually from naturally formed nanomaterials. So, there is an awful lot of work that is going on on characterisation and measurement of nanomaterials of different side.

(Interview material: Defra1)

This quote of an interviewee at Defra explains why Defra's contribution to the government's response to the RS/RAEng Report was to suggest a Nanotechnology Research Coordination Group (NRCG). The NRCG, institutionalised in the beginning of 2005 and lead by Defra, is the materialisation of the nanotechnology policy problem being articulated into a risk regime driven by a *logic of evidence gathering*.

Its [The NRCG's] specific mandate is to develop and oversee the implementation of a cross-Government research programme into the potential human health and environmental risks posed by free manufactured nanoparticles and Nanotubes.

(Government 2005b:10)

The idea in initiating the NCRG was to gather different institutions, actors, and agencies active in risk research in order to coordinate and plan risk research into nanotechnologies.

For this purpose, five taskforces were installed. As can be seen in the composition of these taskforces, risk assessment was the main focus in the institutionalisation of nanopolitics. The public regime of science governance is also reproduced in the NRCG:

One of the task forces has a particular interest in the socio economic dimension. Ethic is one of the areas they are looking at. Public engagement of nanotechnologies has been a big thing in the UK. ... going out speaking with the public.
(Interview material: Defra1)

Task force number five was concerned with social and economic dimensions of nanotechnology. This group gathered people from business relations, STS, and Defra for developing a programme on the social and ethical implications of nanotechnologies, including social research and public dialogue. NRCG's first output was to publish the government's first risk research report in October 2005.

We are slowly composing a picture of what the logic of pre-emption did in UK nanotechnology politics: bringing together people from various backgrounds in coordinated, regular meetings – a big 'we' was created in governance to deal with the perceived challenge of nanotechnology together. This integrating aspect of practices aiming at pre-emption becomes even more clear in the translation of the government's public engagement programme into practices, i.e., in the stakeholder forum, to which I turn to now.

6.2.1.2 Governance Networks

The nanotechnology stakeholder forum, also convened by Defra, has been the main participatory project funded by government, and, at the same time, the third institutionalised political space of nanotechnology governance in the UK. It represents a further implementation of the demand for dialogue and integration, which are central parts of the hegemonic political project, 'the responsible development of nanotechnologies.' It is an excellent example of how incorporation into political rule is supposed to take place across public and private, leaders and led, expert and layperson. The aim of such political rule is to overcome incommensurable interests by constructing a shared information basis and mutual understandings (Finlayson 2007:545). It is the politics of network governance, which is part of the New Labour's network governance in general (see Finlayson 2003). According to my interviewees, Defra's aim in setting up the stakeholder forum was to bring different interests

to the table. Initially, stakeholder forum participation was based on invitation. The organisers tried to have a balance of interests, in the sense that they deliberately brought green NGOs and industry stakeholders together, so that they would challenge each other within the given setting of a stakeholder forum.

Originally when the stakeholder meeting was set up ... again it came through interaction ... people were invited, we knew were already working in the field ... often if you might pick up a media report or a report from different groups you would contact them and invite them along to stay. Originally we had a fixed membership but we invited people all along to an open meeting. So, anyone could come along. But people wanted membership because we wanted a balance of interests around the table.

One of the things the stakeholders would be very very keen to have, to have them, the green NGOs and the consumer groups on the table, as well industry and academics. We wanted people that were a bit challenging.
(Interview material: Defra1)

We see in the quote how conflicts should be confined within the framework of the stakeholder forum and potentially settled before they erupt, in other words how conflicts should be *pre-empted*. Defra was keen to have consumer groups at the table as well as industry and academics. Later, the forum was opened to the public. However, the meetings were not openly announced, and information on the timetable and meeting places were only distributed through an email list by Defra.

The integrating notion of responsible development provided the broadest common ground to make the forum happen. This hints at the power of the discourse of 'responsible development' by it being an ambiguous notion. Nevertheless, collaboration was not easy at the beginning of the forum, and there was a constant danger that the scaffolding would fall apart. The outcome of a review of the stakeholder forum in 2007 was, for instance, that there was one group in the forum that would prefer to talk about innovation, products, and sales, whereas others thought that environmental and health issues were more important. Hence, it was actually suggested that the forum be split in two – which did not happen but the incident indicates how those, who had embraced nanotechnology in an innovation discourse, had grievances about the new hegemony of the risk regime. The official mandate of the government intended the stakeholder forum as a column within regulatory policy-making, and thus as a practice for reproducing the 'responsible development of nanotechnologies.' This excluded an innovation discourse, i.e. this stakeholder forum was definitely not about business contacts. The official mandate of the NSF reads as such:

- make certain that stakeholder/expert views feed into the early deliberations of NRCG when considering what research is needed to set in place appropriate regulation;
- bring greater transparency to the regulatory development process;
- inform government policy-making activities in the area of nanotechnologies more generally;
- begin the process of dialogue on nanotechnologies regulation between Government and key stakeholders/experts and between different stakeholders/experts;
- clarify and challenge different stakeholder/expert perspectives and concerns; and
- add value to the Government's longer-term plans for public engagement.
(Government 2005b:10)

In relation to the mandate, the direct output of these meetings might be modest. Binding decisions were not taken in this forum. One outcome, for example, was that reports that had not been known to all members before a meeting were circulated afterwards. But the most significant output that occurred might be the change in relations among the participants by means of inclusion. Members of the nanotechnology stakeholder forum described the atmosphere of the meetings as a private conversation across government departments, NGOs, self-governing agencies, and industry. Participants appreciated what they called an "interesting spirit of collaboration" in this forum. The possibility of meeting government departments directly on issues at stake seemed to be a crucial change in British politics. The meetings were generally composed of several presentations, for example, by academia on the latest risk research, followed by a discussion. The schedule was usually quite tight.

After having provided insight into the practices of the nanotechnology stakeholder forum, I will now explore further how policy-makers translated the 'responsible development' into actions by turning to the government's programme on public dialogue on nanotechnologies.

6.2.1.3 Public engagement as network politics

I believe the pitfalls and merits of public engagement in nanotechnologies have been sufficiently discussed elsewhere (Delgado et al. 2010, Doubleday 2007, Evers & D'Silva 2009, Macnaghten, Kearnes & Wynne 2005, Pidgeon & Rogers-Hayden 2007, Selin & Hudson 2010). Therefore, I will restrict this section to a short, descriptive introduction to the practices of the 'responsible development regime' in terms of public engagement in the UK and to some general reflections on my interview material that touches upon the issue.

In August 2005, the UK government published its "Outline programme for public engagement on nanotechnologies." First, two project funds on nanotechnology were granted in 2004: Nanodialogues and the Nanotechnologies Engagement Group (NEG).²¹ The third governmentally funded public engagement project, called "Small Talk", was also designed "to bring coherence to the wide range of activities around the UK that are focused on discussing nanotechnologies with the public and scientists" (Government 2005b:3). Furthermore, public engagement groups developed which were not directly funded by the government, such as the conversation card game "Democs," the "NanoJury UK," the "Global Dialogue on Nanotechnology and the Poor" and other activities. The most famous public engagement project is maybe the NanoJury UK, which was initiated by The Guardian, Greenpeace, the Interdisciplinary Research Collaboration (IRC) of the University of Cambridge, and the Research Centre of Policy, Ethics and Life Sciences (PEALS). It brought together 15 randomly chosen lay people from different backgrounds in order to provide a space for people's views on nanotechnologies to have an impact on policy. The ten meetings took place within five weeks in 2005 and started with an introduction to the subject by invited speakers including scientists, civil society representatives and government advisers. Based on this information, the jurors had the task to deliberate on the issues and to draw up policy recommendations (see Statement by the NanoJury UK Oversight Panel).

I cannot assess here how much these public engagement efforts represent a substantial change in governance. However, I want to point out some shortcomings of the upstream-engagement experiments perceived by actors in the field and in secondary analyses of the settings. The report on the "Presentation of the Provisional Recommendations of NanoJury UK" on September 21, 2005, for instance, stated:

The working groups on the next steps and implications for NanoJury fed back that there seems to be no specific place where the broad issues raised by NanoJury (e.g. transparency, directions of research spend, directions of technology deployment) could be addressed. This gap appeared to be caused by no agency or part of government considering it was their mandate or responsibility to take a lead in this area.

(NanoJury 2005)

The quote indicates a problem in translating the logic of pre-emption into practices: the practicalities of transforming the rhetorical commitment to 'science and society science issues' had not been properly thought through. Although public engagement was a significant

²¹ Both were funded within the government's 'Sciencewise public engagement programme' (<http://www.sciencewise-erc.org.uk/>).

aim of nanotechnology policy, the results were not integrated into decision-making processes. The manner in which the government used the recommendations that arose from these public engagement experiments, was, for instance, that they fit them in, in their official statement, wherever it seemed appropriate. For example, the government statement on nanotechnologies of 2008 stated under the heading "'Pull-through' of ideas and skills from the research community to industry" which was a sub-point in the section "How the UK government is looking to promote the opportunities of nanotechnologies:"

Comment – public dialogue revealed generally positive attitudes to nanotechnologies and a desire for Government to spend money on nanotechnologies provided that priority is given to funding research and developments that contribute to a wider social good such as new medical innovations and sustainable technologies. The Government should support nanotechnologies that bring jobs to the UK by investment in education, training and research.
(UK government 2008:14)

The quote shows how demands of participants from the public were adjusted into predefined policies by the government. The meagre uptake of public engagement into 'real' decision-making might be connected to the conception of public engagement of main policy actors in the field: it was about pre-empting conflicts not about changing nanotechnology development.

I argue that the boundaries of public engagement of nanotechnologies were set narrowly. For example, we saw in the mandate of the stakeholder forum earlier how it articulated the demand for public participation into the hegemonic discourse of 'responsible development' which focused on risk regulation. Government departments involved in public engagement – for instance, Defra – show a tendency to articulate public engagement and its output as 'educating the public.' The following quote of a civil servant in Defra is characterised by the 'old' regime of a Public Understanding of Science:

First public at large don't really know what nanotechnology means. ... would only smile and say, oh, that is very interesting. Each of these public engagement exercises needed to have an expert explaining what nanotechnologies are and what they could be used for and what the potential risks are.
(Interview material Defra1)

The quote also exemplifies how – in this kind of public engagement in nanotechnologies – the public is imagined as an entity that carefully weighs risk against benefits. This is associated with the general *appeal to reason* in nanotechnology governance. In the context of the cost-benefit-weighing consumer, nanotechnology is frequently sketched by my interviewees as technology of potential. Whereas consumers did not see the benefits of

genetic engineering, so the story goes, nanotechnology was tied up in a story of rescuing us from climate change and curing cancer. Thus, policy-makers and scientists established a chain of difference that attacked the general equivalence drawn between nanotechnology governance and the governance of genetic engineering. My interviewees frequently argued along that line of reasoning that the cost-benefit-weighting consumer saw the benefits of genetically modified organisms as coming only from the supplier side.

What this reasoning does is to shift responsibility, on the one hand, to the consumer, who is constructed as a rationally calculating individual and, on the other hand, to industry. As a consequence, government and the science community regain agency. If these were the things that went wrong with genetic engineering, the direction of developments can be steered differently with nanotechnologies. One element of responding to this demand for different governance is the government's public engagement effort. However, – as I showed in this section – public engagement is defined and used narrowly. Regarding its impact on decision-making, it should perhaps be called 'public engagement light.' In any case, it did not set the stage for the development of counter-logics challenging the hegemonic discourse of 'responsible development.' The efforts for public engagement (and the mere commitment to public engagement) integrate demands of development and growth; they are governed by a *logic of pre-emption* with the general aim of creating consensus.

6.3 Conclusion

In this chapter, I showed how the logic of pre-emption gripped across multiple sites and how a regulatory regime for nanotechnology was set in place that consisted of practices of evidence-gathering, networking, and public engagement. In the process, a whole range of intermediary actors dealing with nanotechnologies arose in the form of cross-departmental coordination groups, citizen groups, and stakeholder forums. There were of course similarities between the case studies. In both countries, the 'responsible development of nanotechnologies' was translated into a politics of network governance, i.e. in stakeholder forums and public engagement. Both cases also set out to develop risk research strategies indicating that the regime was characterised by a social logic of evidence-gathering.

As I said above, in the nanotechnology governance regime in both Germany and the UK, the political logic of pre-emption manifested itself primarily in the formation of the politics of

network-governance. Networking contributed to pre-empting conflicts because potential opposition became absorbed in the hegemonic project of 'the responsible development;' it created equivalences among the members of the networks who can build up strong and mutually confining relations of trust. Inherent in the grip of pre-emption is also that practices, particularly initiating public engagement, are naturalized. As I explained in the previous chapter, the conceptualisation of public engagement was based on demarcating nanotechnology governance from biotechnology governance. In this chapter, I critically reflected on what this pre-emptive logic means for public engagement, arguing that pre-emptive public dialogue has not much in common with the deliberative democratic ideals in which these participatory practices are originally rooted. Indeed, in the nanotechnology networks that emerged in Germany and the UK, we saw that the logic of pre-emption privileged the construction of cooperation between actors, thereby legitimising practices that sought to forge linkages between potentially opposing demands, at the expense of allowing for the articulation of a conflicting plurality of demands and the recognition of difference. The term 'responsible development's function as an empty signifier is an important conceptual enabler for these political practices. I stressed this in the chapter as regards the UK Nanotechnology Stakeholder Forum: 'Responsible development' provided a common ground to bring what was imagined as pre-defined opposing interests at a table for cooperation. Such stakeholder forums (also the NanoCommission in Germany) shall provide frameworks to confine and pre-empt such conflicts before a polarization on nanotechnology-issues could emerge. In fact, the emerging governance practices in nanotechnology foregrounded the integrating dimension (to absorb opposition) as demonstrated by the embedded practices of public engagement and networking.

This foregrounding of integration is in part the result of the articulation of 'responsible development of nanotechnologies' as not being about risk minimisation but about pre-emption. The classical regulatory element (i.e., directives, laws or guidelines) in the implementation of this regime was thus only touched upon implicitly in this chapter. For example, I described the policy-makers' aim to gather evidence (in the risk research strategy of the governmental agencies in Germany and in the risk research report by the NRCG in the UK); evidence was seen as pre-condition for regulation in both cases. In the following chapter, I will address the question of how the discourse that regulation and risk governance would stabilise nanotechnology development sedimented; the connection between nanotechnology and risk wards off new challenges and maintains its hegemony again.

7 The Regulatory Debate

In the two previous chapters, I examined how a risk regime developed, the 'responsible development of nanotechnologies', and how this discourse sedimented in new nanotechnology governance institutions in the UK and Germany. What I termed the logic of pre-emption manifested itself in social practices of evidence-gathering, a politics of network governance, and moves towards scientification. For instance, policy-makers initiated public engagement exercises, drafted strategies for risk research, and established governance networks, for example the NanoCommission in Germany and in the UK the Nanotechnology Issue Dialogue Group (NIDG). However, I will show in the following that once policymakers moved towards putting in place particular regulatory practices in nanotechnology, the logic of pre-emption became further contested. Nascent tensions between rival actors were reactivated, competing demands as to what the discourse of responsible development actually meant in practice arose, and new spaces of resistance came into being. Such forms of contestation, as well as rival projects and alliances, and the potential dislocations that accompanied them, had to be managed or negated if the regime was to navigate successfully the vagaries of implementation.

This chapter thus shifts the focus of our attention to the difficulties experienced by policymakers in reproducing the emergent risk regime on nanotechnologies in Germany and the UK. I will advance two important arguments. Firstly, in the face of emergent risk governance on nanotechnologies, I argue that policy-makers, who constructed the regulatory object 'nanotechnology' in the first place, proceed to deconstruct it once again. When it comes to the concrete practices of regulation, nanotechnology thereby suddenly 'vanishes' because governmental and industry actors reject regulation "in the name of nano" by highlighting nanotechnology's ordinary and plural character. In explaining the practices underpinning the disappearance of nanotechnology, the very object of regulation, I draw particular attention to processes of differentiation in terms of naming, demarcation, and boundary drawing, examining the rhetorical shifts, metaphors and arguments articulated in British and German policy debates. In fact, much of this debate came to focus upon whether existing regulations were sufficient or whether new regulations for nanomaterials were needed, overtly politicising the questions surrounding whether nanotechnology was considered "new" or "not new", as well as the definition of what was classified as "nanotechnology."

Secondly, I argue that the logic of pre-emption masked over this contestation to the risk regime by negating demands for clear definitions and unambiguous regulations. I suggest that instead of interpreting soft laws as second order or default laws, soft laws actually show there has been a change in technology governance: The uncertainty of the object, nanotechnology, is mirrored in the flexible policy instruments adapted for nanotechnologies. Instead of governing through risk (evidence-based), pre-emption embraced governance through uncertainty, which *pre-empted* conflicts by opening up a space for persuasion, for integration, and for a constant shifting of the policy problem. Hence, the adoption of soft laws kept the uncertainty ongoing and the nanotechnology governance process open and flexible, informed by a social *logic of adaptation*. Being prepared for adapting to new situations allowed most importantly policymakers to integrate opposition. In terms of critically explaining the regulatory regime on nanotechnologies in Germany and the UK, nanotechnology governance can thus be interpreted as a political experiment, driven by a *logic of pre-emption*, which strives to keep the governance process open to allow for plurality and change.

In analysing these practices of nanotechnology governance in each of the cases of Germany and Britain, I follow a threefold process: first, I contextualise the regulatory discussion in each country; second, I show how regulators try to ward off regulation by fragmentising the nanotechnology field; third, I present how the logic of pre-emption overcomes this contestation by implementing a new, adaptive way of regulation. I begin with the German case.

7.1 Germany: Regulating against the background of innovation

For my following presentation of the German substantive regulatory discussion, it is important to bear in mind the conditions under which the risk regime on nanotechnologies developed, as explained in the chapters three, four and five. Nanotechnology was constructed as a field which would bring economic growth, national well-being, and improved life quality. Because of the extension of the signifying chain nanotechnology, nanotechnology became omnipresent and powerful, which facilitated the emergence of horror fantasies. State elites were gripped by the fear of public contestation, and thus initiated a risk regime, namely "the responsible development of nanotechnologies," in order

to protect the nanotechnology-project which they perceived as under threat. Therefore, as I pointed out before, the risk regime addressed nanotechnology being *under* threat *not* nanotechnology being a threat, and set out to pre-empt the threat. In the German context, as we recall, actors representing industry and technology consultants of the Research Ministry had rearticulated regulation as an essential element of stabilising nanotechnology. I showed that this discursive shift led to the implementation of public engagement, to the drafting of a risk research strategy, and to an abundance of actors dealing with nanotechnologies who were finally assembled on a national level in the NanoCommission. Nevertheless, I have not yet dealt with the policy, the content of these political practices. If regulation was essential, how was it enforced? How did politics set out to handle this elusive thing called nanotechnology?

How the background of innovation impacted on nanotechnology regulation can well be exemplified by the contribution to nanotechnology governance by the policy entrepreneur Uwe Lahl. Despite a prevalent uncertainty-discourse established around nanotechnology by the year 2005, the official initiator of the NanoDialogue event Uwe Lahl had clear ideas about the governance of nanotechnology-related risks. He was the director of the Department for Environment and Health of the Federal Ministry for Environment from the year 2001 to the year 2009. The former Green politician drew up a regulatory scheme for nanotechnologies based on concepts of openness, flexibility, and de-centralisation:

An ideal suggestion would be to develop the potentials for environmental politics and to support nanotechnology, while at the same time risk research is intensified and wherever necessary stopped; the entire thing as flexible and dynamic as possible.
(Lahl 2006: 50)

Uwe Lahl suggested that a code of good practice could replace legal regulation. Such a code should give the biggest possible space for action to industry in order to enable innovation, while at the same time securing safety for workers, consumers, and the environment. In his here-analysed paper for the journal 'Political Ecology', he develops a system for a 'code of good practices' that circulates around categories such as "no-go areas" and "innovation spaces." Code of good practices should define how to avoid "no-go areas." For example, if toxicologists define "breathing in free nanoparticles" as the biggest health risk, industry should determine in their code of good practice how to set measures to minimise the exposure to free nanoparticles. In contrast to "no-go-areas," an "innovation space" is composed of applications of nanomaterials that are thought to be safe. For instance, if

nanoparticles are bound in solid materials which prevent them from floating in the air and getting into the bodies. In such areas ("innovation spaces"), the state should abstain from regulating and concentrate on the monitoring and the closing of knowledge gaps. What counts as an "innovation space" or "no-go-area" should be defined in a dialogue among economy, administration, legislation, and environment and consumer organisations. Lahl's ideas are based on self-regulation and on an institutionalised dialogue forum. He presents this regulatory regime as a win-win situation for all participants:

Advantages for the industry. Codes of good practice grant companies a scope of action and foresee ability for future activities and investments. In contrast to state regulation, CGP enable participation by self-responsibility. Attention is drawn to potential issues by regular dialogues with administration, environment and consumer organisations. Thus, companies benefit from such arrangements and as a return they deliver information and data.

Advantages for the environment and for consumers. Protection for environment and for consumers is guaranteed by obligatory agreements within the frame of self-responsibility. Environment and consumer organisations get up-to-date information about products and manufacturing processes. They can bring in their critique, worries and open questions into the dialogue. By so doing, they can influence the self-regulation of the economy.
(Lahl 2005: 51-52)

By the year 2009, nanotechnology regulations were marked by these ideas of an institutionalised dialogue forum and of code of conducts. We see how "to enable innovation" impacted on the regulatory regime. In this chapter, I set about to analyze how these ideas caught on in the regulatory debate. The last section on Germany in chapter 6 ended with the establishment of the NanoCommission, the function of which can be interpreted as collecting streams of activities, and with the commission's attempt to define its work programme. In the first year of the commission's work an incident occurred in Germany that would influence German nanotechnology politics, particularly the regulatory debate, and I will turn to it now.

7.2 Germany March 2006: How much magic or risk or nano?

This section tells the story of the "Magic nano"-case as an incidence in German nanotechnology-politics which challenged the logics of pre-emption. I will argue that the "Magic nano"-case had the potential to point to the limits of the responsible development regime because it made clear that despite the precautionary talk, products were on the market that might endanger human health. I will start with explaining the chronology of this incidence and what it was about.

At the end of March 2006, the Federal Institute of Risk Assessment (BfR) convened an expert group on nanotechnology for a two-day workshop at, organised by René Zimmer in the course of a Delphi study. This is a forecasting method which asks experts to evaluate the future development of, in this case, nanotechnology. The aim of this workshop was to update the BfR on research developments in nanotechnology concerning textiles, cosmetics, and food. On one of the days of the workshop, an employee of the BfR, who was working for another department in the BfR concerned with poisoning, came into the nanotechnology workshop and asked his colleague René Zimmer, whether he could make a public announcement. He told the audience about a series of poisoning cases that were reported to the Federal poisoning centre and which were caused by a sealing spray called "Magic Nano." Those affected by the sealing spray suffered from severe breathing problems. Some persons developed lung oedema and had to stay in hospital (see Giftinformationszentrum Nord 2006).

At this moment, the BfR – one of the governmental agencies we know from drafting the research strategy – became the institution where the first "real nano-incident" in Germany was debated. Subsequently, it played a role as main actor in nanotechnology questions for some time. In general, the BfR's mandate concerns "risks in relation to the end-user" which consists of evaluating risks and issuing recommendations on how to deal with products ranging from food or cosmetics to household requisites. In the context of the BSE crisis, it was suggested in German politics to, in the future, keep the evaluation, management and communication of risks separated, which then lead to institutional changes. From the BSE case onwards, the BfR was assigned the main responsibility of risk communication.

This institutionalisation of the BSE experiences shaped the way in which the BfR treated nanotechnology. In the year 2005, the BfR received the inquiry by the BAuA, mentioned earlier, to develop a research strategy together on the risks of nanoparticles. At the same time, the BfR recruited René Zimmer, a trained biologist and sociologist, who was specialised in citizen participation in environmental issues. He had developed public engagement settings at earlier workplaces such as the Fraunhofer Institute for Systems and Innovations Research (ISI - Institut für Systemforschung und Innovationsanalysen) and the Independent Institute for Environmental Concerns (UfU – Unabhängiges Institut für Umweltfragen). Looking at emerging issues of nanotechnology with BSE-glasses on, the BfR decided René Zimmer would be the right man for the job of dealing with

nanotechnology. In this institutional context, it seemed most logical that the BfR should foster communication on risk of nanotechnologies:

I had the task to initiate projects on communication and nanotechnology and I thought a Delphi study would be interesting: How see experts the future, where do they see risks? What are current developments, which products are on the market, how do experts evaluate these products on the market regarding their risks and regarding their acceptance by the citizens; and which regulatory measures might be needed?

(Interview material: BfR)

Thus the BfR approached the new topic nanotechnology in the year 2006 by organising a Delphi study and a consumer conference: At the same time, the BfR participated in drafting the joint research strategy with the BAuA and the UBA; and it was involved in various working groups and meetings with other organisations on chemical safety, food safety or environmental health safety – all in all, in diverse settings where nanotechnology slowly became an issue.

So, when the Magic Nano case occurred, the BfR was just about to get involved in dealing with nanotechnologies, as one of the institutions in which the logic of pre-emption had gripped. The announcement at the expert workshop did not cause an outcry among the participants of the workshop, but the participants discussed the topic rather soberly as a household cleaning agent causing troubles when used in closed rooms which by chance had a "nano" in the name. Only when the news became a hot issue in the United States, did the "Magic Nano" case get a lot of attention in Germany too. According to an interviewee, the information about the nanotechnology sealing spray that caused poisonings might have spilled over to the U.S. news via an entry in an online technology forum. Then, important media, such as the New York Times, took it up as a big issue. Furthermore, the NGO ETC Group threw themselves into the incident and used it to repeat their demand for a moratorium on nanomaterials via a press release titled "Nanotech Product Recall Underscores Need for Nanotech Moratorium: Is the Magic Gone?" A former employee of the BfR recalled:

Uhm ... we were discussing a household cleaning agent. Only when the debate spilled over to the U.S. and Canada and only when particularly the ETC Group got aware of it, the debate got this nanotouch. Framed as the first accident with a nanoproduct, the debate got back to Germany and the attention on the Federal Institute of Risk Assessment intensified.

(Interview material: BfR)

At the BfR, the "Magic Nano" case fell on fertile ground because the agency had just started to work on a research strategy and to engage in many other activities in diverse forums. It took its mandate of risk communication seriously and published a first press release on 31 March 2006. The article focused on the sealing spray and the propellant used in the spray. According to the press release, a nanosealing spray for ceramics and bathroom tiles was reported to cause breathing troubles. The same spray as a pump-spray version had been on the market for a long time without causing problems. As for the nanotechnology, the press release explained that the spray was equipped with nanoparticles repellent to water which made sealed surfaces waterproof and dirt-resistant (BfR Press release 31 March 2006). From the analysis provided above, the spray obviously should provide one of the main praised properties and functions of nanotechnology applications: self-cleaning surfaces. The ability of nanotechnology applications to deliver self-cleaning surfaces is one of the reasons why nanotechnology had such a positive image in surveys of public perceptions of nanotechnology. People want self-cleaning and waterproof clothes, paints, and surfaces. But this product was recalled from the market; the BfR and the manufacturer advised against the use of the product. Reason for the problem: yet unknown.

It was a moment of hyper-politicization that disrupted normal, bureaucratic politics. The BfR suddenly found itself as the key player in nanotechnology governance in Germany with worldwide attention. From then onwards, the phones did not stop ringing. The topic was taken away from those who had gained expertise during the groundwork, and higher-ranked people within the agencies took increasingly over. To talk about nanotechnology lent celebrity status. The main message of the press release was that because a propellant had been used to spray the product out of the can, the aerosol had become very fine, with a size of around 10 micrometer per gas drop. These small droplets can get deeply into the lungs and could have caused the breathing problems. How much nanoparticles were part of causing the health problem was still uncertain.

In May 2006, the story took another turn: "No nano in magic nano" (news article title by Nanotechbuzz). As a final BfR press release on the issue declared, nanoparticles did not only *not* cause the health problems, but indeed, analyses had concluded with the surprising result that there were no nanoparticles in the spray. A debate on betraying consumers by using nano-labels followed. The manufacturer Kleinmann insisted that the product was 'nano' because it produced a nanometer-thin sealing layer. And in the year 2009 the company itself

was still selling nanotechnology-based sealing sprays²². Kleinmann's insisting that there were nanoparticles in the spray did not change the closure of the public debate.

The first nanotechnology-related accident was simplified into history as not being nano, when in fact the incident was marked by a very high complexity. Toxicological studies by German inhalation institutes and by the Federal Environment Agency had discovered a manufacturing mistake when the concerned spray cans were filled. When the company changed from selling the spray as a pump-spray towards selling the spray as an aerosol using propellants, the pH value of the substance was changed. As a consequence, the liquid dissolved. Those substances that should cause the sealing affect flocculated and remained on the bottom of the container. Thus, the cans were filled with the propellant, nothing else. It is difficult for me as a layperson to report the scientific findings of the results given by an interviewee from an institute that was concerned with the analysis of the Magic Nano incident. These difficulties from my part, however, represent very well what the *logic of scientification* had done to the case: it was shifted into a highly scientific discussion and simplified for the lay public.

The "Magic Nano" case can be read as an episode of a potential dislocatory moment for the narrative of nanotechnology leading us towards a bright future, which was masked over by a *logic of scientification*. It was also a potential dislocatory moment for a political regime which had not yet enforced any regulations on nanotechnologies despite the increasing marketing of nanotechnology products under conditions of knowledge gaps concerning the nanomaterials' consequences for human health and the environment. The incident showed the limits of the 'responsible development regime' – it opened up for a risk agenda where it could no longer be said that governance came in as upstream-engagement (before the marketing of products). German policy-makers masked this disruptive moment by an appeal to science which shifted the accident away from the realm of nanotechnology. Actors, who were defined as experts, due for example to their toxicologist background, took the authority on being able to decide what was 'nano' and what was 'not nano.'

Defining what was nanotechnology, however, truly had dislocatory potential. In the aftermath of the "Magic Nano" case, labelling "nano" as a marketing tool was discussed.

²² For example, "Best Protect Nano" - a spray that shall protect the surfaces of cars and motorbikes from dirt (see <http://kleinmann.ist-online.ws/pages/de/produktlinien/best-protect.php>).

This had an impact on the risk regime which so far had claimed that nanotechnology was too elusive for getting a regulatory grip. The expansion of "nano" that had taken place until the year 2006 was brought into question and made the need to define what nanotechnology was urgent. Furthermore, the incident raised awareness of the nanotechnology products that were already on the market. For instance, the Federal Consumer Protection Organisation (Verbraucherzentrale), which was at that time also part of the NanoCommission, put this issue onto its agenda. A few months after the incident, Monika Büning, the individual responsible for nanotechnology at the Consumer Protection Organisation, said at a public speech at the European Nanofair in St. Gallen, Switzerland, in September 2007:

But does the consumer know that he buys nano? Yes and no. Why yes and no, you will ask yourself. It's very confusing, isn't it? But I think it is also confusing for the consumers. Because on the one hand, there are producers using the word nano on the label on the packages but there is no nano inside and on the other hand there are products containing nano-materials but the producers do not mention that. So, how can the consumer know what he is buying or not.
(Büning 2007)

The speech continued by problematizing this as an issue of trust between consumers and industry and argued for transparency and information. She concluded:

So, what are our demands? What are the demands of the German consumer organizations? First of all, we think that we need a clear definition of nanomaterials, I think this is the first thing we need because otherwise we can't say we want regulation when we don't know what is nano really about. Then we need to clear regulations for nanomaterials and nanoparticles.
(Büning 2007)

This quote shows well what "Magic Nano" meant for German nanotechnology governance: it threw into question whether you can define nanotechnology. But if you can define it, it is not elusive anymore and you can also regulate it. I will now go on to explore the politics of naming nanotechnology in a regulatory debate which circled around the question of whether nanotechnologies mean 'new substances' and thus 'new regulation,' or whether equivalences are drawn to common substances and products that are already covered by regulation. This part of my analysis will focus on the parliamentary debate on nanotechnologies.

7.3 Germany: Is there a nanotechnology to regulate?

The 'Magic nano'-case initiated a debate on what is sold under the label nanotechnology. Indeed, when I organised expert workshops on nanotechnologies, I had already realised that big companies were hesitating to use the word nanotechnology. Manufacturers preferred to use their old terms for the products. They feared that an entire business branch could be eradicated if they would first call a product series 'nano,' and if then a nanotechnology accident would appear.
(Interview material: German social scientist)

In what follows I will show that state elites, who had constructed nanotechnology in the first period of nanotechnology governance, deconstructed nanotechnology again in the face of regulation. I will examine the politics of naming nanotechnology which elucidates a significant aspect of the political in nanotechnology; an aspect usually ignored by traditional approaches to regulatory policy-making.

The Magic Nano case triggered an inquiry in the Parliament by the Green Party in June 2006. They articulated the critique that the government had not carried out the tasks or fulfilled the demands that were formulated in the 2004 motion "Departure into the nanocosmos:"

Considering that more and more applications of nanotechnology are approaching, there are many questions. Health risks caused by a glass and ceramics sealing spray were known to be available for sales and marketed as nanotechnology product. This shows how necessary ELSA research and risk assessment is as well as continuously informing the public. For supporting the marketing of nanotechnology products and for a sustainable securing of the success of nanotechnology, potential risks have to be recognised and removed early.
(Inquiry by the Green Party - 29. June 2006, see Deutscher Bundestag 16/2150: 1)

At this point, the processes of differentiation in a parliamentary regulatory debate in which 'nanotechnology' was fragmentized by a *logic of differences*²³ set off. While the Green Party raised concerns about nanomaterials in general, in the subsequent government responses, the government demanded a differentiation of nanomaterials. Furthermore, the government stressed that nanomaterials are in principle covered by existing regulations. What was at the core of the regulatory debate was the construction of a technology and the impossibility of a technology at the same time. For a long time the imperative was: There is nanotechnology, fund it! But suddenly, there was no nanotechnology to regulate. How did nanotechnology vanish? This paradoxon is analysed here by looking at the parliamentary debate in the year

²³ I analysed policy statements on this issue but would like to refer to Maria Powell (2007) who conducted an interesting study of scientists' nanotechnology risk frames.

2006 and 2007. In the following, I will dig deeper into these political logics and show in detail how these equivalences and differences were played out. I will first present the argumentation of the actors who questioned the existence of a nanospecific character and tried to interrupt such equivalences. Second, I present those who challenged this and who demanded regulation 'in the name of nano.'

Among those who brought forward a differentiated view on the conception of nanotechnology was the government. It demanded differentiation along the following lines: first, they stressed differences among nanoparticles (form, kind, environment, exposure); second, they blurred differences between natural nanoparticles and artificial nanoparticles and questioned any specific characteristic of nanomaterials. The latter is interesting because if nanotechnologies do not have any outstanding, particular character, the entire project of funding nanotechnology loses grounds.

As concerns the first line of reasoning (the differentiation of nanomaterials), the government adopted the position in the parliamentary regulatory discussion on nanotechnologies that nanotechnologies should be considered in plural. Thus, different nanotechnology research projects and applications were demarcated from each other in a *logic of differences*. In their answer to the Green motion, the government said that a consideration of nanotechnologies in laws could not seriously be made because the effects of nanoparticles change depending on form, size, exposure and application (Deutscher Bundestag 16/2322 2006:17). Therefore, the term nanomaterial should be differentiated. Furthermore, the government drew boundaries along a gradation of danger. If nanoparticles as a generative term would be dangerous, this would only be valid for free nanoparticles (as opposed to nanoparticles bound in solid matter) and only when exposure occurs in closed rooms (because the particles would fade away outside). Thus, a very small segment within the vast field of nanotechnology was singled out as risky.

After differentiating within kinds of nanomaterials, the second move of government, operating within a *logic of difference* interrupting the unity of the field 'nanotechnology,' was to undermine differences between natural nanoparticles and artificial nanoparticles. For example, the government said in their answer to another inquiry from the Left Party at the end of the year 2006:

Considering that there is no obligation in the food sector to label particle sizes of ingredients used during the manufacturing of the food product – also not for ingredients on the micrometer scale –, we would like to ask whether an additional nano-label would be a worthwhile and rational measure taken in the interest of the consumer. This needs further examination. We also have to regard that there are particles at the nanolevel prevalent in food products naturally, for example whey proteins in milk.
(Government response - Dec 2006, see Deutscher Bundestag 16/3981: 4)

In this quote, the government argues that a nano-label implied that all milk products in the supermarket would need labelling because they contain proteins which are on the nano-level. This 'argument of place' tries to rule labelling off the agenda by making the demand appear absurd. The boundaries between "synthetic nanoparticles," which are manufactured by the application of nanotechnology, and nanoparticles, in the sense of particles at the nanoscale occurring naturally, are blurred. Blurring these boundaries normalises nanotechnology and makes a connection to unexpected risks seem implausible.

A prominent and strong proponent of the view that nanotechnology was nothing new was also the Association of Chemical Engineers (VCI). According to their narrative, nanomaterials were chemical substances, just very fine-scaled substances, and thus, they were covered by many existing regulations for chemical substances such as the **Registration, Evaluation, Authorisation of Chemicals Directive of the European Union (REACH)** (implemented on June 1st, 2007), worker protection laws, food regulation or emission regulation. The VCI bridged the paradox of nanomaterials offering novel benefits on the one hand but not being something new in terms of risk assessment on the other by incorporating a historicity into the use of nanomaterials. This rhetorical shift can be exemplified by their guidance document on the "Responsible Production and Use of Nanomaterials" which states:

For over 100 years, scientists in the disciplines of chemistry, physics and biology have studied and worked with objects that have nanoscale dimensions.
(VCI 2008: 5)

This is an argument of quality that addresses the character of nanomaterials as substances and weaves this form of substance into at least one hundred years of history. "Temporalization is an important strategy in the construction of political spaces" (Gottweis 1998:254) and, I would like to add, in the deconstruction of political spaces (i.e. there is no nanotechnology to regulate). As part of this transformist strategy of temporalization, the VCI document creates a narrative of how chemical engineers and the chemical industry are highly experienced in treating potentially hazardous substances by frequently highlighting the

"decades of experience assessing materials" (VCI 2008: 6) or "decades of experiences in managing the risks of new technologies" (VCI 2008: 7).

Once this difference between naturally occurring and engineered nanoparticles was broken down, analogies could be drawn. An often established analogy was fine particulate; an analogy by which opponents to nanospecific regulations suggest that it was not possible to distinguish between 'naturally occurring nanoparticles' and 'engineered nanoparticles' in risk assessment, and that it thus was not possible to regulate nanotechnology. I was told the following example two times during my research in Germany: In the course of establishing risk assessment of nanoparticles at the workplace, measurements were taken at a chemical industry company. While the sensors did not indicate the occurrence of any substantial amount of nanoparticles during the first hours, the graphs suddenly showed a strong increase of nanoparticles during lunch time. The explanation was that a forklift truck had crossed the manufacturing hall and the diesel particulate emissions discharged by this vehicle caused the reaction on the measurement apparatus. The anecdote, which has a certain mythical character because one time it was mentioned that this happened during research done by the BAuA and the VCI while another account located the anecdote within research conducted by the NanoCare project, was told to me to point out how difficult it was to measure nanoparticles. Furthermore, it served to point out that nanoparticles were relatively safe, and that daily pollutant problems might be much more serious than nanoparticles.

Uncertain situations have no analogies (O'Malley 2004:13-19, Dose 2004). Introducing analogies means to suggest that nanotechnology could be perceived as if it were another substance, for example, 'diesel particulate'. Hence, the analogy normalizes nanoparticles and suggests that it thus requires the same problem solution as for diesel particulate. As mentioned earlier, policy measures taken to reduce the emissions of fine particulate are emission thresholds for industry, requirements for filters or reducing the speed limit for private cars. These are very 'down-to-earth' measures characterised by *a logic of scientification* compared to a moratorium on the entire technological field.

A reaction of the Green Party to the government's regulatory overview addressed the fundamental conflict about considering nanotechnology as new or not:

You [the government, the author] see no need for actions partly because your premises are wrong. According to you, nanomaterials are in principle covered by existing regulations such as the chemical

regulations of the European Union (Reach). This refers to the substances per se but the characters that only occur at the level of the nanoparticulate are after all not covered. Until now, toxicology was based on the principle that each substance is harmless until a certain threshold is reached. But today we know that it is not only the density that determines the behaviour of substances but as well the size, especially at the nano-level. Because of these new characters of nanoparticles, existing knowledge about the behaviour of substances in the environment and in the human body can NOT be applied. Out of this, gaps in regulation are opened in respect to the environment, food, but as well regarding occupational issues and questions of data protection.
(Green Party 2007, see Deutscher Bundestag 16/4757)

In contrast to the above-mentioned positions which stressed that nanotechnology was nothing substantially different from well-known substances, the Green and the Left Party argued that nanomaterials were new, and that they therefore might show unknown behaviour. In November 2006, members of the German Parliament and the Left Party handed in another inquiry into the government's nanotechnology activities, solely focusing on risks of nanotechnologies. The inquiry referred to a press release from one of Germany's social insurance organisations, called the *SECURVITA Krankenkasse*. According to their press release, nanotechnology particles could develop very explosive dynamics and new attributes compared to "matter of the normal world." Building up on the assumption that nanomaterials are particular, the Left Party argued that nanoparticles were dangerous and toxic for human organisms.

Consequently, nanoparticles develop attributes that matter of the 'normal' world would not have. This might imply the danger that nanoparticles are toxic for the human organism, in fact even more aggressive than particles of diesel smoke or fine particulate.
(The Left Party – 2006, see Deutscher Bundestag, 16/3867: 1)

This quote shows how the Left Party was gripped by fear fantasies that located nanotechnology outside the "normal world." Additionally, the Left Party used two arguments of quality that are of particular interest for this study. First, they referred to the expected high market volume of nanotechnology to underline the urgency of their demands to prevent the marketing of risky products. By doing so, they used one of the strongest arguments from supporters of nanotechnology, which was efficiency and economic growth through nanotechnologies, for their purpose of underlining the demand for precaution. Second, they directly attacked the established analogy to fine particulate. In their inquiry, the Left Party requested to know whether SECURVITA's description of the danger of nanotechnology was accurate, how the government planned to act upon nanotechnology-related risks, and how the free choice of consumers could be guaranteed if there was no labelling of consumer products. Labelling and the integration of risk research within any governmentally funded nanotechnology research project were the concrete requests brought forward by the Left

Party's inquiry. The government answered on December 29, 2006. The answer largely repeated the government's answer to the first parliament inquiry half a year earlier in July 2006. As mentioned above, the government considered existing regulations as covering nanotechnologies. The demand for labelling was also rejected on the ground of existing rules, i.e. the product safety law (Geräte- und Produktsicherheitsgesetz – GPSG) required labelling only on safety aspects. Provisions for labelling to enable consumer choice were not intended.

These rules are principally directed at safety aspects. There is no provision for other labelling requirements only meant as categories of choice for consumers, e.g. concerning the use of certain technologies in the manufacturing process.

(German government – 2006, see Deutscher Bundestag, 16/3981: introduction)

While the government's answer picked up on the Left Party's argument of 'consumer choice,' it ignored that nanoparticles could as well require safety labelling. This is another example of discordant interpretations of the new or mundane character of nanotechnology. The Left Party had stated:

It is certain that nanoparticles can cross biochemical barriers between the blood and the brain, they can get into the placenta and into our skin. Therefore, they hold other hazards than chemicals in a bigger particle form.

(The Left Party - 2006, see Deutscher Bundestag 16/7276:1)

In contrast, the government stated:

The crossing of the blood-brain barrier and the placenta barrier is often seen as a particularly critical character of nanoparticles. However, this substance behaviour is known from medication and therefore nothing new.

(Government - 2006, see Deutscher Bundestag 16/3981:2)

This line of reasoning implies that it is common for substances to cross the blood-brain barrier. The government's response can be read as an attempt to normalise one of the strongest fear fantasies about nanotechnology, that small, invisible particles can invade our body and get into our brain.

From the illustration of the debate between the government and opposition parties, it follows that the answer to whether we need new regulation on nanomaterials or whether existing regulations are sufficient, obviously depends on the perspective one has on the question of the novelty. In contrast to the government, the Green Party adopted the position that existing

regulations were insufficient. This grievance was expressed around 'naming' in the face of the Magic Nano case, which exemplified that unclear labelling rules led to products being labelled as nanotechnology for marketing purposes, even if there were no nanoparticles inside, while other products carried no labels, when indeed nanotechnology-related effects were part of the manufacturing or end-product. The Greens tried to underpin their demand by arguing that regulation would contribute to the stabilisation and social acceptance of nanotechnology. Nevertheless, the government adopted the position that existing regulations covered nanotechnology products and stressed the flexibility of existing regulations, like the German food and cosmetic regulation or the "Devices and products safety law," which prohibits the production of potential harmful products in general. In this respect, the government opinion reflects the VCI position. With regards to chemicals, the government referred to the applicability of REACH. By way of conclusion, the government found existing regulations to be sufficient.

In the current state of knowledge, the government does not see any need for changing existing laws and regulations because of developments in nanotechnology. The existing system of laws and regulations on national and supranational level (e.g. REACH) offers flexible instruments for recognizing and reacting on potential risks of nanotechnological developments. Nanomaterials are in principal covered by these regulations.

(Government - 2006, see Deutscher Bundestag 16/3981:2)

The quote exemplifies that the German government did not intend to take action on regulation, and that its actions were restricted to participating in international efforts (OECD, EU, ISO). Disagreements as to whether there was a risk in nanotechnology or not were still prevalent in the year 2009, when the governing parties CDU/CSU and SPD brought forward a joint motion in April. According to an interviewee, discussions on how much the word risk might be used (SPD stance) or whether they should just talk about chances (CDU) were so strong that the process of negotiating the motion was suspended for almost a year. Finally, the SPD was successful with their demand that ten percent of the nanotechnology funding should go into ELSA research and risk research.

My analysis pointed out that the pre-emption risk regime was challenged when it came to fixing the content of regulation. Logics of differences (naming, boundary drawing) prevailed in the government's rhetoric and displaced contestations that nanotechnology was new and had new effects and thus demands new, specific regulations. By particularising nanotechnology into a diverse set of particle-forms, the demand for a unified nano-regulation was broken into many differential demands. The 'moving sand', which regulators had to

handle in nanotechnology, was not stopped from moving, but the contested meaning of nanotechnology became the focus of the debate. In the following and last section on Germany, I will show that the logic of pre-emption, however, managed to implement a compromise. It manifested itself in a new style of regulation: adaptive, flexible guidelines and codes of conduct instead of strict, definition-dependent classical regulation.

7.4 Governing uncertainty: Ordering reality but allowing for ambiguities

So far, I explained that the Magic Nano case initiated a discussion to fix the content of the regulatory aspect within the pre-emptive regime. However, a struggle emerged in which the ambiguous term allowed for constant rhetorical shifts in the regulatory debate. In the following section, I will show that the logic of pre-emption bridged the dichotomy between 'no regulation' and 'clear regulation.' I will argue, based on my analysis below, that codes of conduct and recommendations, such as the ones developed by the NanoCommission, are driven by a *social logic of adaptation*.

Previously, I argued that the establishment of the NanoCommission can be interpreted as an attempt to form a space between nanotechnology and society in which the relationship between nanotechnology and society could be discussed. The political *logic of pre-emption* expressed in the hegemonic regime of the 'responsible development of nanotechnologies' led to the institutionalisation of a set of new social logics and, thus, to a new mode of governance inclusive new constellations of actors. Maybe earlier, policy-making was mainly "an attempt to establish a situation of fixation" (Gottweis 1998:264), but below I will argue that the nanotechnology regulatory regime, which is marked by codes of conduct, stakeholder forums, reports, conferences, and so forth, rather tries to invent a situation of monitored openness and flexibility. Nanotechnology might as well point to a dislocation of how regulatory policy-making is done, because the consequences of human intervention at the nanoscale might as well be unimaginable, unthinkable, or never be able to be predicted (Nordmann 2011). Let me exemplify how this challenged was dealt with in the work of the NanoCommission.

As introduced in section 6.1.4, the NanoCommission took up its work in 2006, and it formed the three working groups "Chances for environment and health," "Risk and security research," and "Guideline for a responsible development of nanotechnologies." The titles of

the working groups illustrate which work programme the NanoCommission considered important: name the chances, gather information on risk, and reflect on whether and how we can govern despite uncertainty (which measure could be taken when lacking evidence). The definition of this work programme, which indicates what the Commission constituted as the policy problem, was in itself one of the most substantial outcomes of the NanoCommission. Members of the NanoCommission remember:

In a very long process, we defined what the working programme of the NanoCommission actually was. Uhm ... the Environment Ministry did not approach us with a detailed to-do list but they only said stakeholder dialogue, key word 'responsible development of nanotechnology' with a focus on the self-responsibility of stakeholders themselves. Out of this, the NanoCommission was created. And it took us more than half a year to compound with each other.
(Interview material: Member of the NanoCommission)

Ok ... in the beginning ... well, it took us about a year until we actually achieved to have a dialogue. It was more about getting to know each other and assessing the others. Everybody wanted to participate but there was no real goal and we did little concrete work.
Later the chair tried to govern the process more output-oriented. We had to speed up. Otherwise the government wouldn't have anything to show off. That wouldn't be appreciated, so we had to publish something. Suddenly there was a pressure to do something.
(Interview material: Member of the NanoCommission)

The quotes give a good impression of how the NanoCommission worked, how unclear its mandate was, and how the actors tried to find their way in an unusual setting. Much of the subsequent work was carried out within the three working groups. Each of the working groups drafted their own interim and final reports, and these three drafts were integrated into a final, general draft titled "The responsible use of nanotechnologies" in 2008.

Analysing the final report of the NanoCommission comes most closely to answering the question of this thesis on how governance takes place in situations of uncertainty. As the central national dialogue committee, the NanoCommission took over the task of evaluating risks and benefits of an emerging technology in a situation of insufficient knowledge. Part of the reaction to this situation was to try to create order. Based on an analysis of existing studies on nanomaterials, the working group on risk and security aspects developed three categories for nanomaterials: a) potential danger, b) probable danger, and c) unlikely danger. The highest risk potential was ascribed to breathing nanomaterials in. In contrast, nanomaterials bound in a matrix (such as in surface coatings) were considered to be less likely dangerous. The NanoCommission's attempt of categorization reflects the demands for differentiations presented earlier. Furthermore, it can be read as an endeavour to order reality and thus, to make an uncertain situation governable by introducing markers as to where

governing should start (at the high risk category). At the same time, the final report of the NanoCommission showed a certain inconsistency with this categorisation when it argued, only one paragraph after introducing these three broad risk categories, that too little was known about risks of nanomaterials for a categorisation, and that thus a case-by-case assessment was needed.

Indeed, acknowledging uncertainty (in contrast to neglecting it, like in the BSE crisis) might indicate the new and dominant strategy of governing uncertainty, which we can identify in nanotechnology governance: to allow for ambiguity and conflicting views. Apart from inconsistencies like the contradiction between the demand to form risk categories and the demand for case-by-case assessment, the report discussed how it was impossible to give a general answer on the risk question concerning nanomaterials due to their diversity and various application contexts. The report said:

Considered from a scientific angle, general statements on nanotechnology cannot yet be seriously taken. But such simple answers are looked for by the public debate. Maybe the challenge is to deal with the inevitable complexity, to communicate this complexity and to make these steps of evaluating chances and risks transparent.
(NanoCommission 2008)

The vagueness of the report represents a positioning into a field of ambiguity, uncertainty and complexity that does not aim to overcome these fallacies for regulation. Overall, the final report rather reads like a discussion paper than like the closure of a debate. Working group number three on the "responsible development of nanomaterials" even included a paragraph with the subheading "aspects where we could not reach consensus:" the obligatory registration of nanomaterials in a register accessible to the general public, an abandonment of critical nanomaterials, and the extension of the nanotechnology up to 300nm depending on whether they had nanospecific effects.

The open style of the document is part of the aim to avoid polarisation, and the allowance for opposing views can be tracked back to the social practices of writing the report.

For us, the first draft of the NanoCommission report was unacceptable. [...] We had a different perspective on many things, and ... yes, we went through the entire thing in detail. That means we added comments with the track-function of the Word-programme and we wrote entire sentences new. So we changed the entire text and added many comments. Of course, not all of these changes were adopted but the consequence was that the final draft looked substantially different from the first draft.
(Interview material: Member of the NanoCommission)

Grievances expressed in the report indicate that the working groups did not take the uncertainties they faced easily. Particularly, the report of working group number two on risk and safety aspects hinted at how they desperately seemed to want to get a handle on the moving sand they faced in the nanotechnology field. An interviewee said:

In the moment, it is like this that nobody actually really knows what there is to regulate at all. So ... what ... what do we actually talk about? Of course, you know about different applications, but nobody has an overview what there exists on the market, and which risks may occur, which expositions, for example. There are ... it is also a big problem for government agencies that they almost cannot evaluate nanotechnology. So from this arises the hope that a public register would give an overview. What is on the market and what are we actually talking about, which things are there actually that we maybe have to regulate.

(Interview material: Member of the NanoCommission)

Despite this radical uncertainty, the risk and safety working group came up with its suggestion of a three-fold categorization of nanomaterials. The overall guidelines brought forward by the Commission in the end were: to identify and make transparent who bears which responsibility in management (good governance); transparency regarding nanotechnology-based information; the willingness for dialogue with interest groups; the institutionalisation of risk management and the taking of responsibility in the life cycle of the product. Even in the highest risk category, the report did not demand to eliminate the possibility of humans being exposed to these materials, but demanded only to minimise exposure. Thus, the demands expressed were very moderate. The providing of solutions to how a certain commitment to responsible development of nanotechnology can be achieved without obligatory regulation was postponed to the next phase of the NanoCommission.

The outcome and influence of the NanoCommission can be problematized in light of the following political matter: On November 10 2009, the European Parliament and the Council issued a recast regulation on cosmetic products. The new regulation talks about "specific characteristics of nanomaterials" and acknowledges knowledge gaps about the "risks associated with nanomaterials." As a consequence, it took the step of implementing requirements for cosmetic companies to inform the European Commission if they were about to launch a product containing nanomaterials. This information has to give details about size of particles, physical and chemical properties, exposure conditions, quantity of the nanomaterials included, and about the toxicological profile of the nanomaterials (EU Cosmetics Regulation 2009:50). Additionally, the new legislation demanded labelling: if an ingredient of the product has a nanoform, this has to be indicated on the ingredient list in

brackets (ibid: 62). The following definition of nanomaterials was decided on until a common international agreement could be reached (ibid: 9):

(k) 'nanomaterial' means an insoluble or biopersistent and intentionally manufactured material with one or more external dimensions, or an internal structure, on the scale from 1 to 100 nm.
(EU Cosmetics Regulation 2009: 25)

According to the regulation, a publicly available register of nanomaterials used in cosmetic products will be established, consisting of a catalogue of marketed products (ibid: 51).

Germany objected to the cosmetic regulation recast. In a statement on the proposal forwarded to the Council (see Council Statement 17 November 2009), Germany argued against nanospecific legislation based on the argument that current safety regulations, already in place, only allow for the marketing of safe products. This official statement of Germany's government reflected the position of industry (VCI) and was not informed by recommendations of the NanoCommission, despite all the efforts of a balanced stakeholder dialogue. In this statement to the Council, Germany also argued against nano-labelling, reasoning that such a labelling might come across like a warning to consumers. Besides, Germany requested to make the nanodefinition dependent on altered properties instead of size (nanoscale).

By way of conclusion, the outcome of the NanoCommission in terms of influence on the official political stance taken by Germany was low. The governance network had no decision-making power at all; with their toilsome detail work, they only developed recommendations. Decisions like the final report of the first NanoCommission have no legal status. Furthermore, if we consider Innes and Boher's (2003) general critical evaluation of participatory governance, the NanoCommission representatives from industry, ministries or governmental agencies might not even manage to persuade their own institutions to implement the guidelines that were agreed upon within the NanoCommission. However, I argue that the output of such stakeholder dialogues might not be the recommendations like Code of Conducts that are issued. The most important output might be that in the dialogue process borders of what is sayable about nanotechnology are enacted. I develop this argument in detail in another paper, (Åm 2011) in which I argue that personal relations of trust are built in governance networks such as the NanoCommission. That again shows that

practices in a 'responsible development' regime are more about pre-emption than about risk governance.

7.5 UK – From a demand for evidence to a logic of adaptation

In this section, I will explore which actions the new risk regime on nanotechnology provoked in the UK and particularly how the UK government met the requests formulated in the RS/RAEng Report. As introduced in Chapter Five, risk governance became an important column of the 'responsible development of nanotechnologies' in UK nanotechnology governance. From the RS/RAEng Report onwards, regulation went from being a threat to innovation to a strategy of securing the development of the emerging technology. Now, the question is how these commitments were translated into action. We do already know that a set of groups were formed (NIDG, NRCG, stakeholder forum) within a politics of network governance. I will now turn to exploring the substantive discussions within these groups.

In analysing the UK regulatory debate, I will show that nanotechnologies lead to a dislocation of practices of evidence gathering. In the context of evidence-based policy-making, this could have led to a stalemate. In this situation, codes of conduct are – apart from self-regulation to pre-empt regulation – expressions of the demand to act despite uncertainty. Thus, regulatory action was no longer postponed until sufficient was known, but regulation was initiated, even if it was 'lighttouch.' Finally, the demand for 'light-touch' regulatory regime that was, in the UK for instance, expressed in the Taylor Report of the year 2002, was met:

Clinical proving is vital. A new application needs rigorous testing for effectiveness if it is to be taken up on a large scale. The critical issue here is the interface between the developers of applications and regulators, so that regulatory acceptance of new delivery systems can be achieved with **'light-touch' and speedy regulatory regimes**.

(Taylor Report 2002: 53, subheading: "Drivers of change", my emphasis)

The narrative of the following chapter is that *the political logic of pre-emption* weakened a regime of evidence-based policy-making. As also argued elsewhere (Barben, Fisher, Selin & Guston 2007, Kearnes & Rip 2009), the new regulatory regime is expressed in the new governing discourse of *adaptive* management. On the following pages, I critically explain how this adaptive governance could catch on. For this, I will first contextualise the

developments in nanotechnology governance within the regime of evidence-based regulation and within the demand to decrease the regulatory burden now.

A first important contextualisation of the nanotechnology regulatory discussion is that any regulatory debate was first and foremost marked by a strong demand for an evidence base for policy-making in the Labour government's modernisation agenda (Parsons 2002). In other words, regulatory policy-making based in a wish to know, and knowledge was seen as a prerequisite for acting. Indeed, already one of the first regulatory discussions on nanotechnology well exemplifies how the politics of the nanotechnology regulatory discussion was gripped by a social *logic of evidence gathering*. Regulators stressed knowledge gaps in their presentations and in the subsequent discussions, and they made it very clear that nobody considered taking action as long as these gaps were not filled. The following quotes from the minutes of this meeting exemplify the hegemonic demand for evidence:

It was thought that the current levels of **evidence and knowledge** surrounding nanoparticles' toxicity **were insufficient to base regulations on**, and that more work was required.
(RS reg. meeting 11 Feb 2004:2, presentation by Mike Depledge Environment Agency, my emphasis)

The opinion was then expressed that **all good regulation is based on evidence** that a wide range of people can accept, but it was thought that evidence on the ecotoxicity of nanoparticles is currently non-existent.
(RS reg. meeting 11 Feb 2004:2, my emphasis)

One attendee stated that regulators make a judgement of the balance between risks and benefits before determining the need to regulate, but **that action cannot be taken in the absence of evidence**.
(RS reg. meeting 11 Feb 2004:3, my emphasis)

If nanoparticles cannot be measured in an agreed way, regulation cannot be enforced.
(RS reg. meeting 11 Feb 2004:7)

The Chair then asked what regulators would like to see in the final report of the study, and what may create hindrances to the regulation of nanotechnology. One attendee said that he would like to see **gaps in scientific knowledge identified that may prevent regulation from being formed**.
(RS reg. meeting 11 Feb 2004:8, my emphasis)

We see how the practices of UK regulators were governed by a *logic of evidence gathering*; by which I apprehend that regulators perceived their only alternative to be postponing regulation until sufficient evidence was available. What was true for the regulator's workshop in 2004, was still valid during my interviews in 2009, which indicates the stalemate which can follow from such an evidence-logic:

There are certain things that have to be put in place before you ... you know, you have to understand the characterisation and metrology, the definitions have to be in place before you can start a lot of the

other work.
(Interview material: Defra2)

While regulators were sticking to the evidence requirement, it was already indicated at this regulators' workshop that nanotechnologies' complexities might disclose the limits of these evidence-based practices and thus endanger the current risk-regime with dislocation. For example, regulators would base their regulatory activities on measurement of particles on a mass basis but the special properties of nanoparticles would not be considered in such a measurement based on mass. In addition, it was unknown how much the size of a particle says about its toxicology. Thus, the regulatory debate on nanotechnologies touches upon a far-reaching issue: the special properties of nanoparticles might undermine and thus dislocate social logics of the current regulatory regime.

Another attendee felt strongly that a move away from mass to particle number could result in the exclusion of some chemicals or **skew the whole regulatory picture**.
(RS/RAEng's regulators' meeting 2004:2, my emphasis)

In sum, nanotechnology brought the contingency of risk regulation to the fore. To be precise, nanotechnology indicated that customary practices of evidence-based regulation may not work.

A second important contextualisation of nanotechnology regulatory discussions is that, in the British context, the tendency towards soft laws has to be set against the increasing narrative that the UK was the most tightly regulated, risk averse country apart from the USA. Grievances were expressed that Britain as a nation was marked by a collective anxiety about terrorism, global warming, or child safety that amassed a general fear of challenge, which again could endanger the nation's entrepreneurial spirit and stifle competitiveness and innovation, in part because of the paralysing of industry and business by bureaucratic paperwork (Rogers - ESRC 2007:1). As a consequence, the New Labour government attempted to reduce regulation ('the regulatory burden') in the UK. For instance, one of Gordon Brown's first actions in office was to move the Better Regulation Commission out of the Cabinet Office and into the Department for Business, Enterprise and Regulatory Reform, where the BRC's first task was to start reducing bureaucratic paperwork for businesses (ibid.). The BRC continued working along these premises and published, for instance, a report "Whose Risk is it Anyway" in autumn 2006, which announced a target for government departments and agencies alone to cut 500 regulations (ibid: 29). In this context,

even conferences were held to educate the public that there was no such thing as zero risk, for instance, the conference "The End of Zero Risk Regulation: Risk Toleration in Regulatory Practice" held at the University of Cambridge in September 2007. One of the keynote speakers was Dame Deirdre Hutton, chair of the UK Food Standards Agency, who also participated in the RS/RAEng Report on nanotechnology.

Thus, nanotechnology was also articulated into an emerging discourse of accepting certain risks. A scientist for the London Centre for Nanotechnology, whom I interviewed, argued, for instance, that there were always doubts in new scientific developments in the last centuries and things that could not be known with the current knowledge. Also the Nanotechnology Industry Association and the government suggest certain risk toleration in nanotechnology development in their reports:

It is not possible to fully ascertain that a material is totally safe, and most risk assessment will evaluate relative levels of hazard and risk. Even materials that are essential to living organisms (i.e. those that oxygen, water, etc.) are also lethal in excessive doses, but these risks are mitigated against.
(Nanotechnology Industry Association, 2007: 4)

4.6 It is worth noting that it is never possible to be completely certain that a product is safe. Risk assessments, even for products which have been on the market for many years, rely on the best available existing knowledge. But there is always the possibility of further information coming to light which challenges the prevailing view. No progress would ever be made were we to avoid using or consuming products until every possible eventuality had been explored.
(Government statement 2008: 18)

From this context, we see that there existed counter-logics challenging the hegemony of the pre-emptive regime: accounts who pledged for pre-empting public contestation by eradicating their fears; that is, to change the public instead of nanotechnology governance. It is important to be aware that 'the responsible development' is only one possible response to the perceived threat to nanotechnology development; increasing risk-allowance would have been another one. When we now come to the sedimentation of the responsible regime, we see how its hegemony is indeed contested. How this contestation is played out, is the topic of the next section in which I turn to the issue of naming nanomaterials, which exemplifies the ambiguities and complexities of regulatory policy-making on nanotechnologies.

7.6 Political logics: Rhetorical shifts and strategic naming in the UK-regulatory debate

On 11 February 2004, Dr. Colin Church from Defra held a presentation for the RS/RAEng regulatory working group. He gave an introduction into current chemical regulations. For example, he explained that current chemical regulations divide chemicals into two categories: new and 'existing substances.' As decided by the European Union, chemicals declared before 1981 were 'existing substances,' and everything declared after was a 'new substance.' Once a material was registered, it was an 'existing substance.' 'Existing substances' had lower requirements for testing and assessment (Regulators' meeting 11 February 2004). This rule applies to the British "Notification of new substances regulations" (NONS) and "Existing substances regulations" (ERS) as well as to the new EU chemical regulations, REACH.

What does this anecdote tell; why was this relevant for nanotechnology regulations? We see that the definition of nanomaterials as either 'new substances' or 'existing substances' (in smaller form) impacts on the regulatory framework applicable to them. If they are classified as new, testing requirements are strict. If they are classified as 'existing substances' (in a smaller form), no additional safety tests are required. The minutes of the first regulatory meeting, for example, state:

Thus any currently regulated chemical can be produced at a smaller particle size without the obligation to inform regulators.
(RS reg. meeting 11 Feb 2004:3)

Hence, if I as an actor in the regulatory debate would prefer that no regulations specifically for nanomaterials be adopted, it would be advantageous to argue that nanotechnology was nothing new, but part of existing substances. Consequently, nanomaterials would be considered as covered by regulation strict risk assessment criteria would not apply. In fact, this strategy is pursued and the articulation of nanotechnology as something 'not new' is often supported by diverse stories linking nanotechnology to existing fields or to the past. In the following, I will argue that the outstanding and new character of the nanotechnology field that policy-makers created in the first period of nanotechnology governance was deconstructed again, when they field faced regulation.

In this part of the chapter, I will analyse the discursive logics of including and excluding in 'nanotechnology' – by ways of naming, creation of equivalences (e.g. analogies drawn to nature or to fine dust but as well to asbestos), and creation of differences (e.g. singling out different fields from within the generative term 'nanotechnology,' like engineered free particles, carbon nanotubes, nanosilver). As in *period I*, careful attention has to be paid to how equivalences and differences are played out in the extension and restriction of the use of the term 'nanotechnology.' For example, Colin Church, who worked within the chemical division of Defra, considered existing chemical regulations applicable to nanomaterials. Less surprisingly, his contextually dependent definition of nanotechnology articulates nanotechnology governance as one field within chemical regulations and, thus nanomaterials as chemical substances. Blurry definitions of 'nanotechnology' allow for linking it with different fields. As said in the theory chapter, political frontiers are constructed, stabilised, strengthened, or weakened in a dynamic process through logics of equivalence and difference (Glynos & Howarth 2007:215.) On these, I focus in this chapter.

We can clearly see how logics of equivalences and differences are played out when it comes to the question of whether nanotechnology is something new or not new. The UK Government response to the RS/RAEng Report in 2005 acknowledges the need for a full safety assessment and that particles on the nanoscale may behave differently from their bulk material. However, the response clearly and explicitly misses stating that nanoparticles should be considered as new materials. This is a prerequisite for the government's stance, which they adopted all along until 2009, that nanotechnologies are covered by existing regulations:

4.3 The Government is committed to understanding the potential risks and to managing them within a proportionate regulatory framework. For example, the UK, in collaboration with others, is undertaking a substantial programme of research and other evidence gathering to inform policy decisions, for example on whether new or amended legislation is needed to cover free engineered nanoscale materials.

4.4 In the meantime, protection is offered by existing legislation. [...]

4.5 Most products are covered by legislation [...]

4.6 It is worth noting that it is never possible to be completely certain that a product is safe. [...].
(UK government 2008:17)

The quote of a UK government statement on nanotechnologies, published in 2008, exemplifies how government displaces regulatory decision-making according to a *logic of evidence gathering* and adheres to the stance that nanomaterials are covered by existing

legislations. The government also explicitly talks about 'free engineered nanoscale materials.' The politics of naming 'nanotechnology' 'free engineered nanoscale materials' or 'nanoparticles' is an example of the rhetorical moves in governmental reports.

In the government's first risk research report, published by the NRCG in autumn 2005, the government shifted the definition of the term 'nanoparticles.' Instead of referring to particles at the nanoscale, which would include natural and artificial (deliberately engineered) nanoparticles, the government decided to use the term 'nanoparticles' to stand in for all forms of engineered free nanomaterials.

The term 'nanoparticle' has been used in this report to represent all forms of engineered free nanomaterials.
(UK government 2005c:1)

This is an argument of definition which centres on the names of things in an attempt to define a thing in an advantageous way (Finlayson 2007:554). This rhetorical shift of government to redefine the term 'nanoparticle' was crucial. It allowed the blurring of the boundaries between 'engineered free nanomaterials,' which are manufactured by the application of nanotechnology, on the one hand, and nanoparticles, in the sense of particles at the nanoscale occurring naturally, on the other.

The blurring of naturally occurring and engineered nanoparticles is a rhetorical basis for analogies drawn as part of rhetorical practices of normalising nanotechnology. For example, Defra drew an analogy to fine particulate and air quality at the first nanotechnology regulators meeting. This analogy has two consequences. First, opponents to nanospecific regulations suggest that it is not possible to distinguish between 'naturally occurring nanoparticles' (fine particulate) and 'engineered nanoparticles' in risk assessment, and thus that it is not possible to regulate nanotechnology. The minutes of the first regulator meetings address this issue, for example, as such:

[...] there is a change in properties between chemicals in their large and small particulate forms, but also [that] nanoparticles have existed in the environment since before humans. Humans have thus evolved in an environment rich in nanoparticles, and therefore it might be expected that they have developed physiology that can deal with them. Whether new or synthetic nanoparticles may cause a problem however is currently in question. One problem which then arises is how to measure these 'new' nanoparticles against a background of 'old' nanoparticles, and whether this may present issues for regulators.
(RS reg. meeting 11 Feb 2004:3)

We see that the blurry demarcation between artificial and natural nanoparticles challenges regulatory policy-making when there is insufficient knowledge. Second, the analogy to fine particulate depicts the environmental problem of nanotechnology applications as a common problem and as only one instance of environmental pollution.

In addition to the fine particulate analogy, other analogies are drawn that can be read as rhetorical shifts towards a naturalisation or normalisation of nanotechnology. For example, interviewed researchers from the National Physical Laboratory and the Institute of Nanotechnology, as well as documents of the Nanotechnology Industry Association, argue that there is much similarity between nanostructured materials, in the sense of deliberately engineered materials, and the structure of materials occurring in nature.

There is risky research done by people dealing with diseases caused by viruses. This is probably more worrying for me than people making devices a little bit smaller than before.
(Interview material: Nanoscientist)

This line of reasoning attempts at normalising nanotechnology. An argument frequently used by scientists is that viruses operate at the nanoscale although they are part of nature. Hence, the argument is that there is something in nature which is more dangerous than nanotechnology. This step of normalisation is sometimes built upon by promoters of nanotechnology by establishing an equivalence of science and technology with 'fundamental laws of nature.'

As long as we have not gathered the data, we do not understand the fundamental laws of nature and hence policymakers cannot take decisions.
(Interview material: Nano Lobby group)

We see that part of the *logic of evidence gathering* is to construct the relationship between technology and nature as though the world is out there waiting to be discovered. The advocates of nanotechnology employ a political rhetoric that ignores the intervention of humankind into nature, which could create something previously non-existing. Besides, this idea is based on the fantasy that human beings are subordinated to never-changing, almost all-mighty laws of nature and does not take into account that these laws were written and constructed by humans themselves.

Another strategy of normalisation – as part of a *logic of difference* interrupting generalised demands for regulation of nanomaterials – which I identified in my UK interviews was a strategy of temporalization, similar to the temporalization employed by the VCI in Germany.

Looking at things like crystals, crystal structure, the ordering of atoms, the spacing of atoms, has been done for almost the century. So, it's really an old subject which is becoming more of uhm ... an 'in'-subject at the moment.

(Interview material: Nanoscientist)

In the British context, part of the articulation of nanotechnologies as something old or common is the reference to the Lycurgus cup. The object, which is property of the British Museum in London, was created 400 AD in the Roman Empire and changes colour when held up to the light. The opaque green cup turns to a glowing translucent red when light is shone through it (see British Museum online). It does this because of light effects on the nanoscale, which scientists understand today (Nanowerk Spotlight, July 31, 2007). Civil servants participating in the NRCG and NIDG referred to the object in my interviews in order to articulate nanotechnology as something that has been used for centuries. Thus, they employed an argument of quality (Finlayson 2007: 554) which aims at establishing the nature of nanotechnology application as handicraft work, with a century-long tradition. These equivalences contributed to the regulatory debate by strengthening the position that existing regulations were sufficient. They weakened connections to unexpected risks, because things that are well known do not behave in an unexpected way. Articulating nanotechnology as equivalent to environmental pollution, ancient objects or well-known products contested the demand that nanotechnology would require special regulation due to its novelty.

A policy paradox (in comparison to the government's claim that nanotechnology is something old and natural, as exhibited in the attitudes towards risk regulation) is that the demands to invest in nanotechnologies are based on the articulation of nanotechnology as something new and outstanding. Because the very nature of materials changes on the nanoscale, nanomaterials are supposed to be different from the same material on bulk scale. As analysed in *period I*, the fantasy of inventing something entirely new, of exploring the last frontier, and of overcoming the limits of nature, underpinned the rise of nanotechnology. In contrast, the empirical data generated in the regulatory debate indicates that nanotechnology is not new at all. In the following, I will take an even closer look at what happened to the supposed novelty of nanomaterials in the regulatory debate.

7.6.1 *Regulatory reviews: Prevalence of a logic of difference*

The novelty of nanomaterials and a general demand for nanospecific regulations was further weakened by considering nanotechnology applications in relation to existing fields. Throughout my interviews and in the analysed policy documents, nanotechnology was constructed as inherently uncertain, complicated, and crossing departmental boundaries and scientific disciplines, which challenges the way people are specialized in, i.e.:

Nanotechnologies and its applications are rather diverse. Therefore, in a sense they are not you know there is not a natural epistemic community. People start to be interested in food, people start to be interested in computing, you know, it ... it ... it crosses it crosses ... nanotechnology crosses sectors but then again so does, for instance, waste regulation. Nevertheless, people you meet in the waste circles are completely different from people that you meet at the nanotechnology circle. Most people are if you like single issue specialists.
(Interview material: Expert in regulation)

As a consequence of the articulation of nanotechnology into diverse fields, many reviews of existing regulations were carried out. The existing relevant environmental and product legislation ranged from the Notification of New Substances Regulation (NONS); the Existing Substances Regulation (ESR); the Chemicals Hazard Information and Packaging for Supply Regulations (CHIP); the European Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Directive; to the Integrated Pollution Prevention and Control (IPPC) Directive, as well as different water, medical devices and foods directives and regulations, and so on (in all, about 35 directives). All these laws contain the premise that, in principle, you should not release anything into the environment that could be a problem for human health or the environment. Whereas Gottweis concluded in his study on biotechnology that the meaning of 'recombinant DNA's hazards' and its hegemonic status in the political discourse was stabilised by crafting a new regulatory policy narrative that semantically linked such diverse fields as the protection of citizens from the hazards of genetic engineering, workplace safety, and economic modernisation (Gottweis 1998: 78), I assume that the articulation of risks related to nanotechnology into existing regulatory fields *destabilised* attempts to articulate these risks as new risks because it linked nanotechnology applications within known and regulated areas. For example, the UK government statement on nanotechnologies asserts:

Regulatory reviews

4.7 To assess whether existing legislation is adequate to deal with potential risks from nanoscale materials, the Government commissioned reviews of the adequacy of existing legislation, and an independent overview to identify any existing or potential gaps, inadequacies or inconsistencies. This work concluded that the existing regulatory framework is broadly adequate, although there is the potential for engineered nanoscale materials to fall outside regulatory control in certain circumstances. [...]

4.8 In this respect, nanotechnologies are no different from other new products and technologies and it should be recognised that these are potential, not necessarily real, regulatory gaps. [...]

(UK government 2008:17)

Hence, the 'newness' which potentially could be disruptive was weakened and the argument that nanotechnology was already covered in existing regulation strengthened. Besides, this huge field of nanotechnology with its proposed transformative effects was disentangled and separated by relating it to single fields.

Regarding the argument that nanotechnology was covered by existing regulation, Defra, for instance, particularly proposed that REACH (the chemical regulations of the EU which requires a general registration of all substances produced in or imported to the EU) is a good regulation for nanomaterials. But already at the first regulators' meeting in 2004, problems with applying REACH to nanomaterials were pointed out. The strict testing and registration requirements of REACH apply only to chemicals produced above one tonne per year. One tonne would be a rather immense amount of nanoparticles; by 2009 that amount had not been produced at all. So, nanomaterials would not have to be considered for registration and risk assessment because they are used in much smaller, gram to kilogram proportions (Defra SID 5 2/05 206: 3). This problem was also articulated by one of my interviewees from Defra, but at the same time diluted within the same interview:

Nanotechnology isn't excluded from REACH ... because they are chemical applications. They ARE covered. The fact that they are a new version of probably old material doesn't mean they are excluded just because they are small. If you have a new material, you would have to register it under REACH no matter whether it is on the nanoscale or whether it is what they call above scale, just normal size. The fact is the nanoscale doesn't make any difference you would still have to register ... yes, nanotechnologies are covered, just that they are small doesn't make them special in any way.

(Interview material: Defra1)

The interviewee argues that nanomaterials are covered by REACH by strangely turning around the arguments of those who say nanomaterials are not covered. The respondent stresses that nanosubstances are not excluded from REACH. But the point is that already registered substances in bulk form do not have to be registered (and tested) again in particle form, even if their behaviour is completely changed.

Strategies of including natural nanoparticles in the discussion about nanotechnology regulation can also be found when it comes to the discussion of labelling requirements. The scenario created during an interview with policy-makers of the NIDG was that the entire series of supermarket products would have to be labelled nanotechnology, in case of an obligatory nano-labelling. They employed the argument that cheese would have to be labelled nanotechnology because it was produced by enzymes coagulating milk at the nanoscale; and whereas these processes have been applied for some 6000 years or more, they can be better understood nowadays using nano techniques (which means in this case forceful microscopy and light-scattering techniques) (see Nano Science Centre DK).

By way of conclusion, the analysis of the regulatory discussion on the previous pages shows the prevalence of *a logic of difference* employed by regulators to prevent or displace demands that nanotechnology is new and has new effects which would require new, specific regulations. Rhetorical practices of drawing analogies contribute to normalising or naturalising nanotechnology, which makes a connection to unexpected risks seem implausible. In the following section, I will take this discussion further by shedding light on the politics of problem definition in nanotechnology.

7.6.2 *Shifts of Attention: Nanoparticles – Nanotubes – Nanosilver*

A particularity in nanotechnology governance is the politics of problem definition. Regarding the substantive regulatory discussion, the question is, what of this vast nanotechnology field should actually be regulated. I will argue that a challenge in the policy field is that the question, what is the policy problem, is constantly shifted. Nanotechnology remains elusive and difficult to grasp in regulation, which allows for shifting the policy problem rhetorically. In addition, there are no discursive strategies aiming at a fixation and closure of the field, but rather, a *logic of adaptation* prevails. One consequence is that the process of defining the policy problem is kept open. In the following, I will develop this argument in more detail.

From my close reading of policy documents and the analysis of interview accounts, I conclude that a striking element of the process of debating nanotechnology governance in the UK was a shift of attention towards different fields of nanotechnologies. As shown above, this process of disentangling started with the RS/RAEng Report that picked out 'free

engineered nanoparticles' within the field of nanotechnologies. Over the years then, carbon nanotubes and nanosilver were shifted into the focus of the debate, next to free engineered nanoparticles. I argue that each time a topic was brought up, the debate was restructured in a way that contributed to the attempt to disentangle the broad term 'nanotechnology' again. When the term was extended to include almost everything as we have seen in *period I*, this proved to be unfeasible within a regulatory regime of evidence-based risk assessment. Thus, policy-making made attempts to single out diverse fields.

In the following, I will describe the three areas that are most often articulated as potentially problematic: (engineered free) nanoparticles, carbon nanotubes, and nanosilver. In one of my first analyses of UK documents in 2006, nanoparticles stood out as major policy issue. When I conducted a first series of interviews in May 2008, which happened to be right after the publication of Ken Donaldson's study about carbon nanotubes' asbestos-like behaviour, interviewees were most concerned about nanocarbontubes. In my second interview series in spring 2009, nanosilver was the hot topic.

First, attention was drawn to the possible hazardousness of engineered nanoparticles, for instance, by the RS/RAEng Report. They feared engineered nanoparticles differ significantly from the particulates which were traditionally examined by toxicologists, and that normal exposure tests would not work. From the outset, the RS/RAEng defined the problem posed by nanotechnologies as how human beings and the environment were exposed to nanoparticles and what consequences this exposure has for human health and the environment. Thus, the regulatory topic was defined as how current and future regulation should prevent possible negative consequences of nanotechnology applications. As a result, the problem definition in policy-making was focused on nanoparticles from 2004 to 2006. Already, the topic of the first regulators meeting on nanotechnology was on engineered free particles. This shows a successful problem definition – in excluding other concerns – by the Royal Society and Royal Academy of Engineering who convened this regulators meeting. Accordingly, the first government report focused on nanoparticles. In the review progress of government activities in the UK in 2006, sometimes the notion 'nanopollution' was used, which connected environmental and health problems that could arise from the effects of nanoparticles when they enter the body or stay in the environment (for example, in lakes after using sun milk with nanoparticles). Risk talks concentrated on 'nanoparticles.'

Second, carbon nanotubes came on the policy agenda because of equivalences drawn to asbestos. "Carbon nanotubes: the new asbestos?" was the title of a publication in *Nature* on 20 May 2008. The article talked about the results of a study conducted by Ken Donaldson of the Institute of Occupational Medicine (IOM) in Edinburgh which suggested that carbon nanotubes could pose a cancer risk similar to that of asbestos. Carbon nanofibres were similar in size and structure to asbestos fibres. Experiments with mice conducted during the study showed that an exposure to nanotubes caused mice to suffer from an inflammation of membranes around some bodily organs. For people who had been exposed to asbestosis, this kind of inflammation was one stage leading towards cancer. This did not mean that the study showed the fibres caused cancer because there were no exposure studies, like inhalation studies, but the materials were injected. However, carbon nanotubes were already on the market in consumer products such as tennis rackets and golf clubs. The beneficial characteristic of these materials was to strengthen products but at the same time to lighten them. The study's team recommended that government should take action to prevent people from being exposed to these materials and protect their health. Now, the government would have had the evidence it required, but as Manning (1989) says:

Facts alone are not an issue, because when facts are known there may be debates about their relevance; or facts may be seen differently; [...].
(Manning 1989:77)

The UK government responded to the study by focusing attention on the study's claim that the potential health threat only referred to carbon nanotubes that were free, whereas the fibres in available consumer products were embedded in composite materials. Hence, a further refinement (and therewith exclusion from the policy problem) took place: if nanocarbontubes are hazardous, it is only free ones. Furthermore, the IOM's results that only long carbon nanotubes could represent a danger were highlighted compared to the safe short and curly nanotubes. Again this shows an argumentative pattern in the government's rhetoric of focusing on one element within nanotechnology as problem in order to deflect from nanotechnology in general.

During my interview series in 2009, nanocarbontubes were largely off the debate. Increasingly, carbontubes were no longer considered as potential threat, which was accompanied by a decline in interest from the scientific community after the promising properties of carbontubes proved not to be easily applied. For example, carbon nanotubes

clutched to each other, and singling them out (in order to apply them) was a difficult exercise.

Third, the regulatory debate moved to nanosilver:

From a personal point of view, I am beginning to feel that carbon nanotubes are ... uhm ... a bit of the ... well ... yeah ... they are not the main area to worry about. [...] I am much more interested in nanosilver and its potential, not ... not for human health effects but certainly for environmental effects. [...]

The Advisory Committee on Hazardous Substances has been asked for advice on nanosilver. [...] There are not that many products of nanosilver on the market in the moment ... uhm ... there is a lot of research done but many results are not conclusive in the moment. So, the ACHS is putting together an advice in the moment on where we need to go next, [...] whether we need to take regulatory measures, whether we need a precautionary approach toward nanosilver products and an advice for further direction of research.

(Interview material: Defra2)

And I think nanosilver is quite likely to be it. Sooner or later there will be a catastrophe caused by nanosilver getting into someone's gut, getting into water treatment works or something and then everybody will wake up and say, oh, why didn't we stop this?

(Interview material: Chemical Engineer with focus on Environmental Technology)

We know what silver will do particle-sized. But at the nanosize we know it behaves quite differently. We don't know how and we won't know how over a longer period. So, there are some interesting scientific issues.

(Interview material: Member of the House of Lord's Science Committee)

The rhetorical shift of the policy problem to nanosilver is another example of singling out one risk issue within the broad nanotechnology field. Nanosilver came on the agenda when the U.S. Environment Protection Agency began a widespread investigation into nanosilver (see Hasslberger December 07, 2006). Nanosilver has antibacterial properties. Its application ranges from textiles (antibacterial socks available at Marks & Spencers), to food additives and laundry machines to baby dummies. The consequences of a widespread application of the material to the environment have not yet been researched. One fear is that bacteria develop a resistance to silver of all sorts, similar to the increasing resistance to antibiotics. This would be problematic as silver is used, for example, as an important antibacterial coating of medical devices. In 2009, the House of Lords subcommittee of the Select Committee for Science and Technology, which was investigating into 'food & nanotechnologies,' identified nanosilver as one of the few real problems in nanotechnology. Also, the UK Advisory Committee of Hazardous Substances (ACHS) was running an examination of nanosilver and developing recommendations for Defra in the year 2009.

Interestingly, within this narrow focus on nanosilver, a further exclusion was taking place by arguments of place: nanosilver was increasingly cast as a purposeless public relations effort in the marketing of products. In my interviews, environmental scientists and Defra questioned whether products like socks that contain nanosilver to prevent them from stinking were useful. This is an argument of place because it allows for maintaining the promises of a nanotechnology which is without risk and shifts risky areas to the edge by articulating risky nanotechnology as useless and deviate forms of nanotechnology, anyway. For example:

On a personal level, I can't see much uhm ... much use of silver in a lot of products. You know when it's put in socks, underpants and the overalls, plastics ... You know, what's the point of this? People are not going to die; bacteria have been around ... as long as you're healthy there is no problem.

I can see that there is a lot use of silver in certain medical applications; in bandages an anti-bacterial property is clearly a useful thing to have. But as I say ... in other applications it is just another way of selling more products but that's entirely useless. It doesn't have any beneficial use at all.
(Interview material: Toxicologist)

Nanosilver is widely used as an antibacterial, for example for wound dressing. There are probably many beneficial aspects of those uses but you also begin to see slightly less important applications. There are uhm ... uhm ... like babies tummies, you know, they put it in their mouths. I think there are baby tummies with nanosilver ... you kind of think well there isn't any point in that, isn't it? There is not any benefit for the baby or for anything else for having an unnecessary application of nanosilver. You got nanosocks as well, clothes with nanosilver and ... there are all sorts of using of nanosilver, it is a really trendy application and it may be that there are significant problems and there is a lot of research going on at this point. [...]
(Interview material: Defra2)

The aim of the discussion in this section was to show how the agenda of regulatory debates constantly shifted in nanotechnology and how arguments of definition reset the boundaries of the problem differently again and again. While the consequence of these efforts was reflected in the tendency for regulations to be considered unnecessary for nanoproducts, critical voices tried to keep the debate alive by stressing products yet to come. Like proponents of nanotechnology in the 1990s who shifted attention towards the future in their demands for funding, it was claimed that regulation could be necessary to future generations of nanoproducts even if not to present nanotechnologies. For example, the RCEP Report wrote:

[And third,], in the longer term, we are also concerned that more sophisticated third and fourth generation nanoproducts may represent a further step change in functionalities and properties, which would be even more difficult to capture in a regulatory system primarily focused on the bulk chemical properties of a material.
(RCEP 2008: 5)

By way of conclusion, I argue that the pre-emptive risk regime was contested and policy-makers set out to deconstruct nanotechnology when it came to regulation. First, references to objects from the past and common consumer products, like cheese, as well as analogies drawn to fine dust establish an impossibility to tackle with the particularity of engineered nanoparticles. Second, attempts at disentangling highlight complexity, because the concept of nanotechnology lives from its simultaneous articulation as new and not new, and thus cannot be easily disentangled. As shown in the first chapter on the UK, the social imaginary of the 'newness' of nanomaterials and the promises of an industrial revolution were essential for a rise of the field in the first place. But now, these claims are neglected. Third, references to future prevent a closure of the regulatory debate and allow for potentially integrating upcoming issues. In sum, nanotechnology as political space is maintained, but kept vague and elusive. In the next section, I will critically explain how the logic of pre-emption nevertheless manifested in regulatory action (in the form of standards, a voluntary reporting scheme, and a code of conduct).

7.7 Implementing different regulatory governance in the UK: Towards adaptation

In my analysis of the UK regulatory discussion, I have so far established the argument that – similar to what happened in the German case – the substantive nanotechnology regulatory discussion was marked by a *logic of difference* which particularised and thus rejected demands for regulation 'in the name of nano.' At the same time, the constant negotiation of what nanotechnology actually is, dislocated a regulatory regime which was marked by a *logic of evidence gathering*. You cannot produce clear measurements, if the regulatory object is not even defined. Nevertheless, the government reiterated their social practices of evidence gathering, which led to grievances, which I will show below. In the following and last section on the UK, I show how the logic of pre-emption overcomes its contestation by implementing a new, flexible, adaptive way of regulation.

We know that the Royal Society and Royal Academy of Engineering published a holistic study on nanotechnologies, inclusive recommendations for risk governance. For example, they demanded precautionary measures that nanoparticles should not be washed out in the waste stream from laboratories. After the publication of the RS/RAEng Report, government departments – governed by the *politics of network governance* – set up government networks

(NRCG, NIDG) and governance networks (stakeholder forum, public engagement). As the government was gripped by the fantasy that we can govern, in the sense of control and steer, as long as we only know enough, government activities were gripped by a strong demand or *logic of evidence gathering* which manifested, for instance in the establishment of the Nanotechnology Research Coordination Group (NRCG), as we learned on earlier.

Within Defra we set up a cross government research coordination group. There are five Taskforces. The first looks at measurement, characterising everything. Another is looking at exposure. And they want to find out what are the potential exposures, where nanotechnology is used, how might they get out in the environment, how the main exposure routes would be through ... different ways that you're exposed to it.
(Interview material: Defra1)

The NRCG should coordinate and plan risk research into nanotechnologies. Thus, the government focused on filling the knowledge gaps, and regulators were convinced that action could not be taken before this was done.

The vague and elusive discussions that often went in circles and the lack of action taken (apart from the establishing of working groups or the publishing of reports) because of the *logic of evidence gathering* led to some grievances that were expressed by interviewees of mine and in the policy debates. Their problem was that it might take many years until measurement techniques were refined, and we might never get to the point where we can know everything about nanomaterials' behaviour. Thus, they demanded to take action despite uncertainty. Nevertheless, regulators followed their unswerving course of collecting evidence.

In addition to this disagreement about when to start regulatory actions, discontent developed because of a lack of governmental funding on risk research. The RS/RAEng had demanded funding for risk research. But the government did not allocate funding. The Royal Society and Royal Academy of Engineering's reaction to the government response expressed disappointment that no new money was dedicated to research to underpin regulatory activity. Also the media picked up on this, as noted in the protocol of the Nanotechnology Issue Dialogue Group (NIDG), which had coordinated the Government Response:

There was a short discussion on reactions to the Government Response. Members considered that the Royal Society comments were mostly favourable but noted that the Royal Society were concerned about lack of any new funding. It was noticed that the media in general had picked up on this, but that there was no large-scale backlash against the Government's stance.
(NIDG 2005)

Thus, there was no budget allocated for increasing the knowledge base, when at the same time government insisted on evidence-based regulatory policy-making and nanotechnology regulation thus was led into a stalemate-like situation.

The lack of regulatory activity in combination with a lack of funding for risk research caused grievances. In 2006, the Council of Science and Technology conducted a review of progress on actions set out in the Government's response to the RS/RAEng Report. For this purpose, a subgroup was convened, and a call for evidence was published.²⁴ Critics like Greenpeace, the Institute for Occupational Medicine, and concerned scientists took issue with the government's claimed commitment to fund risk research in the 2006 CST review. Researchers within environmental sciences and risk research interpreted the low funding made available for risk research as showing an unwillingness of government to act. The critics challenged the government's new identity of being a responsible actor by a counter-logic that established a new chain of differences in the form of a new story of decline: whereas the UK government had taken the lead in the 'responsible development of nanotechnologies,' it said this was no longer true. The critical statements pointed out that the government employed a circular reasoning when they said risk research was needed before regulatory action could be taken, but then no money for risk research was provided. A joint statement of the RS/RAEng, for instance, said:

The Government highlighted that the significance of this recommendation will depend on whether specific types of free nanoparticles or nanotubes are hazardous. However, the Government's failure to provide adequate directed research funding to investigate this means that there remains insufficient evidence.

(RS/RAEng Response to Call for Evidence by CST)

Similarly, the Institute of Occupational Medicine complained:

Even at this stage, it is not clear how, when or indeed if funds will be allocated. We are particularly concerned about the emphasis on responsive mode funding by the Research Councils. From the perspective of the research community, it is difficult to see how a piecemeal approach such as this can result in the necessary strategic programme of research given that all of these proposals will be assessed individually.

(vgl. IOM Response to Call for Evidence by CST)

²⁴ It was answered by: The BSI Nanotechnologies Standardisation Committee (NTI/1), the Department of Health, the European Nanotechnology Trade Alliance, Greenpeace, the UK Government, the Nanotechnology Engagement Group, the Nanotechnology Industries Association, the Royal Society/Royal Academy of Engineering, the Royal Society of Chemistry/Institute of Physics, the Safety of Nanomaterials Interdisciplinary Research Centre (SiNRC), the British Soil Association and some international scholars.

And Doug Parr, for Greenpeace UK, in 2006 said at the 2nd CST Review Subgroup Meeting:

The publication of the RS/RAEng Report was seen as a turning point at the time, but it appeared not to have been taken on-board by the Government. The lessons of e.g. GM had not been learnt – with about 100 products with nanoparticles available there was no risk assessment framework in place, and regulation was weaker than it had been for GM.
(Greenpeace 2006)

These critical statements articulated the demand for funding of risk research and a coherent risk research strategy.

According to an interviewee responsible for the nanotechnology activities of the Environment Agency at this time, the problem was less that the government was unwilling to act (as critics accused the government of) but that there was a governance failure in the handling of the new nano-field. The uptake of how the RS/RAEng recommendations should be tackled in the political process was quite particular. The RS/RAEng outlined the need for five to six million Pounds a year over 10 years for risk research. Usually, such funding would be distributed by the Research Council. However, the government decided to allocate the decision-making on distributing funding within government agencies itself when it came to nanotechnologies. The argument for this move was that government departments and regulatory agencies were in a better place to understand industry and what industry's needs for nanotechnology research were. This shows that the *logic of commoditisation* gripping technology governance and the articulation of nanotechnology into innovation discourses, as we saw in *period I*, have not vanished in the risk regime of nanotechnology, but that they are maintained in the 'responsible development of nanotechnologies.' So, government departments had to fund nanotechnology research. The problem, however, was that government departments did not have the mandate to fund basic research. This was the mandate of research councils who again had no mandate to fund nanotechnologies and thus sat on their hands. The two new governance bodies, NIDG and NRCG, could not fund research because they were lacking the mandate from top-down. So, nothing happened for some time.

It was only through the individual initiatives of policy entrepreneurs (such as the former leader in the Environment Agency of a group working on nanotechnologies) that an environmental nanoinitiative providing funding for research on environmental effects was set up. He described the process as ground level work:

I started a programme of research from the ground up because we didn't have the mandate to fund the research from the top down. So, we ... I got a couple of industries and from government together and said we need to put up money to nanotechnologies.

I remember it was back in December 2005, when I was literally trying to say look we need to get over some money here, none of them had it! The research councils were sitting on the table but for them it was not a big issue because they had no mandate. The departments, they did nothing actually, government departments couldn't fund anything. So, literally nothing happened.

Then I had to go the backway and literally know the people at the research councils to say set a programme up with money which we did [...] in 2005.

But it was very much a ground ... sort of grass root thing ... it wasn't ... it didn't come down through the normal routes of government saying we are going to have [...] money here.

(Interview material: Environment Agency)

In short, while the government stressed knowledge gaps about nanomaterials, there was a lack of action to change this situation in the first years of institutionalised nanotechnology politics in the UK.

Interestingly, when I entered the field, one thing that was puzzling to me was why there was no opposition lobby against nanotechnologies. Only the NGO "British Soil Association," which promotes organic food and cosmetics, demanded a moratorium on nanotechnologies (British Soil Association 2008, Smithers 2008 in *The Guardian*). After my interviews, I came to the conclusion that the struggles were more subtle. It was the evidence-based regulatory regime (not nanotechnology itself) which became dislocated and challenged in the course of nanotechnology policy-making. The challengers sat at the interface of academia and regulatory agencies.

Proponents of a new adaptive governance regime, which is an alternative to evidence-based decision-making, are situated in academia. A well-known scholar is David Guston. He is the director of the Center for Nanotechnology and Society at Arizona State University. In 2007, he and colleagues published, for instance, the influential article "Anticipatory governance of nanotechnology: Foresight, engagement, and integration," which argues that nanotechnologies' uncertainties and complexities require new assessments and new engagement in the production of knowledge:

Anticipatory governance implies that effective action is based on more than sound analytical capacities and relevant empirical knowledge: It also emerges out of a distributed collection of social and epistemological capacities, including collective self-criticism, imagination, and the disposition to learn from trial and error.

(Barben, Fisher, Selin & Guston 2007: 991)

Barben et al. consider public engagement and future scenario workshops in nanotechnology governance. Other scholars, such as Owen, Grieger and Brown, thought these ideas through even further. By the year 2009, the demands from academia for anticipatory governance transgress the boundaries of STS scholars. In a *Nanotechnology Nature commentary*, the physicist Simon Brown argues, for instance, that nanotechnology governance is marked by a 'new deficit model.' In contrast to the old deficit model, which assumed that lay people had to be filled with knowledge in order to be positive towards new technologies, the new deficit model presumes that scientists have to be filled with knowledge in order to stimulate regulatory action. Brown points out that the impact of nanomaterials might never be fully assessed, and he calls for beginning the process of regulation by giving up on the idea that we will ever know and that we have to wait with regulation until we know:

Effective governance of emerging nanotechnologies will require an acknowledgement of these unknowns, an open and adaptive approach to regulation, and the courage to make decisions.
(Brown 2009)

Another important scholar is Richard Owen, the former leader of the UK Environment Agency, who became a Professor at Westminster University in the field of "Responsible Innovation" because he considers academia the better place for developing new ideas towards technology governance. He and his PhD students aim at developing adaptive risk-governance frameworks which facilitate near-term decisions and thus overcome the postponement of decisions until risk assessment is available (Grieger, Baun & Owen 2009):

If the development of regulation based on quantitative risk assessment is an inherently slow governance process, then one answer might be to undertake research that leads to one or more governance frameworks that are more responsive and adaptive.
(Grieger et al. 2009:6)

The last UK report on nanotechnologies, which was conducted by the Royal Commission on Environmental Pollution (RCEP), also articulated this view of adaptive governance:

[Increasingly], it will be impossible to settle questions about the environmental and human health impacts of nano- and many other new materials consistently and in a timely fashion using traditional risk-based regulatory frameworks. [...]
These considerations of trans-science, world views and the control dilemma suggest that nanomaterials, like other emerging areas for technology, require an adaptive governance regime capable of monitoring technologies and materials as they are developed and incorporated into processes and products.
(RCEP 2008: 15)

The demand for adaptive governance mechanisms, thus, overcame the dichotomy between the view that existing regulations were sufficient and the demands that new legislative regulation for nanotechnology was needed. For example, the RCEP came to the conclusion that many aspects of nanomaterials were already covered by existing regulations, but that there might be instances where it might be necessary to go beyond the existing regulatory arrangements – and this was by means of new governance arrangements (RCEP 2008: 59.) Adaptive management can be read as an answer to prevent that the existing regulatory regime might be dislocated because the reliance on evidence-based policy-making could not be sustained under conditions of uncertainty.

I think it is a common political governance issue, not just in the UK. It comes back to similar issues on demanding regulation and very poor mechanisms of filling that gap between innovation and regulation. They just don't know what to do. They ... rely on regulation, or ... and ... the trouble is that people don't understand what the policy was and still is and ... we don't understand ... we don't have enough ... we have lot of uncertainty because we don't have any data. We're going to commission programs of research which will inform the development of policy and regulation. We're also going to have voluntary reporting schemes that tell us about what people are making and those two information strands come together and on the basis of that you amend policy and regulation. That's the policy, that's the framework, that's the governance, it's evidence-based policymaking but because innovation *is* in its nature innovative, it doesn't fit the existing model. Regulation always has to try and catch-up. So, you have to go beyond regulation and you have to accept that with nanotechnology we probably won't have a regulatory fit for purpose method supporting regulation.
(Interview material: Former regulator)

This discourse sedimented into the general tendency in nanotechnology governance for regulators to integrate what they referred to as an adaptive, and thus flexible, management in nanotechnology governance. This practice pre-empted an emerging conflict, as articulated in the critical quotes of Greenpeace, the Institute of Occupational Medicine, and the Royal Society. It was translated into the dominant soft law approach towards nanotechnologies, such as codes of conduct or voluntary reporting schemes: the UK's Voluntary Reporting Scheme (VRS) on Manufactured Nanomaterials was launched by Defra in September 2006. The idea of the scheme was to open a way for industry and research organisations to submit data on nanomaterials that would provide the government with information to understand the risks posed by free engineered nanomaterials (Defra homepage, nanotechnology policy). The VRS was largely considered to be a failure by my interviewees due to the disappointingly low submission rate. As of May 2009, Defra had received only 13 submissions. Requests for a mandatory scheme were rejected with the argument that mandatory schemes would have to be implemented on an international or European level. Another voluntary measure taken within Defra was that the Environment Agency issued guidance on safe handling of waste materials containing nanotubes (Environment Agency 2008). The briefing included

suggestions on the classification of waste containing nano carbontubes (CNTs) within the waste directive (as 16 03 03 inorganic wastes containing dangerous substances), as well as an outline of current knowledge on how to destroy potentially hazardous nanostructures. The guidance stressed that only waste containing unbound CNTs was concerned. Former responsables from the Environment Agency as well as a member of the chemical division of Defra considered this guidance as precautionary measure because it was based on a single study that produced preliminary data on CNT's resemblance to asbestos in a mice experiment. Another guidance document on the safe handling and disposal of manufactured nanomaterials in general was developed by the British Standards Institute. Apart from that, the Responsible NanoCode was issued by the Nanotechnology Industry Association (NIA) and developed together with Insight Investment and the Royal Society. The Responsible NanoCode issued seven principles on how to deal with nanotechnologies in a responsible manner and a series of good practice examples. In practice, the work on the code was marked by considerable troubles, to the extent that many working group members opted out of the process. From the perspective of actors like the Royal Society, the aim of the code was to try to get industry to acknowledge responsibility in nanotechnology. From the perspective of industry, the main advantage of this code for business was, according to the NIA, to demonstrate a commitment to being open and proactive in addressing the potentially controversial emerging technology (Friedrichs 2008). However, the good intention had to be proven when it came to commitments. There were concerns that the code could become too strict, e.g. by incorporating the best practices examples into the principles:

There have been some problems with the British code. Industry is not against regulation, the question is more subtle. What sort of regulation and at what costs a regulation? You know, they thought it would be much softer. But then they feared there could be legal consequences for breaching a civil code ... when ... this must not be true ... it is complex. How do you measure compliance? People involved have not really foreseen or thought about that what they might have been doing in that process really is to make a statement. What's considered responsible? It is actually about putting duties on people.

(Interview material: Expert in regulation)

I would like to conclude with this quote which exemplifies clearly that the responsible development regime was contested in practice when it came to fixing its content.

By way of concluding this section on the UK, I suggest that we should not interpret the soft laws as second order, default laws, but that they actually show there was a change in technology governance, which is that the uncertainty of the object nanotechnology was mirrored in the flexible policy instruments adapted to nanotechnologies.

Codes of conduct are facing the critique that they are not binding but this flexibility is necessary, otherwise you are stuck with definitions.

(Speaker of the European Commission at the NanoObservatory Workshop March 2009, London)

Hence, the adoption of soft laws kept the uncertainty ongoing and the nanotechnology process open – both aspects that allow for integrating opposition.

I think nanotechnology has already or has always been cautiously sketched as a technology with potential and government recently has been willing to accept uncertainties. [...] Public engagement was certainly the big story that came out of GM. But of course there has been a lot of subtle work been done around nodal governance, around different use of experts - about considering having more well defined experts, e.g. working group Royal Society. [...] In general, there is more openness and willingness to do experiments with policies ... also all the other things like the nanotechnology stakeholder forum, whenever was there a GM stakeholder forum, you know, it opened up government process, that's pretty good governance.

(Interviewee Royal Society)

The opening of the political system by a logic of pre-emption led to an integrative governance and to a weakening of the evidence logic which is expressed in the new governing discourse of adaptive management. Nevertheless the Responsible NanoCode exemplifies that there are shortcomings in the current tendency to consider existing regulations as sufficient and to adopt only voluntary measures.

7.8 Conclusion

From the beginning, the 'responsible development of nanotechnologies' driven by a logic of pre-emption emerged to secure support for the nanotechnology-project. In this chapter, I clarified what regulation against the background of innovation means: a new way of regulating had to be developed that integrated opposing demands. Such a regulatory regime has to be flexible and adaptive; indeed it is not a question of regulating developments in nanotechnology but of avoiding contestation and conflict.

In Germany, I showed that the Magic Nano case indeed pointed to the limits of the responsible development regime. It was also a potential dislocatory moment for a political regime which had not yet enforced classical regulations on nanotechnologies. However, German policy-makers managed to conquer this disruptive moment by an appeal to science which shifted the accident away from the realm of nanotechnology. In fact, the constant redefinition of nanotechnology laid at the centre of the nanotechnology regulatory discussion

such that nanotechnology constantly seemed to vanish, whenever it came to questions of 'hard' regulation. In this process, policy-makers effectively normalized nanotechnology by blurring differences between natural and artificial nanoparticles (e.g. similar to milk proteins, historicity (we did it a long time), similar to fine particulate). My analysis carved out whether regulation was considered as sufficient came to rest on the particular perspective taken on novelty and the dynamics of innovation. At the same time, the logic of pre-emption privileged or found a way out of what seems an endless discussion on novelty: a pre-emptive regime does not take a stance whether nanotechnology is novel and how to define it. In so doing, uncertainty is acknowledged and promotes as a new way of regulation in form of adaptive, flexible, open guidelines as solution.

There was a similar story in the UK. The outstanding and new character of the nanotechnology field that policy-makers created in the first period of nanotechnology governance was deconstructed again, when they field faced the challenge of putting in place concrete practices of regulation. Because new substances require stricter regulation, nanotechnology's newness was increasingly downplayed, by blurring artificiality and novelty. In addition, nanotechnology was articulated into existing regulatory fields which destabilised its extraordinary character and the demand for nanospecific regulation. Furthermore, if problems arose (i.e., nanosilver) these problematic areas were excluded from the signifying chain 'nanotechnology.' Nevertheless, grievances were expressed that the government was not taking action and the demand to take action despite uncertainty became louder. These demands were addressed with adaptive, and thus flexible nanotechnology governance that – as in Germany – sets aside attempts to define nanotechnology. In fact, we witnessed across both cases a change in technology governance, with the uncertainty of the object nanotechnology mirrored in the flexible policy instruments adapted to nanotechnologies. It is to such broad conclusions as to changes in regulatory governance that I now turn in the conclusions to this study.

8 Conclusion

This thesis set out to answer the question of how regulatory regimes come into being, surfacing the limited attention paid to hegemony in traditional accounts of policy-making. In detail, I addressed the conundrum of how a particular interpretation of the regulatory problem with a new technology, and of its solution, could catch on under conditions of uncertainty. Indeed, I sought to address this conundrum of how to regulate a new technology through a study of nanotechnology governance in Germany and the United Kingdom. In my analysis, I identified a new form of regulation which is characterised by – what I conceptualised as – a *logic of pre-emption*. This *logic of pre-emption* manifested in a new regulatory regime marked by the 'responsible development of nanotechnologies.' In so doing, it led to a governance regime that rearticulated the notion of regulation against the background of innovation. In this concluding chapter, I recapitulate the key elements of this analysis, critically evaluating the work of the logic of pre-emption in Germany and the UK, how it came into being and the lessons, both for theory and practice, that can be drawn from the study. I begin by reviewing how the logic of pre-emption worked in my two case studies in the identified new way of regulating the unknown.

8.1 Pre-emption: A new way of regulating the unknown

As I said above, in seeking to explain the emergence of a regulatory regime in nanotechnology, I identified what I characterise as the emergence of a new regime of regulating an emerging technology in both Germany and the UK, with the primary contribution of the analysis being to demonstrate how this regime was characterized by a political *logic of pre-emption*: Nanotechnology is governed by the continuing imagination of potential conflict and the strong demand to avoid polarisation and protest. Therefore, the political logic of pre-emption led to a nanotechnology regulatory regime which can be understood as the hegemony of the responsible development discourse. Nanotechnology governance is marked by conditions of uncertainty and in such a context, disagreements and competing truths range from what the policy problem actually is to the means of policies. But successful governance must bind at least some of these things together (Finlayson 2007:550). Hegemonic discourses (i.e. responsible development) bind together; they constitute alliances and transform thus, in social and political practices, separated identity

positions into a collective 'we.' Drawing on poststructuralist policy analysis in general and on the contributions of political discourse theory formalized in the logics-framework developed by Jason Glynos and David Howarth in particular – I approached nanotechnology regulatory policy-making with the assumption that a (regulatory) regime consists of social and political practices that are characterised by social, political, and fantasmatic logics. In the case of nanotechnology, I identified across the cases five social logics which characterize this new form of pre-emptive regulation: a logic of scientification, a politics of network governance, a logic of evidence-gathering, a politics of naming and a logic of adaptation. When I recapitalise them in the following, it must be considered, of course, that in the examination, I draw analytical distinctions that in practice are difficult to maintain as all practices have social, political, and fantasmatic elements.

The social *logic of scientification* captures how the social practices of the governance actors in Germany and the UK who dealt with the challenge of nanotechnology were marked by demands for reason and factuality, and practices of evidence-gathering. That is, what was considered as an emotional debate on GMO issues was rejected; nanotechnology discussions should be based on 'facts.' Therefore, demands for risk assessment were, for example, foregrounded. The logic of scientification operated in different ways in my two case studies but it was in both cases installed by a political logic of pre-emption. In these moves of scientification, when nanotechnology was articulated as risk issue but as well as a technical matter, nanotechnology politics became depoliticised because the visionary debate was left behind. I critically explained that the horrific fantasies could be excluded from the nanotechnology-discourse because of a *logic of scientification*. Nanotechnology as a policy issue was channelled into a regulatory debate in which the demands for considering the ethical and social aspects were met by public engagement. In Germany, for example, nanotechnology was relocated into a science discourse and equated as a technical policy issue similar to fine particulate. In the UK, nanotechnology policy-makers, for instance, demarcated a scientific discussion from critiques, such as Prince Charles, who were discredited as believers in science fiction.

Most importantly, the *politics of network governance*, I suggest, captures how the logic of pre-emption manifested itself in the arena of public engagement. The politics of network governance led to an abundance of networks at various governance levels in both cases reaching from stakeholder forums and cross-departmental coordination groups, to citizen

groups, and public engagement, e.g. dialogue forums. Networks and the integration of multiple actors within them contributed to pre-empting conflicts because potential opposition was negated, once every actor was absorbed in the hegemonic project of 'responsible development.' In short, it is difficult to maintain a critical position, if you are part of the governing 'we.' Networking is a political practice with the outcome that the elements, the actors, become related (a chain of equivalences) – they become moments of the responsible development discourse which changes their identities. In this instance, responsible development came to function in both Germany and the UK as an empty signifier which provides a common ground to enable that potentially opposing actors can work together. These distinct manifestations of the politics of network governance have in common that they absorb potential opposition.

With the social *logic of evidence-gathering*, I argue that regulators perceived their only alternative to be postponing regulation until sufficient evidence was available. In other words, because knowledge was seen as a prerequisite for acting, decision-making on regulation was constantly postponed. For this reason, regulatory policy-makers, especially in the UK, have talked about 'filling the knowledge gaps' since the first regulatory discussion until today. Indeed, how much nanomaterials bear a risk for human health or for the environment is unknown. Risk research desperately seems to try to catch on with the speedy marketing of new nanotechnology-products, but their results seem to stay behind. Uncertainty might prevail for a long time because conventional toxicity tests are partly inadequate and measuring nanomaterials is inherently complicated because what is true for, e.g. a gold particle of 4 nm size might not be valid for a silver particle of the same size and it might not be valid for a gold particle 1,2 nm size neither. In fact, the behaviour of nanomaterials is impacted by abundant factors, such as manufacturing process, characteristic of the material, density, size, and so forth. In this context, practices of evidence-gathering could have postponed regulation eternally. Therefore, the logic of evidence-gathering is intertwined or challenged by the logic of adaptation.

The social *logic of adaptation* captures how the logic of pre-emption masks over potential moments of dislocation by keeping nanotechnology governance open and flexible. Instead of closing discussion on nanotechnology regulations with unambiguous rules and clear-cut definitions, the uncertainty of the regulatory object, nanotechnology, is mirrored in the flexible policy instruments adapted to nanotechnologies. When a struggle about definitions

and rules loomed, the logic of pre-emption manifested in soft laws which negates closure and thus wards off the eruption of conflict. The logic of adaptation represents the newness of technology regulation most clearly: Nanotechnology governance, in this respect, seems like a political experiment, which allows for plurality and motion.

In fact, I demonstrated how it impacts on nanotechnology regulatory policy-making, when the political space of nanotechnology is kept elusive in my analysis of *the politics of naming* in the field. As such, the regulatory object nanotechnology seemed to 'vanish', when it came to defining the content of regulation, such that demands for nanotechnology regulation were particularized by highlighting the diversity within the nanotechnology field. Thus, while the first empirical chapter shows how nanotechnology was constituted as a 'promising project' by subsuming diverse scientific fields, the last empirical chapter explains that this unity was dissolved in order to prevent regulation. The nanotechnology regulatory policy debate focused on the question whether nanomaterials need new policies or whether existing ones are sufficient. In the debate, nanotechnology was normalized by advocates of the position that nanospecific regulations were not required. For example, a strategy to deflect from nanospecific regulation was to question nanospecific properties and to highlight the diversity of materials on the nanoscale, including their shape, characteristics and behaviour. So, discussion in the science journal *Nature* with which I introduced this thesis was part of a regulatory discussion which revolved around the question of how 'new' or 'not new' nanomaterials were. My analysis tracked how policy-makers demarcated nanomaterials from each other or from other materials. I contributed to the literature of nanotechnology and society with this analysis of how nanotechnology actors used the term nanotechnology in regulatory debates in concrete contexts. In both the UK and in Germany, the governments underpinned their stances that, according to current knowledge, existing regulations sufficiently covered nanomaterials by highlighting that nanomaterials were ordinary and therefore ordinarily covered by existing laws that generally prohibit the release of dangerous materials into the environment or on the market. Nanotechnology's exceptional character, which advocates constructed in the innovation-period of nanotechnology governance, was downplayed by connecting nanotechnology to ordinary policy problems such as fine particulate, by strategies of temporalisation, which connected nanotechnology with long time-experience, and by blurring the boundaries between the artificiality of engineered nanoparticles and naturally occurring nanoparticles.

This complex array of social logics characterises a regulatory regime which is marked by the hegemony of the responsible development discourse and the logic of pre-emption. This dissertation brought out the complexity, contingency, contradictions, and multiple logics at play and ultimately the politics of nanotechnology regulation. In fact, the logic of pre-emption goes further than the logics of anticipation identified by other scholars of nanotechnology governance (see Kearnes 2009, Barben et al. 2007). Crucial in pre-emption is not, generally-speaking, the anticipation and imagination of technology development and the intervention at an early phase, but the imagination of *potential conflict* and that – this is my argument – nanotechnology governance is aligned in the goal to pre-empt conflict, that is, to avoid a politicisation of nanotechnology. At the same time, this is not to reduce public engagement to a 'pure' instrumental act but to highlight that the logic of pre-emption has important implications for democratic policy-making, as I will discuss below. Another demarcation to the anticipatory governance work of others is my level of explanation; that is, I investigate why nanotechnology actors set out "to do it right" with nanotechnologies at all in the first place and why the imagination of an anticipatory radar system could catch on: How, in detail, did this new pre-emptive risk regime emerge?

8.2 Explaining the emergence of a regulatory regime

My dissertation critically explained how a pre-emptive regulatory regime on nanotechnology, 'the responsible development of nanotechnologies,' developed. Deploying political discourse theory, I have demonstrated that the process of the emergence of a regulatory regime is best characterised as a hegemonic project, dependent on socio-political context and on an ability to present itself as the only possible alternative which implies the role of fantasmatic appeals and articulation. In contrast to the premises of traditional approaches to regulatory policy-making, a fruitful investigation into the emergence and change of regulations thus does not focus on causality but on conditions of possibility. The starting point for any regime to become embedded is hegemonic struggle between political projects; that one project becomes hegemonic implies thus exclusion. Indeed, hegemony is gained by constructing a dominant discursive formation with an empty signifier: Constituting such an empty signifier involves defining what the hegemonic project is and is *not* (a constitutive outside) and in this process rhetorical strategies and fantasies play a crucial role. Horrific fantasies are projected onto the outside, while beatific fantasies fill the inside with content. Demarcation by political logics that function as chains of equivalences

(referring to the inside) and chains of differences (referring to the outside) is thus central for the stabilisation of hegemonic projects. By taking this into consideration, I could therefore demonstrate what the conditions of possibility were for the nanotechnology regulatory regime to develop. That is, I deconstructed what the problematizations of nanotechnology in policy-making were demarcated to in the specific socio-political context of my cases. Most importantly, the construction of the object was central to this analysis, while it is often ignored in standard accounts. As I will conclude in the following, I carved out the importance of fantasy in the constitution of nanotechnology and in the initiation of regulatory response, as well as the importance of context, and the role of articulation and of the emptying of meaning.

First, I addressed the role of fantasy and the affective dimension of nanotechnology governance. When nanotechnology rose on the agenda of science policy, policy-makers were gripped by powerful fantasies of what there was to come: a technology which would bring economic growth, technical leadership, unemployment, stop of world hunger, and a solution to climate change. These promises were carried on by policy reports marked by *practices of forecasting* which contributed to stabilising the emerging technology. When, nanotechnology later was articulated into a cascade of technology and governance failures, such as the BSE crisis, cancer caused by asbestos, or GMO protests, state elites (i.e., civil servants, STS community, industry representatives) were alert to these developments. Against the background of GMO protests, they were gripped by the fear that the public might be prone to believe in horror fantasies, such as the grey goo scenario. They came to perceive the innovative nanotechnology-project as under threat and the discourse could catch on that all efforts had to be aligned to avoid another technology governance failure. Consequently, regulation was set in place to protect this nanotechnology-project.

We see, thus, how the construction of nanotechnology and fantasy were important vectors impacting on the upcoming regulatory regime. I showed in both case-studies how regulation was re-articulated from a threat to innovation to a necessary element guaranteeing regulation. My analysis brought to the fore that the move towards a risk regime on nanotechnologies emerged from internally; that is, from policy-makers who started to pre-empt what was potentially threatening innovation. They put in place a regulatory regime in order to stabilise nanotechnology development. In both cases, the 'responsible development of nanotechnologies' could catch on because nanotechnology turned into a policy issue of

"applying lessons learnt." In other words, nanotechnology governance was the solution to the problem of GMO. This demarcation to the outside (GMO as the dismissed other) was again central for stabilising the new hegemonic regime of responsible development. Policy-makers in Germany (i.e., the VDI TZ, the VCI, DECHEMA) as well as policy-makers in the UK (i.e., Defra or the RS) took this equivalences between nanotechnology and biotechnology as given. Enrolled in this way by the fantasmatic appeal of the wow-yuck narrative, they articulated the responsible development as the only alternative. As a result, the logic of pre-emption gripped across policies and could manifest in various practices. It set in place governance practices as characterised in the previous section of this conclusion.

In fact, I suggested throughout my study that 'the responsible development' could catch on because the concept bridges the dichotomy between progress and stand-still. It represents the fantasy of 'getting it all' by constructing the possibility of a win-win-situation: we still continue developing, but responsibly. Thus, 'responsible development' does not endanger the vision that the nation-states Britain and Germany can gain a better quality of life and general well-being through nanotechnology. It does not threat to steal enjoyment, such as a restrictive moratorium would.

Second, I demonstrated the importance of context by deconstructing the process of the rise of nanotechnology as a research field in the discursive economy of the two case-studies and by embedding the discursive shift towards the responsible development of nanotechnologies in the general move towards a public regime of science governance. I pointed out that we have to consider that a shift in research and development policies to innovation policies took place in the 1990s in both countries; a shift which was characterised by a *discourse of commoditisation*. The overarching policy aims of such innovation politics were that research should quickly be translated into tradeable products. Classical rhetorical tropes of innovation policy are *efficiency, exploitation and competition*. Policy entrepreneurs articulated nanotechnology into this rhetoric and thus it could grow. I showed that nanotechnology was articulated as part of an overarching modernisation-project in both cases: of the 'politics of catch-up' in Britain and of 'ecological modernization' in Germany. Furthermore, I pointed to the circulation of international nanotechnology discourses and to their reiteration in the UK and Germany. Particularly, the rise of horror fantasies in America (Drexler's grey goo, Joy's *Why the Future doesn't need us*, and Crichton's science fiction novel *Prey*) changed the context of nanotechnology governance in my cases.

Third, my analysis pointed out that an articulation of nanotechnology as solution to problems of the time was accompanied by loading and emptying of the term 'nanotechnology.' As such I brought out the contingency in the constitution of nanotechnology. The construction of the regulatory object impacts heavily on the emergent regulatory regime but is ignored in traditional studies on regulatory policy-making. Ironically, the extension of the signifying chain 'nanotechnology,' that developed in the innovation-period, made it possible that nanotechnology came under threat because nanotechnology seemed to be omnipresent and powerful. The promising nanoworld was ultimately challenged when, internationally, technology critics and NGOs argued that nanotechnology could get out of control and that it might constitute a risk for human and environmental health and safety. As this was based on the extension of the signifying chain, the signifying chain was (and could be) particularized again in substantive discussions of regulatory policy-making.

To summarise, my dissertation has revealed the importance of the often taken for granted elements of regulation, such as the construction of the regulatory object. In addition, I opened up new insights into the constitution of regulatory regimes by pointing to the role of fantasy and the affective dimension of policy. The innovative part of my study is to show the grip of fantasies in nanotechnology governance (promises, visions, but as well horror fantasies) and that they triggered a change in nanotechnology governance. I see myself as stepping back from what others take for granted (e.g. any obvious link drawn from nanotechnology to biotechnology) and rather, I try to track how this link was established in the rhetoric of nanotechnology documents; in other words, how nanotechnology was articulated within a cascade of technology accidents or governance failures from asbestos, BSE to GMO. The nanotechnology regulatory regime was initiated by the imagination of conflict. GMO was met with precaution: first with policies to contain hazards in the laboratory, and then (in the EU) with the precautionary principle as a reaction to public protests. But nanotechnology governance did not react, it pre-empted. It aimed at avoiding the situation where classical governance by state institutions and regulatory agencies would become necessary, by avoiding a potential politicisation. But what do my results say about theoretical development and the application of political discourse theory in the field of public policy?

8.3 Discourse theory in the field – explaining policy change

As the preceding sections demonstrated, political discourse theory drives us to examine how governing practices change existing regimes, constitute new norms, and how this transformation is reproduced in new routines and institutions. Poststructuralist policy analysis assumes that these developments are contingent and political discourse theory thus highlights that a particular hegemonic project results from hegemonic struggles. For the analysis of hegemony in policy analysis, political discourse theory equips us with a range of concepts such as empty signifiers, dislocation, and chains of equivalences and differences. The latter are captured as political logics in the methodological framework that I applied. Throughout my case studies, I showed how political logics of differences and equivalences can be analysed through a thorough study of political rhetoric. Demonstrated thus at the level of empirical enquiry, I contributed to the field of Interpretative Policy Analysis by articulating political discourse theory together with rhetorical policy analysis. Rhetorical policy analysis provided helpful explanatory devices on the micro-level of analysis, such as arguments, analogies or rhetorical shifts.

However, my analysis raises questions of conceptualising change. As said in Chapter Two, political discourse theory's explanations of change depend on dislocation. In a political discourse theory approach, policy change is a response to discursive change which again is triggered by hegemonic struggles over dislocations (Torfinn 1999:241). A dislocation emerges when an event cannot be represented by the hegemonic discursive structure, which consequently is disrupted (ibid.: 149). Now, my empirical analysis showed that change was predicated on fear fantasies: I argued in this thesis that a change of the regulatory regime from GMO to nanotechnology was governed by *a logic of pre-emption*. Thus, the shift from seeing regulation as a threat to reconceptualising regulation as necessary condition for development was rather triggered by a fear of the fear caused by reasoning of analogy (to GMO) than by a disruptive moment. Certainly, the rising horror fantasies had dislocatory potential but was this a dislocatory moment? I showed in my analysis that fantasmatic appeals are inherent in what governance actors construct as discursive change. That is, change is triggered by struggles about dislocations but I consider the moment when and why actors *decide* that hegemonic discourses *were* dislocated as not sufficiently problematized in theory. This concerns in particular the question of how fear (horrific fantasies) fits with understandings of dislocation. A criticism of political discourse theory is thus that *change*

can be more incremental and does not necessarily require a disruptive moment evoking dislocation.

By means of applying the conceptual grammar of a *logics of explanation*, I was equipped with a methodology that put me in a position to analyse nanotechnology governance from a new perspective, but I experienced ambiguities in employing the terms of analysis. The new regulatory regime comprises a set of social and political practices, such as networking and the writing of guidelines. The boundary as to how much these practices are social or political practices is not clear cut (Glynos & Howarth 2007: 123). On the one hand, these practices became the normal way of doing nanotechnology politics; on the other hand, the paper showed how they were significant in the institution of this new responsible regulatory regime. We can look at these practices as ones in which the "social dimension is foregrounded," (ibid.:121) insofar as they prevent public contestation because the potential dislocation of nanotechnology is concealed by their displacement into supposedly pre-political settings. At the same time, this hints at the political dimension of such practices. Indeed, this is only one facet of the challenges when problematizing, operationalizing, and demarcating logics in practice. The logic of evidence-gathering, for example, could be as well be part of the logic of scientification; and in addition its relation to the logic of adaptation (adaptation does not overcome evidence-gathering but it still transforms a logic of evidence-gathering) is problematic from a theoretical perspective. However, these conceptual ambiguities do not diminish the value of my empirical results. I, as the researcher, articulated empirical data along theoretical concepts and I, thus, decided on the naming of logics – any such judgement is necessarily only heuristically because all practices contain social, political, and fantasmatic elements.

Indeed, this indicates another problem of the logics framework, which is, that the logics can be easily over-determined and that they bear the risk of subsuming the empirical with theoretical concepts instead of articulating the empirical and theory together to produce a critical explanation. That is, readers and researcher have to bear in mind in their interpretations of this and future studies in political discourse theory that the relationship between empirical data is not found but brought into being by articulating it with theoretical concept. Political discourse theory has been developed since the 1980s and the added value of the approach derives from concepts such as discourse, hegemony, signifying chain, or empty signifier. The logics-framework formalises discourse theory and overcomes its

methodological weaknesses; that is, it increases the access to and comprehensiveness of discourse theory to policy analysts. How much it facilitates on the one hand or complicates analysis on the other hand must be evaluated case-by-case and by the researcher.

As concerns the conditions of *emergence* of the new regulatory regime, I brought to the fore the role of fantasmatic appeals and emotional, affective responses in policy-making. The *fantasmatic wow-yuck logic*, by which industry and policy-makers were gripped, was a significant explanatory device for why regulation was initiated. In addition, fantasy is also an inherent part of the responsible development which, as said above, bridges a structural problem of technology development: it promises progress and safety at the same time. Everybody agrees to 'responsible development;' as any hegemonic project it absorbs opposition, and it does not threaten to steal enjoyment. We can also see its successful hegemonic appeals insofar as other alternatives – such as to stop development – are no longer an option. In the following, I will critically evaluate what such pre-emption does to policy-making.

8.4 Discussion: Implications for practice

When nanotechnology governance, as I claim, constitutes a change in technology governance – what are the implications of this pre-emptive move for policy-making? In the following, I will reflect on the pre-emptive logic. I will first shed light on its constructive side, and then turn to its flipside.

This thesis contrasted the institution of the new regulatory regime characterising nanotechnology with the contested regime of biotechnology governance. But we could as well see the soft mode of nanotechnology regulations in opposition to the hegemonic mode of evidence-based policy-making. In this respect, we can see a constructive side of the pre-emptive move: the regulatory debate was first and foremost marked by a strong demand for evidence, in other words, by social practices which consider knowledge (evidence) as a prerequisite for regulatory policy-making. Such a context could have meant stalemate, but the governance of the 'responsible development of nanotechnology' enabled action despite uncertainty. This action consists of the establishment of a communication system, permanent surveillance of developments in the nanofield, and the appointment of actors responsible for dealing with nanotechnologies in each institution. In a way, the object nanotechnology is

mirrored in the flexible policy instruments adapted to nanotechnologies. The adoption of soft laws sustained the flexibility of interpretations, and it kept the process of regulating nanotechnologies open – both aspects that allow for integrating opposition.

However, the pre-emptive aim has to be problematized.²⁵ Conflict, discussion and irrational fears are legitimate inputs to policy-making which should not be erased but addressed within our democratic system. As Freeden (2005) argues: "[t]o attain idealtype consensus is, ultimately, to silence criticism by disabling it" (132). And Chantal Mouffe writes:

In politics the public interest is always a matter of debate and a final agreement can never be reached; to imagine such a situation is to dream of a society without politics. One should not hope for the elimination of disagreement but for its containment within forms that respect the existence of liberal democratic institutions.
(Mouffe 2005: 50 [1993])

Important political decisions are concealed, if the pre-emptive mode of science and technology governance is successful in pre-empting a public politicisation (Åm 2011:128). In the course of my interviews, upstream engagement and stakeholder dialogues were often considered as *pre-political discourse process*. 'Pre-political' has two different meanings in this respect. First, it refers to 'pre-politics', that is, the aim to locate the politics of defining the policy problem away from conventional politics, such as party politics. Discussions take place in newly established governance networks which can be dislocated from normal politics, i.e. a parliamentary discussion. The second sense of 'pre-political' in 'pre-political discourse process' means to avoid contestation and polarisation. I suggest that these efforts to avoid polarisation are based on a simplified conception of 'the political' as politics of predefined interests that have to be overcome. It ignores that "social relations take shape and are symbolically formed" (Mouffe 2005: 11 [1993]) at the political level. Thus, we have to draw attention to "the identity of the 'we' that is going to be created through a specific form of collective action" (Pitkin after Mouffe 2005: 50 [1993]), such as a NanoCommission. By relating different interests to the common project of 'the responsible development of nanotechnology,' a temporal unity among the members of stakeholder forums might be reached that also transforms subject positions, because subjects are woven into new constellations of social relations that generate trust and mutual responsibilities. If due to the efforts in stakeholder forums such as the NanoCommission, adversary claims are no longer publicly articulated, the project was successful in preventing a public politicisation. At the

□ A part of this discussion has been published: Åm, Heidrun (2011). Trust as Glue in Nanotechnology Governance Networks. *Nanoethics* 5(1):115-128

same time, this is a *political* outcome because it contributes to ordering social relations. Thus, current nanotechnology governance can never claim to constitute a pre-political discourse process. The political in the seemingly apolitical must be highlighted in order to identify potential democratic pitfalls of new governance instruments.

For example, the practices of coming together in stakeholder forums produce constraints and opportunities for the relation between nanotechnology and society. When the members of the commission try to make sense of this vague thing called nanotechnology, they enact the relationship between nanotechnology and society in a way which implies that certain issues are ruled off the agenda. As Finlayson put it, they contribute to setting the boundaries of the political argument:

Arguments of place are attempts to set the boundaries of political argument and may be particularly important since to rule certain issues off the agenda is to win before argument has begun.
(Finlayson 2007: 555)

When defining the policy problem of nanotechnology and developing recommendations like codes of conduct in governance networks, participants are not only exchanging arguments, "but [this is] also a performative process in which the boundaries of argumentation are defined" (Gottweis 2007: 245).²⁶

In the future, the question will be where in the politics of pre-emption the relationship between society and nanotechnology can be defined, whether the inclusive practices of consensus allow for counter-movements and alternative projects, and how much this kind of regulatory regime is proof against risks. Policy-makers highlighted that these pre-regulatory initiatives (such as code of conducts) were developed 'upstream' that is before the marketing of products. Nanotechnology governance was hailed for coming in early. By the year 2011, however, the marketing of nanotechnology products has increased substantially. According to the Woodrow Wilson inventory of nanotechnology-based consumer products, there were 1317 products available on the market²⁷ in April 2011. Future research has to track what happens to the pre-emptive modus in the practice of governing specific products in their life cycle by in-depth case studies of regulatory approaches to actual nanotechnology applications within their socio-political context.

²⁶ End of reference to Åm 2011.

²⁷ See www.nanotechproject.org/inventories/consumer/

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10 Annexes

- German Summary
- Curriculum Vitae

Deutschsprachige Zusammenfassung

Regieren unter Bedingungen der Unsicherheit: Nanotechnologie-Governance als Lösung für das Problem der Gentechnik

Diese Doktorarbeit erklärt wie das hegemoniale Nanotechnologie Regulierungsregime, das sich einem „Verantwortlichen Umgang mit Nanotechnologien“ verschreibt und von loser, flexibler Regulierungspolitik, wie *soft laws*, und von intermediären Institutionen wie Stakeholder Foren geprägt ist, entstand und sich durchsetzen konnte. Meine zentrale These ist, dass wir in Nanotechnologie-Governance eine neue Art der Regulierung identifizieren können und dass die Implementierung dieses Regulierungsregimes von dem Politikziel angetrieben wird, Konflikte vorwegzunehmen und diese zu entleeren bevor sie entstehen; Konflikten also ihren Möglichkeitsbedingungen zu entziehen. Das theoretische Erklärungsmodell, das ich dafür entwickle, bezeichne ich als *logic of pre-emption*. Im Laufe der Arbeit zeige ich, wie sich diese Logik im hegemonialen Diskurs des „Verantwortlichen Umgangs mit Nanotechnologien“ manifestiert und zu einer neuen Art der Regulierung unter Bedingungen von Unsicherheit führt.

Vor dem Hintergrund strenger Vorsorgemaßnahmen, die im europäischen Raum für Gentechnik getroffen wurden, sind die nichtvorhandenen nanospezifischen Regulierungen verwunderlich, besonders da bereits hunderte Nanotechnologie-Produkte auf den Markt gebracht wurden, ohne dass die Risikoabschätzung diverser Nanomaterialien abgesichert wäre. Diese kritikarme Verbreitung ist besonders überraschend als gemeinhin davon ausgegangen wird, dass Nanotechnologie Governance sehr früh ansetzt und dass wir in einer Gesellschaft leben, die sich den negativen Auswirkungen von Technologieentwicklung schmerzlich bewusst ist; Stichwort Tschernobyl, BSE und Asbest. Andererseits könnte es eine Missinterpretation sein, *soft laws* vorschnell als eine schwache Form der Regulierung zu bezeichnen. Wichtige Regulationstheoretiker wie Giandomenico Majone (1994) und David Levi-Faur (2005) betonen, dass es sich bei diesen Regulierungsformen, um eine sehr enge, konstante Form der Kontrolle handelt. Das wirft wiederum die Frage auf, was die Nanotechnologie so verdächtig macht, dass sie einer Überwachung bedarf? Denn es ist unsicher, inwieweit sich Nanomaterialien anders verhalten als herkömmliche Materialien und ob sie Risiken mit sich bringen.

Die vorliegende Arbeit widmete sich diesem Problemaufriss entlang der zwei Fallstudien Großbritannien und Deutschland aus der Perspektive einer poststrukturalistischen Analyse von Hegemonie in einem Politikfeld. Mein Ziel war, das Entstehen und Verändern von Regulierungen und wie in diesem Prozess Antagonismen überwunden werden zu erklären. Das beinhaltet, dass ich davon ausgehe, dass Bedeutungen kontingent und konstruiert sind. Was Nanotechnologie ist und warum und wie sie reguliert wird, ist demnach Ergebnis einer hegemonialen Auseinandersetzung von einander entgegenstehenden Artikulationen. Wenn eine Bedeutung erst hegemonial wurde, werden ihre Wurzeln oft vergessen. Es bedarf demnach einer genauen Dekonstruktion der Möglichkeitsbedingungen für ihre erfolgreiche Hegemonie. Traditionelle Ansätze der Politikfeldanalyse schenken der Konstruktion des Regulierungsobjektes keine Aufmerksamkeit, sondern gehen von einem essentiellen Charakter des Feldes aus. Fehlende Nanotechnologie-Definitionen werden in diesem Fall zum Beispiel als Probleme gesehen, die gelöst werden müssen (und können), während meine Arbeit auf die Kontingenz und Veränderung der Begrifflichkeiten verweist und die Konsequenzen daraus auf die getroffenen Regulierungsmaßnahmen herausarbeitet.

Dadurch war es mir unter anderem möglich zu zeigen, dass Ziel des Regulierungsregimes, das sich in Nanotechnologie-Governance herausgebildet hat, ist, das Nanotechnologie-Projekt zu stabilisieren, also die Weiterentwicklung des Diskurses zu garantieren. Ich bin zu diesem Ergebnis gekommen, in dem ich untersucht habe, wie Nanotechnologie als *policy issue* innerhalb von Regulierungspolitik artikuliert wurde. Nanotechnologie wurde ursprünglich von WissenschaftlerInnen, Beamten und TechnologiekonsulentInnen als Thema innerhalb von Wissenschafts- bzw. Innovationspolitik positioniert. Im dritten Kapitel habe ich detailliert gezeigt, wie Nanotechnologie als Lösung verschiedener gesellschaftlicher Probleme präsentiert wurde: Nanotechnologie würde die Effizienz von Produkten fördern, die Effektivität der Umsetzung von Forschungsförderung in Industrieapplikationen verbessern, sowie uns vor Welthunger und Klimawandel retten und generell ein besseres Leben und Wirtschaftswachstum mit sich bringen. Meine Analyse hat im Kontext meiner Fallstudien nachgezeichnet wie sich Nanotechnologie vor dem Hintergrund eines Wettbewerbsstaats und der Kommoditisierung von Wissen positionierte und wie in diesem Prozess die Signifikationskette des Begriffes "Nanotechnologie" konstant und mit Versprechungen darüber, was noch kommen würde, erweitert wurde, so dass Nanotechnologie zur Schlüsseltechnologie oder zur Technologie des 21. Jahrhunderts wurde, die eine neue industrielle Revolution mitbringe. Mehr und mehr Elemente (zum Beispiel

Wissenschaftsdisziplinen, Produkte, Forschungsinstitutionen und fantastische Versprechungen) wurden Momente des Nanotechnologie-Diskurses, womit sich die Identität dieser Elemente sowie "die Nanotechnologie" veränderte. Gleichzeitig war das die Möglichkeitsbedingung, um Nanotechnologie als wichtiges nationales Modernisierungsprojekt zu artikulieren, wie das in beiden Fällen geschah. Wichtige Kontexte, die das Wachsen der Nanotechnologie bedingten, waren dabei Großbritanniens "Politik des Aufholens", die durch Nanotechnologie vorangetrieben werden sollte, und Deutschlands "Ökologische Modernisierung", in der die Nanotechnologie eine wichtige Umwelttechnologie wäre.

Meine These ist, dass die Kehrseite dieser Erweiterung der Signifikationskette war, dass Nanotechnologie sich als durchdringende, mächtige und allgegenwärtige Entwicklung präsentierte. Das öffnete ein diskursives Feld in dem sich auch Gegenbewegungen einhaken konnten. Als kurz nach der Jahrtausendwende, eine Kritik der Nanotechnologie lauter wurde, reagierten staatliche Eliten, die sich aus ForscherInnen, SozialwissenschaftlerInnen, PolitikerInnen, IndustrievertreterInnen und BeamtenInnen zusammensetzten, äußerst wachsam. Von furchtbaren Vorstellungen gefesselt, dass die Öffentlichkeit das wunderbare Nanotechnologie-Projekt aufgrund von irrationalen Ängsten zurückweisen könnte, entstand die Überzeugung, dass man Nanotechnologie von dieser Bedrohung schützen müsse. Wie ich im vierten Kapitel darstelle, muss diese Wachsamkeit im Kontext von Protesten gegen Gentechnik gesehen werden. Tatsächlich bescheiden Untersuchungen der Nanotechnologie eher positive Umfragewerte, was wirklich etwas in der Nanotechnologie-Politik änderte, waren nicht die Horrorfantasien, dass die Technologieentwicklung außer Kontrolle geraten könnten, sondern *die Angst vor der Angst*, von Arie Rip als Nanophobia-phobia bezeichnet. Das ist der Ursprung des pre-emptiven Regulierungsregimes, das sich von da an entwickelte und damit hat die Arbeit innovativ auf die zentrale Rolle von emotionalen, affektgesteuerten Reaktionen im Policymaking verwiesen. Es ist wichtig sich dieser Wurzeln des Regulierungsregimes zu verdeutlichen, denn der Hintergrund, dass es bei dem Regulierungsdiskurs, um die Stabilisierung von Innovation ging, hat Implikationen auf möglichen Entscheidungsalternativen. Es geht dann nicht, um die Restriktion von Technologieentwicklung zur Vermeidung von Risiken, sondern um die Ermöglichung von Technologieentwicklung mit der gleichzeitigen Vermeidung von Konflikt.

Im fünften Kapitel habe ich dargestellt wie diese diskursive Veränderung konkret in den Politikfeldern meiner Fallstudien Fuß fasste und im sechsten Kapitel, wie sich die pre-emptive Logik in neuen intermediären Nanotechnologie-Institutionen manifestierte. Generell besteht ein Regime laut dem in der Untersuchung angewandten methodologischen Rahmen aus sozialen und politischen Praktiken. Soziale Praktiken beinhalten das tägliche, unhinterfragte Tun in dem ein hegemoniales Regime beständig reproduziert wird. Das Konzept der politischen Praktiken bezeichnet jene Praktiken in denen diese sozialen Praktiken öffentlich herausgefordert werden in dem sie deren Kontingenz verdeutlichen; also darauf hinweisen, dass es auch anders sein könnte. Der Terminus der Logik erfasst, was eine Praktik treibt; wie sie funktioniert. Ich habe im Laufe der Arbeit folgende zusammenfassende Charakterisierung des Regulierungsregimes "Verantwortliche Entwicklung von Nanotechnologie", das von einer politischen *logic of pre-emption* installiert wurde, entwickelt: Aktuelle Nanotechnologie-Governance ist geprägt von sozialen Logiken der Verwissenschaftlichung, der Netzwerk-Governance, der Evidenzsammlung und der Adaption. Im Folgenden gehe ich kurz auf diese Governance Praktiken ein.

Mit der sozialen *Logik der Verwissenschaftlichung* erfasse ich, dass sowohl in Deutschland als auch Großbritannien, Nanotechnologiepolitik von zentralen Forderungen nach Vernunft und Sachlichkeit gesteuert ist. Was von meinen InterviewpartnerInnen und in Policydokumenten als überhitzte, emotionale, unsachliche Gentechnik-Debatte artikuliert wird, soll betreffend Nanotechnologie vermieden werden. Die soziale Logik der Verwissenschaftlichung implementiert damit das Ziel der politischen *logic of pre-emption*. Einerseits operiert die Logik der Verwissenschaftlichung dabei als strategische Grenzziehung, denn für ein hegemoniales Projekt ist es immer konstitutiv, sich von einem Außen, dem Anderen, abzugrenzen. In dieser Verwissenschaftlichung wurde zum Beispiel Nanotechnologies technologischer Charakter betont, damit der visionäre Anteil am Begriff ausgegrenzt und so die Debatte depolitisiert. Am deutlichsten wurde das im Fall von Prinz Charles, der nach seinen öffentlichen Appellen für Nanotechnologie-Risikogovernance als Anhänger von Science Fiktion Theorien bezeichnet und damit aus der "vernünftigen, wissenschaftlichen Politik", die Deutungshoheit beanspruchte, ausgegrenzt wurde, womit sich die Autorität seiner Kritik verringerte. Andererseits treibt die soziale Logik der Verwissenschaftlichung Praktiken wie wissenschaftliche Risikobewertung voran.

Weiters hat sich die pre-emptive Logik in der *Politik der Netzwerk-Governance* manifestiert. Die zahlreichen Formen von Netzwerken (Stakeholder Foren, Kommissionen, Arbeitsgruppen, Öffentliche Dialogforen), die in beiden Fallstudien implementiert wurden, tragen dazu bei Konflikte zu entleeren, weil potentielle Opposition im hegemonialen Projekt des "Verantwortlichen Umgangs mit Nanotechnologie" absorbiert werden, wenn sie Teil des regierenden "wir" werden. Wie die Logik der Verwissenschaftlichung ist die Netzwerk-Politik Teil der Grenzziehung zwischen innen und außen; Netzwerken konstituiert Äquivalenzen zwischen Governance-Akteuren.

Die Funktion des Begriffes "Verantwortlicher Umgang mit Nanotechnologien" als *Empty Signifier* ist in der Politik der Netzwerk-Governance im Besonderen – und in der Institutionalisierung der pre-emptiven Logik generell – zentral, weil es die Zusammenarbeit in den Netzwerken unter einem gemeinsamen Nenner ermöglicht. Ich habe in meiner Arbeit außerdem gezeigt, dass dieser Empty Signifier "Verantwortlicher Umgang mit Nanotechnologie" hegemonial werden konnte – also sich als universelles Projekt etablieren konnte – weil es die Fantasie repräsentierte, dass wir alles haben könnten: Entwicklung *und* Nachhaltigkeit, ohne die Vision, dass Nanotechnologie ein besseres Leben bringt zu bedrohen.

Im siebten Kapitel habe ich gezeigt, dass die Hegemonie des pre-emptiven Regimes in der Regulierungsdiskussion durchaus herausgefordert wurde. Der Diskurs, dass Regulierungen zur Stabilisierung des Nanotechnologie-Projekts notwendig sind, findet keine einhellige Zustimmung, wenn es darum geht, den Inhalt der Regulierungen zu fixieren. Tatsächlich wird die lange Equivalenzkette, die den Signifier "Nanotechnologie" seit Ende der 1990er Jahre charakterisiert, in der Regulierungsdiskussion wieder in ihre Bestandteile aufgelöst. Die Forderung nach einer nanospezifischen Regulierung, in anderen Worten nach Regulierung im Namen von Nanotechnologie, wird zurückgewiesen und die Forderungen werden fragmentiert. Ich habe diesen Prozess mittels der Analytik einer Rhetorischen Policy Analyse untersucht und damit einen wesentlichen Beitrag zur sozialwissenschaftlichen Nanotechnologie-Literatur geleistet. Was ich zeige ist die gleichzeitige Möglichkeit und Unmöglichkeit einer Technologie. Grundsätzlich dreht sich die Nanotechnologie-Regulierungsdiskussion um die Frage, wie neu Nanotechnologie ist und damit neue Regulierungen erfordert, oder wie herkömmlich ihr Charakter ist, wodurch sie von bestehenden Vorschriften gedeckt wäre. Die Befürworter der Nanotechnologie, die zuerst den außergewöhnlichen Charakter des Feldes betont haben, werden in der Regulierungsdiskussion

nicht müde, die Gewöhnlichkeit der Nanotechnologie hervorzuheben und diese zu normalisieren. Ich argumentiere, dass das, zum Beispiel, durch rhetorische Strategien geschieht, die Nanotechnologie eine Historizität verleihen. So argumentieren WissenschaftlerInnen, dass sie bereits seit Jahrhunderten auf Nanoebene arbeiten. Eine weitere rhetorische Strategie ist durch Analogien Äquivalenzen zu bilden, demnach Nanotechnologie beispielsweise genauso ist wie Feinstaub und dementsprechende ähnliche politische Lösungen erfordert (die von einem Moratorium weit entfernt sind). Eines der stärksten Argumente ist, die Grenzen zwischen Nanopartikeln, die natürlich entstehen, und Nanopartikeln, die durch Nanotechnologie hergestellt wurden, zu verwischen. Zum Beispiel traf ich in der empirischen Arbeit an beiden Fallstudien auf das Argument, dass alle Milchprodukte nanoskalige Milchproteine enthalten; eine Nanoregulierung also zu einem Nanolabel auf jeder Milchflasche führen würde. Dieser sich im Kreis drehenden *Politik der Namensgebung* in der Regulierungsdiskussion entkommt ein pre-emptives Regime aber, wie ich im Folgenden rekapituliere:

Das Neue an der Form der Regulation und der Charakter des hegemonialen Projektes des "Verantwortlichen Umgangs mit Nanotechnologien" (Englisch: responsible – response able – die Fähigkeit zu antworten) wird am deutlichsten in der sozialen *Logik der Adaption*, die das Regime auch charakterisiert. Mit dieser Logik erfasse ich, wie Nanotechnologie-Governance potentielle Momente der Dislokation maskiert, also mögliche Konflikte vermeidet, in dem die Regulierungen offen und flexibel gehalten werden. Anstatt beispielsweise an einem konkreten Gesetz zu arbeiten, dass eine klare, eindeutige Definition, Daten der Risikoforschung erfordert und Zustimmung verschiedenster politischer Akteure erfordert, werden grobe, abstrakte, generelle Richtlinien formuliert, beispielsweise der NanoKommissions-Report.

Diese adaptive Gestalt verdeutlicht den Vorteil und die Errungenschaft des pre-emptiven Regulierungsregimes: Es ermöglicht Handeln trotz Unsicherheit. In einem politischen Kontext in dem Politikformulierung Evidenz geleitet ist – was für Regulierungspolitik generell zutrifft und für Großbritanniens Politik im Besonderen –, hätte das nichtvorhandene Wissen über die Eigenschaften und Auswirkungen der Nanomaterialien zu völligem Stillstand in Entscheidungen über Nanotechnologie-Regulierungen führen können. Das pre-emptive Herangehen bewirkt, dass trotzdem etwas geschieht. Governance Akteure wurden in Stellung gebracht und ein Regime aufgebaut, das fähig ist bei negativen Entwicklungen rasch zu

antworten, weil ein konstantes Monitoring implementiert wurde und es in verschiedensten Behörden und Ministerien Verantwortliche für Nanotechnologie gibt.

Allerdings ist das generelle Ziel eine Politisierung der Nanotechnologie-Debatte zu vermeiden problematisch. Öffentliche Dialoge, die unter diesen Prämissen geleitet werden, stehen den deliberativen, demokratischen Idealen solch partizipativer Governance eigentlich entgegen. Politisch ist das Resultat jedenfalls, denn jede hegemoniale Bedeutungskonstruktion ist nicht unschuldig, sondern mit Macht und Deutungshoheit verbunden. Die Frage ist letztlich in welchen politischen Räumen das Verhältnis zwischen Nanotechnologie und Gesellschaft tatsächlich formuliert wird und wer und welche Vorstellungen in diesem Raum inkludiert oder ausgeschlossen sind.

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- Huber, Heidrun (2010). Governance. (In D. H. Guston (eds) *Encyclopedia of Nanotechnology and Society*, Sage: 291-296.)
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CONFERENCE PAPERS

- Åm, Heidrun (2010). Nanotechnology Politics: Rhetorical Shifts in Science Policy Practices. EASST 2010, Trento, Italy, September 2-4 2010
- Huber, Heidrun (2009). Rhetorical Shifts, Strategies and Institutionalised Systems of Meaning in the Emergence of the UK Regulatory Regime on Nanotechnologies. 4th Interpretation in Policy Analysis Conference (IPA), 25 - 27 June 2009, University of Kassel, Germany
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