Introduction

Since Donald Trump became president of the United States in January 2017 and two successive proponents of environmental deregulation were placed at the head of the US Environmental Protection Agency (EPA)—Scott Pruitt first and then Andrew Wheeler—this agency has undergone a massive disruption, both in the orientation of its policies and in the traditional way in which it develops standards and regulations for environmental protection.

Protecting the public against environmental and health threats, one of the agency's key goals for decades, has been replaced by a job protection mantra, as if the agency's mission were to promote the economy and as if regulatory measures to clean up the environment and protection from health risks linked to environmental degradations, in and of themselves, were detrimental to the economy. This reorientation motivated the reversal of many standards advanced by President Barack Obama's EPA, from greenhouse gas emissions standards for cars and light trucks, to the contemplated ban of the pesticide chlorpyrifos, to the obligation to declare methane emissions from drilling operations. These efforts look like an unprecedented attack on environmental rules adopted in the United States and the fundamental vocation of the agency (Dillon et al. 2018).

In keeping with this reorientation, the new leadership of the agency has radically altered the way that the agency uses science. The budget cuts inflicted on the EPA have severely reduced the capacities of its Office of Research and Development (ORD). References to the agency's scientific mission in its official website presentation have been obliterated and, very recently, the use of the term *science-based* has been banned in official agency communication. The membership of the Science Advisory Board (SAB), a panel of external scientists who review key policies and proposals of the

agency, has been completely renewed, based on a rule that excludes researchers who benefited from research grants by the agency—thus promoting scientists funded by other sources, notably by the industries that the agency regulates. In 2018, the EPA administrator unilaterally decided to apply at the agency a bill that had repeatedly failed to pass in Congress, according to which unpublished scientific studies may not be used as evidence by the agency (Hakim and Lipton 2018). This provision de facto excludes epidemiological studies of the health effects of pollution on populations (such as biomonitoring studies) that are generally not published in order to preserve the confidentiality of the people included in the cohorts. It severely deconstructs what is considered acceptable evidence, and restricts the use of the regulatory knowledge that is most conducive to protective standards (Mayo and Hollander 1991; Wagner and Steinzor 2018; Wagner et al. 2018).

With these measures, these two administrators reversed the traditional policy focus of the agency on the reduction of risk, as well as the pattern of using science to advance this policy. They are ignoring what had become a rule in the EPA: the formal separation between scientific assessment of environmental issues and policy development—a central tenet of the risk paradigm that the agency embraced in the early 1980s. For past administrators of the agency, whether Republican or Democrat, this is a complete and dangerous reversal of the rules that made the credibility of the EPA (Ruckelshaus 2017; McCarthy and McGabe 2018).

This attack on science and the traditional process for regulating risks is due, first, to the belief among Republicans that science is a bastion of politically biased environmentalism. Over the past two decades, Republicans have become fierce opponents of environmental policy and regulation (Layzer 2012; Sellers 2018). Second, the attack reflects a more fundamental and gradual decline in trust in science among conservatives. Since the 1990s, political conservatism compounded with religious conservatism to create a rise in the proportion of Republicans who do not believe in evolution (nearly 70 percent) and who maintain that the effects of global warming have been exaggerated (50 percent) (Gauchat 2012). During the two terms of President George W. Bush, this stance translated into aggressive editing or twisting of the science produced inside the agency to support the Republican's agenda (UCS 2008; see also Rich and Merrick 2006, Freeman and Vermeule 2007, Rest and Halpern 2007, Shulman 2008, and Shapiro 2009). The attack on the EPA's science in the current presidency is not the

first one that the agency's science has had to endure (McGarity 2001; Fredrickson et al. 2018).

But conservatives attack the use of science in policy for a third, perhaps even more fundamental reason. Risk regulation is rooted in science, and their wish is precisely to roll back or eliminate altogether environmental constraints on business development. Science is, to use Mark Brown's apt phrase, a "proxy battleground for politics" (Brown 2009, 3) and, further, a medium for the assertion of legitimate policies and institutions. Conservatives are not attacking science as much as science-backed federal administration (Miller 2017). The radicalism of these attacks reflects the deep, historical institutionalization of the recourse to science for policymaking at the EPA, as well as the way in which science has authorized the EPA to address environmental and health hazards. The EPA is an agency that regulates thanks to scientific work and large programs of measurement, experimentation, and modeling, and thanks to the contribution of multiple constituencies of scientists in various parts of the agency. Science-based decision-making is an essential part of its identity, legitimacy, and autonomy.

Science, Risk, and the Design of the EPA

The US EPA was established by the National Environmental Policy Act, adopted by President Richard Nixon in late 1970, which placed the services that administered statutes related to the environment and variegated kinds of pollution under the same institutional roof. It is in charge of the implementation of an immense variety of legislation and programs (Weinberg and Reilly 2013), among which the best known are probably the program for criteria air pollutants [National Ambient Air Quality Standards (NAASQ)] and hazardous air pollutants [National Emissions Standards for Hazardous Air Pollutants (NESHAPS)], for pesticides [Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)] and toxic substances [Toxic Substances Control Act (TSCA)], for Superfund sites [Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)], for hazardous waste [Resource Conservation and Recovery Act (RCRA)], and for drinking water [Safe Drinking Water Act (SDWA)] and surface water [Clean Water Act (CWA)]. These statutes are risk-based: They rest on the principle that the hazards due to technologies (notably chemicals) can be anticipated and should be addressed before they materialize (Shapiro and Glicksman 2003, 31). And even though

not all the programs administered by the agency are risk based (many statutes command actions of measurement and monitoring, depollution, decontamination, and technology assessment and substitution based on established, deterministic knowledge, from the Emergency Planning and Community Right-to-Know Act to the Endangered Species Act, through the Energy Independence and Security Act, the Marine Protection, Research, and Sanctuaries Act, the Noise Control Act, or the Energy Policy Act), the notion of risk has consistently influenced the image of the EPA's bureaucracy and its handling of environmental and human health problems.

William Ruckelshaus inaugurated this practice of deriving the identity of the EPA, as well as an image of how it is acting, from this technical, rationalistic language of risk. In a speech he gave at the National Academy of Sciences (NAS) at the end of June 1983, soon after being reappointed by President Ronald Reagan to end the crisis to which Ann Gorsuch had brought the agency (Ruckelshaus had been the first administrator of the EPA between 1970 and 1973), he articulated the public mission of his agency and the ways of fulfilling it in just this way (Ruckelshaus 1983c, 1026):

> EPA is an instrument of public policy, whose mission is to protect the public health and the environment laid down by its statutes. That manner is to set standards and enforce them, and our enforcement powers are strong and pervasive. But the standards we set, whether technology- or health-related, must have a sound scientific base … Scientists assess a risk to find out what the problems are. The process of deciding what to do about the problems is risk management. The National Academy of Science report recommends that these two functions—risk assessment and risk management—be separated as much as possible within a regulatory agency. This is what we now do at EPA and it makes sense.

To today's reader, this might not sound like a very original argument. At the time that this speech was pronounced, however, the rubrics of *risk assessment* and *risk management* were hardly used in law, in public discourse, or in the actual processes of the EPA to describe what it was doing or had to do as a whole. It was probably the first time that an EPA administrator could formulate what the identity and goal of the agency were in such an integrated manner. At this moment, *risk* became used to refer to the class of things that the EPA, across the many laws it applies and the various missions of its offices, could identify with, above and beyond cancer-causing chemicals, oil spills, species extinction, emission-reducing technologies, or other elements. Along with risk emerged a legitimate description of this

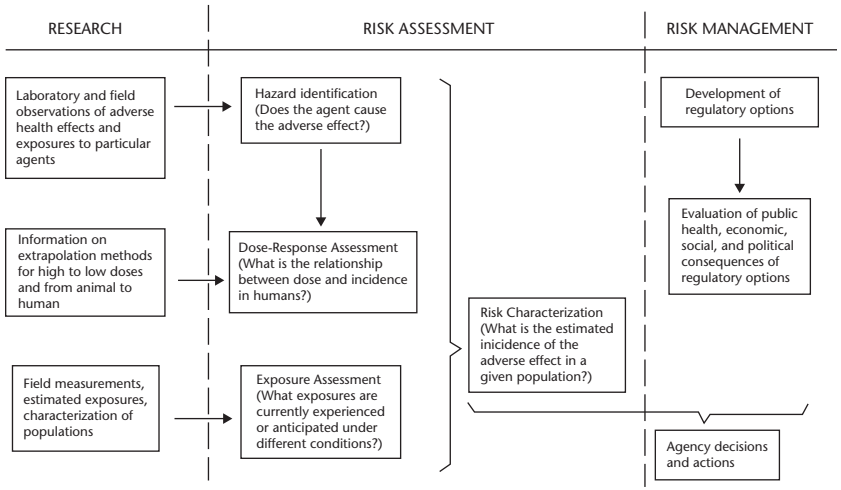

Figure 0.1
Elements of risk assessment and risk management (adapted from NRC 1983).

bureaucracy's own way of producing effective and legitimate rules. *Hazard identification, hazard characterization, exposure assessment, risk characterization, and risk management*: each of these rubrics referred to disciplinary exercises that are necessary to the agency and embody its expertise and competence. They helped rationalize and represent the way that the EPA was using science, which science it chose to use, and how it used this science to legitimately regulate the environment and the behavior of industries and citizens through the making of *decisions*.

This mixed scientific and administrative vocabulary acquired its authority through a report by the National Research Council (NRC),[1] with a vivid red cover, later called the Red Book (Johnson and Reisa 2003; Rodricks 2007). In this report, titled *Risk Assessment in the Federal Government: Managing the Process* (RAFG) (NRC 1983),[2] regulatory practices on uncertain environmental health hazards were codified as consisting of risk assessment (comprising several scientific exercises, as described previously, and preceded by a research stage) and risk management. An oft-reproduced graph included in the NRC report shows the logical organization of these processes to produce a decision (see figure 0.1).

It comprises what is known as the *risk paradigm* (Barnes 1994),[3] a set of conventional commandments, which may be summarized as follows:

- Analyze risk quantitatively, using data or studies enabling the description of the hazard (hazard identification), its seriousness under various circumstances (hazard characterization), and the extent to which people face the hazard in the actual environment (exposure assessment).
- Characterize the risk and ensure that all judgments and assumptions used to calculate the risk are made explicit.
- In the adoption of the final standard, or the risk management stage, take into account a wide variety of elements, from the results of the risk assessment to the costs and benefits of the potential standard; consideration of fairness or other values is legitimate at this stage only, and it should always be distinguished from the risk assessment.
- Make sure that those responsible for making choices, either analytical or political, are identified, and distinguish (at least formally) the risk assessment from the risk management.

Since the 1980s, this paradigm has evolved a great deal. In the initial design presented in figure 0.1, the regulatory process is presented as making a frank decision, based on an initial act of knowledge production. Risk management is separate and downstream in the process. Over time, it has appeared more legitimate to place risk assessment within the sphere of risk management (Power and McCarthy 1998; Jardine et al. 2003; Power 2007; Renn 2008; NRC 2009; Assmuth et al. 2010). Simultaneously, the need to involve the public and to create opportunities for deliberating about the balance between economic development and environmental goals has been increasingly recognized. The public should not be at the receiving end of a linear decision-making process; rather, it should participate throughout (Stern 2009). These transformations toward more risk communication and public participation were promoted by landmark reports of the NRC that, after RAFG, renovated the paradigm of science-based decision-making for environment and health hazards (NRC 1994, 1996, 2009). More rules were articulated in these reports and complemented the initial paradigm (e.g., Van Zwanenberg and Millstone 2005; Renn 2008; NRC 2009; Pellizzoni 2009; Abt et al. 2010; Hultman et al. 2010). Key new prescriptions include:

- Monitor and research the variety of potential hazards facing the public.
- Measure and rank problems according to their gravity, but also according to the costs and benefits of addressing them.
- Once you select the problem, formulate it clearly.

- Do not solely minimize individual risks, but also aim to improve health and environmental conditions.
- Engage with the public during all stages of the decision-making process.
- Evaluate and review the consequences of the adopted standard.

This evolving paradigm has structured the image and identity of the agency, inside and out. The paradigm has value for the internal integration of the agency. It has been used as a way to assemble an organization with perennial problems of internal cohesion, split as it is between multiple program offices. Functional offices for research and development, for policy management or for legal affairs as well as the agency administrator and deputy administrator also, frequently have difficulties controlling the rules and decisions that are shaped within program offices. Processes for joint assessment or analysis of risks and environmental conditions, in this context, have been conceived as an instrument to re-assemble the organization. And indeed, nearly all the guidance documents adopted since the early 1980s, be it by the offices governing air pollution, water, pesticides or other topics, build on the four standard exercises of hazard identification, dose-response calculations, exposure assessment, and risk characterization. Most, if not all cross-agency programmatic documents are founded on this process and division of responsibility, referring back to RAFG or to the agency's flagship reports in which this paradigm is frequently presented (e.g., EPA 1984b, 1995b, 2012). This paradigm is used to justify the role of the ORD vis à vis program offices. It has given rise to the creation of risk assessment and risk management services inside regulatory offices. It has also translated into the creation of a host of high-level transversal bodies in the agency, such as the Risk Assessment Forum and Risk Management Council—now called the Science Policy Council. And in the nearly five decades of the agency's existence, almost its entire staff has been trained in the technical exercises and procedures of risk assessment and risk management.

But the risk framework is essential for the outside, too. The model underpins the public representation of the agency, of its unity, credibility and rationality. There have been fourteen confirmed administrators of the agency since its creation in 1970.[4] William Ruckelshaus was the first to embrace the paradigm publicly, but his immediate successors basically took the same course, publicly emphasizing the risk-based nature of the agency. Bill Reilly, EPA administrator during the term of President George H. W.

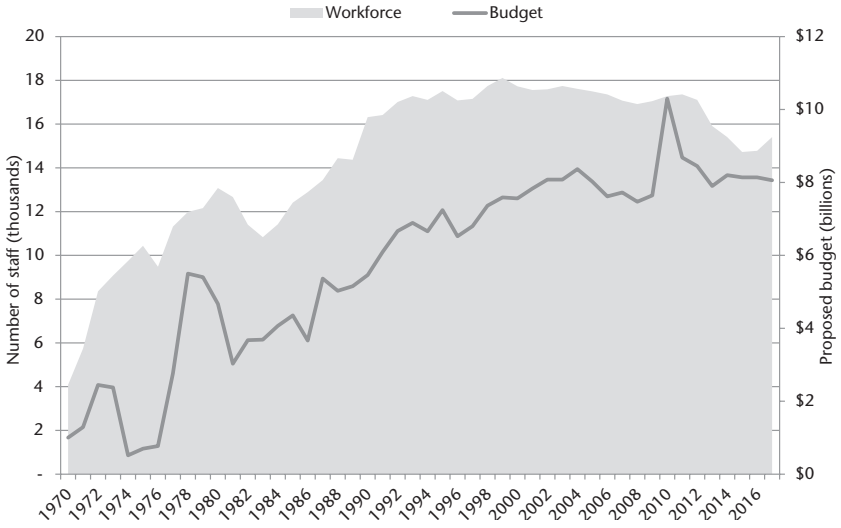

Figure 0.2
EPA budget and workforce, 1970–2016.
Source: EPA's Budget and Spending (https://www.epa.gov/planandbudget/budget, last consulted December 13, 2018).

Bush, also promoted risk analysis. Carol Browner, appointed by Bill Clinton, initially seemed to distance herself from science and risk analysis, but she ended up defending them as an important tradition of the agency. Christine Todd Whitman, appointed in 2001 by George W. Bush, praised the "long-standing traditions" of "precaution, science-based risk analysis, and sound risk management, including consideration of benefit/cost" (cited in Gibb 2001). Interestingly, risk assessment and risk management continued to be central pillars of the EPA in terms of defining its generic objects of action, its typical knowledge, and its way of making decisions, even during times when the president chooses to restrict its budget and staff. The statistics in this regard from 1970 through 2016 are given in figure 0.2.

Most of what Daniel Carpenter would call the audiences of the EPA (Carpenter 2010)—including other agencies, principals in the executive or in Congress, the regulated industries, scientists, environmental nongovernmental organizations (NGOs), and courts, among others—have to come to accept this identity of the agency as an entity that assesses and manages risk. They describe its operations and goals in these terms too, and hold agency administrators accountable related to this vision. Most assume and expect

that some pattern corresponding to these criteria and codes of decision-making will be apparent in what the agency does. When the Government Accountability Office (GAO) of Congress reviews the EPA's performance under a given program, it assigns the risk assessment/risk management model to the agency's actions (GAO 2008). When an EPA official needs to inform a congressperson in a hearing about how the EPA works, she starts by explaining what a risk assessment is, using the four operations defined in RAFG and in agency guidelines, and then discusses how risk assessment informs risk management measures. The courts review the EPA's proposed rules against the benchmark of risk assessment methods and the due separation between risk assessment and risk management processes. NGOs describe (and also attack) the EPA using these terms to refer to what it does and should do.

The Puzzle

The notion of risk and procedures for the assessment and management of uncertain hazards has thus been very central in the institutionalization of the EPA, as well as in the assertion of a public image of how it acts and why.

There is a seldom noted paradox in this centrality of risk for this agency: Risk evokes models of coherent and rational administrative action—models of decision-making based on analytical knowledge and adjusted to defined probabilities. The paradigm works as an integrated and coherent representation of knowledge and action (Power 1997). It looks like a mini-regime of risk regulation, comprised of a delimited set of processes to address risks systematically (Hood et al. 2001). But *risk* is also the generic name for extremely controversial issues that the US polity and institutional system are struggling to frame and solve. The governance of environmental and health hazards is an area of extreme political polarization and constant disputes about what the real risks are, the appreciation of experts of these risks, and hence the legitimacy of administrations to manage them. How, then, are integrated designs for administrative knowledge and action invented and reinvented, projecting an impression of rationality, credibility, and control in societies that constantly question these very attributes of administrations? How does one forge an accepted, legitimate model for making decisions amid intense controversy, doubt, and actual difficulties to establish shared, frank decisions about environmental problems?

Risk is synonymous with calculation and control, but also with controversy (Nelkin 1985; Beck 1992; Leiss 2000). Hazards constitute "zones of ignorance" (Callon et al. 2009). To make claims about these hazards (and, in particular, to anticipate these hazards), one needs to make a number of assumptions about what information is needed in order to know about these hazards, what kind of calculations can reveal their true, future extent, and the parameters to use in making these calculations. Risk assessment thus involves choices that are determined by viewpoints, moral assumptions, and visions of nature and technology. Given that these are diverse across the polity (Douglas and Wildavsky 1983; Beck 1986; Lash et al. 1996; Collingridge and Reeve 1986), technical uncertainty soon turns into a political or structural kind of uncertainty (Wynne 1987; Schwarz and Thompson 1990; Jamieson 1996; Borraz 2008, 2011). Structural uncertainty translates into the flexible, irreconcilable interpretation of information (Collins 1981). Injecting more science into the debate makes things worse, not better, because its diversity and disunity mean that anyone will find facts, information, or theories to support his or her existing opinion (Sarewitz 2004).

Risk invites controversy all the more easily, as it is a subject of pressing institutional action and urgent social demands. With environmental risks, we are in a regime of "post-normal science" (Funtowicz and Ravetz 1993, 739). We stand outside the realm of normal or research science, into what has been called *regulatory science* (see Salter 1988; Jasanoff 1990): a science that aims to fill knowledge gaps and make difficult predictions of human health risks in the context of multiple, contradictory, and pressing institutional demands. In postnormal or regulatory science, the deconstruction of scientific claims and the apparent impossibility to decide controversy are the rule rather than the exception (Jasanoff 1995; Irwin et al. 1997). The assertion of truth and scientific authority is a constant and daunting (if not impossible) challenge in such a context. Again, risks involve complicated interpretations of information, but visions of what information is needed and why and for what scientific information is used also matter. Scientists may be accused by policymakers of making decisions in their stead, while pretending not to. Policymakers, in turn, are regularly criticized for not being able to face the facts and for making decisions without taking into account the available information and evidence.

In matters of risk, we see constant disagreements, miscommunications, and opposition of interests between scientists and policymakers, making

this boundary a site of dispute as much as a site of mutual construction of authority (Gieryn 1983; Jasanoff 1987, 1990; Halffman 2005). And so, risk assessment itself, the cornerstone of its model of science-based decision-making, is an object of dispute (Clarke and Short 1993; Wartenberg and Chess 1993; Slovic 1999). The "ideals of good governance" based on rational risk analysis have increasingly been publicly challenged in contemporary societies (Power 2007, 20). Even though they sometimes initially supported the application of risk assessment and cost-benefit analysis,[5] public interest groups and environmental activists have gradually distanced themselves from these methods, which they found to be "slow, to be insensitive, to be costly for agencies and society as a whole, and to frustrate the health-protective goal of environmental health legislation" (Cranor 1997, 103). They are accused of delaying the adoption of regulatory measures on the issue—which is called "paralysis by analysis" (Mirer 2003, 1129)—and of serving the interests of polluters (Shabecoff 2003). Its underlying utilitarian meaning is frequently indicted as well (Shapiro and Glicksman 2003). Alternatives to risk assessment, for this reason, have been actively explored (Silbergeld 1993; Frosdick 1997; O'Brien 2000), even as scientists and the regulated industries were busy defending and advancing it (Michaels 2008).

Last but not least, risk invites controversy because of its implications about the distribution of power in society (Nelkin 1995). Risk implies measurement and comparison of situations based on observable levels of hazard, probabilities, but also and relatedly, costs and benefits. It is the subject of a large quantification of the natural world and life. It grants power to those who quantify and compute, as well as to new experts, who impose prescriptions about what the true risks are and judge whether citizens are right to worry about something. Under notions of risk perception and communication, risk thus establishes a certain relationship between the state and society, or between knowledgeable experts and the individual. This rationality of government is at the very least worthy of discussion, given the way that it treats the individual citizen as someone who does not understand risk and that should make utilitarian decisions. It is discussible, and in fact it is often contested for this very reason. Risks are objects of intense conflict, in which the scientific measurement of risk gets embroiled in broader disputes about the "meaning and morality of protecting the environment, about the distribution of resources and about the locus of power" (Nelkin 1995, 445).

All of this accentuates the paradox. There are, so to speak, two facets to risk. *Risk* is the name of an apparently rational way of defining and addressing environmental issues, underpinned by the reduction of scientific uncertainty, the calculation of odds, and the adjustment of public decisions to what knowledge establishes (Bernstein 1996). And the EPA has been at the forefront of the codification of this way of handling environmental issues, organizing and representing itself along the lines of such a model of risk-based administration of the environment.

On the other hand, *risk* is also the name of a state of controversy—mixing scientific, moral, and policy dimensions—that has become pervasive in industrial societies and leads to radically questioning the institutional and administrative system by which the environment and public health are protected (Beck 1992). This level of controversy is something that the EPA also embodies. Bill Reilly, EPA administrator between 1988 and 1992, once noted that 80 percent of all the standards he signed ended up being challenged in court (O'Leary 1995). Each piece of data advanced in support of its standards, its calculations, or models gets forensically deconstructed. Most of its choices for the assessment of risk and its determinations of how to reduce these risks are attacked in courts by corporations and environmental groups alike. The levels of risk that it declares acceptable are constantly debated. These divisions are reflected inside the agency.

The EPA is an agency that suffers from problems of internal cohesion. Its offices enact different pieces of legislation that, in their diversity, reflect the structural uncertainty existing in society, and among audiences, concerning what a risk is and how to establish it. Offices of the agency, therefore, make policies in different ways. Its professionals frequently disagree about when an issue implies a joint determination of the risk and of environmental standards. In matters of environment, where something affecting water also tends to affect the air, and ultimately the health of populations, it quite often does so. The EPA is required to act in an integrated manner, and yet it cannot.

So, what we have with the risk paradigm is the unlikely coexistence of a harmonious, standard design for governing the environment on the one hand, projecting the smooth coordination of all involved—scientists, economists, layers, political managers, industries, communities, and environmental groups—to make collective decisions on seemingly accepted criteria; and on the other, continuous public disputes about uncertain environmental

and health issues, their nature, their importance, and the legitimacy of those who are charged with addressing them. The fashioning of an accepted model of rationality in a context of controversy and conflict of rationalities is the main puzzle that this book is interested in addressing.

Folded within this paradox, one finds a number of other intriguing questions about risk-based decision-making and its institutionalization as a model of administration and bureaucratic operation. The first concerns the use of science in policy. Why is science so closely reflected in the design of an agency when the use of science in policy and administration is the subject of so much controversy? Why does the administration of the environment and public health materially rely on something that is so disputed, and even distrusted (Ezrahi 1990; Hilgartner 2000; Jas et Boudia 2014)? This puzzle is a version of what Bijker, Bal, and Hendriks (2009) called "the paradox of scientific authority," or the intriguing observation that scientific advice continues to appear "effective and influential in an age in which the status of science and/or scientists seems to be as low as it has ever been" (Bijker et al. 2009, 1). In the case of the EPA, the paradox is that science has been incorporated into the standard way in which the various offices develop standards and rules, and thus make policies, at a time when it has become more difficult to agree on the right forms of knowledge to conduct environmental policies, as well as to trust scientific experts (Nelkin 1975). Science is as much a currency of environmental politics as it is a source of authority (Cozzens and Woodhouse 1995; Weingart 1999). Various people inside the EPA, but also the regulated industry and environmental groups, defend their views and construct their interests through science (Tesh 2000). All try to achieve results that advance data and scientific interpretations, while contesting others. Confusingly enough, they all also do so in the name of good science, jeopardizing the very possibility for anyone to gain the ground of objectivity, truth, and scientific authority. Regulatory knowledge is a field of contention (Demortain 2017; Wagner et al. 2018). So, why does science appear to be an instrumental resource for regulating controversial matters when its interpretation is the battleground for so many disputes? How, specifically, could an agency foster a model for the use of scientific knowledge in policy, when this knowledge is contested?

A second puzzle concerns the science of risk. While it appears to be a well-defined science—resting on the calculation of odds using statistics and probabilities to adjust actions and attribute responsibility (Ewald 1986,

1991)—and one that has become increasingly sophisticated at that, it is not strictly reducible to a science. It involves, by nature, evaluative and normative choices within the very act of calculating, of choosing models of extrapolation and statistical methods. These choices help establishing criteria for definitive decisions, separating what is safe from what is not safe, acceptable and nonacceptable. Observers of risk regulation, in the longer run, confirm that such an instrumental paradigm has been dominant (Fisher 2007). The linear model "involving usually a scientific process of risk assessment and then political processes of risk management and risk communication … has come to dominate much of the policy and legal discourse" (Fisher 2013, 125). However, folded within the logic of calculating uncertain hazards, one finds a multiplicity of other epistemologies and styles of statistical thinking (Hacking 1990; Jasanoff 1993a; Bernstein 1996), or what O'Malley (2004, 21) calls "configurations of uncertainty."[6] Analyzing risk also may mean ranking them, rather than calculating them individually with utmost precision—a commensurative and prioritizing approach. The decisionistic approach to risk also may be supplanted by a predictive approach, believing in the possibility to eliminate uncertainty and illuminate choices thanks to full, exact knowledge. Finally, a deliberative logic, finding uncertainty in the preferences of decision-makers and the public and organizing the confrontation of preferences in order to make a collective choice emerge, is not completely foreign to risk science. What is the relation between these various conceptions of governing uncertain hazards, and what makes risk such a malleable notion? How do these models of administration engender one another or coexist in the agency?

The third puzzle concerns the invention and institutionalization of models for administrative governance. The risk paradigm is the basis of a now widely accepted administrative gospel, or what Jasanoff (1999) calls the "songlines of risk." It has been institutionalized worldwide (Winickoff and Bushey 2010; Fisher 2013), and many of the international texts describing the paradigm refer their readers to the NRC report of 1983 (Jardine et al. 2003), as well as to the experience of the EPA (WHO 2009; Demortain 2011; Demortain 2012). We know a great deal about how and why organizations facing complex and uncertain situations, such as risk bureaucracies, copy each other (Di Maggio and Powell 1983; Brunsson and Jacobsson 2000), but much less about how they innovate. What makes the EPA the source of these innovative frameworks that make the use of science in policy so

credible and routine, when its autonomy, authority, and legitimacy are challenged so often? How did it innovate through this ambiguous notion of risk, and succeed in changing institutional forms that change rarely and slowly (Sewell 1992)?

What is more, the EPA has formalized and applied this knowledge of risk much more than any other federal agency in the United States dealing with health, the environment, and safety, such as the US Food and Drug Administration (FDA; Lehman et al. 1955) or the Occupational Safety and Health Administration (OSHA). These other agencies have also invested in formal risk assessment methodologies and risk-based decision-making. In fact, the FDA did so before the EPA. But at no point have these agencies used a model of decision-making through risk assessment as the embodiment of what they are doing or as a standard of credibility and legitimacy of their actions. What makes the EPA, an agency with presumably less autonomy and power than others (especially the FDA) (Carpenter 2001, 2010), institutionally innovative?

Strategic and Cultural Perspectives on Rational Administration

These puzzles connect to a broader question concerning the way in which rationality in administration takes form and the roles of analytical tools and knowledge in the constitution, both material and symbolic, of an agency and of its capacity to administer intractable public problems. They defy two broad ways of analyzing how and why bureaucracies embrace rational analysis and decision-making tools—one that can broadly be called *strategic*, and the other *cultural*.[7]

One way to approach an administrative organization like the EPA is as an expression of the historical force and progression of formal, instrumental rationality, in line with Max Weber's conception of bureaucracy. Weber portrayed bureaucracy as the incarnation of the rational spirit, with *rationality* meaning the instrumental, formal means-end rationality that, in his view, was reaching into more and more areas of social life. Where he speaks about expertise and technical specialization of administrations, it is a signal that he considers that science and bureaucracy partake in the same kind of rationality, based on a "means-ends decision-making calculus" (Reed 2005, 119), and the same process of expansion and accentuation of this rationality.

The theory of organizational decision-making showed that formal, means-end rationality is not the way in which administration was rational (Simon 1969). Decision-makers in organizations do not spontaneously compute all information accessible to adopt the means that are most adapted to an end. Multiple forms of limits of administration impose a bounded model of rationality (Hood 1976; Forester 1984; Lodge and Wegrich 2016). The rational model came under scrutiny with Charles Lindblom's work on incrementalism (Lindblom 1959). Listing all values related to a policy in order of importance, ranking policy outcomes in terms of how efficiently they satisfy each value, and choosing among policy alternatives and instruments to achieve these outcomes comprise a comprehensive-rational model that is an idealization of the scientific method. It enshrines a "rationality project" (Stone 2012/1988, 9): namely, the project of making policy "with rational, analytical, and scientific methods," based on a model of reasoning in which "decisions are or should be made in a series of well-defined steps" (ibid., 12). But in the actual, material "administrative rationality" (Pfiffner 1960), facts and values are not easily separated, and pluralism in the organization makes it difficult to reach common goals, and measures of efficiency. Decision-making tends to be incremental, circular, multidimensional, and in conformity with the power structure of the organization (Nicolaidis 1960).

Subsequently, a vast literature on strategic decision-making confirmed Lindblom's initial findings, according to which "formal analysis has only a partial, incremental role to play in decision making" (Langley 1989, 623). Assessing the variety of ways in which formal analytical tools were used in the strategic management of organizations—the processes and practices unfolding around them, the kind of leadership and governance structures with which they were associated (Langley 1989, 1991), and their outcomes across a large number of organizations and cases of decisions (e.g., Hickson 1987)—it highlighted that formal analysis has only indirect effects on the formation of decisions (March 1982; Brunsson 1985). In practice, they serve to communicate already-formed decisions in order to justify them a posteriori (Bower 1970; Meyer 1984; Langley 1989), extend the control of the dominant coalition in the organization (Mintzberg 1980; Newman and Rosenberg 1985), or deflect attention from issues that leaders of the organization fail to answer (Meltsner 1976).

In public administration, the application of rational analytical tools "reflects the interests, strategies, and compromises of those who exercise

political power" (Moe 1989, 267), and the politics of bureaucratic design more generally (McCubbins et al. 1987, 1989; Macey 1992). It is defined by the strategies of principals to control regulatory agencies and limit their powers (Howell and Lewis 2002; Wood and Bohte 2004). One of the rules or expectations that principals apply, in the case of regulatory agencies, is that the agencies will strictly work to establish facts and refrain from deciding policy values and making law (Yellin 1983). Risk analysis and various kinds of analytical exercises thus get used in regulatory agencies because of the preferences applied by the coalition of actors that conceive and control the agency (Shapiro 2011). Agencies retain some power in this relationship with principals, and of course, they may use rational analytical tools in such a way as to disguise substantive policy choices. But whatever the actual pattern of use of analysis, it appears rational and instrumental in terms of the behaviors and strategies of actors in this interinstitutional game (Allison 1971).

There are three limits to this strategic vision of analytical knowledge in bureaucracy, as a "technology of rationality" (March 2006, 201). The first is that this perspective grants little autonomy to agencies and pays little attention to the content and effects of their expertise. It tends to "minimize the role of bureaucratic action" and disregard the real "capacities to analyze, to create new programs, to solve problems, to plan, to administer programs with efficiency" (Carpenter 2001, 14–15). Second, it simplifies the environment in which the agencies operate, erasing from the picture a whole set of other audiences among which agencies construct their role and define the knowledge they need to use and the outcomes they try to achieve (Arrelano-Gault et al. 2013). Third and finally, this literature keeps instrumental rationality as its horizon, and in a sense, takes it for granted (Cabantous et al. 2010). It leaves aside the hypothesis, deriving from Weber, that formal, instrumental rationality may be in tension with other material rationalities, or systems of meanings and values in an organization (Diesing 1962; Swidler 1973; Clegg 1975, 1989; Kalberg 1980; Brubaker 1984; Townley 2008; Baunsgaard and Clegg 2012).[8]

New institutionalism takes a different approach to the question of rationality, which it does not approach strategically, but rather culturally. Dobbin (1994, 118) argues that the work of Weber on bureaucracy and instrumental rationality was structured by a "tension between the modern tendency to see rationality as acultural and the sociological tendency to see

all practices and understandings as part of culture" (see also Hindess 1987). New institutionalists built on such a cultural vision in order to articulate a new vision of rationalization, in which "supposedly universal precepts of organizational efficacy are simply abstractions from social practices that emerged for complex historical reasons" (Dobbin 1994, 122). Rationality is a product of what is normatively considered as the rational form within a given organizational field. The main logic at work in the adoption of rational models is not efficiency and performance, but legitimacy, which is understood as conformation to socially defined norms of what it is to be rational: "Highly structured organizational fields provide a context in which individual efforts to deal rationally with uncertainty and constraint often lead, in the aggregate, to homogeneity in structure, culture, and output" (Di Maggio and Powell 1983, 147). The context of these organizational fields is where it becomes rational to embrace particular organizational forms and practices, true "rational myths" for organizations (Meyer and Rowan 1977, 360). The adoption of such templates leaves a generally quite large degree of decoupling. It does not mean that practices in the organization are regulated down to the minute level in the way the template dictates. But the adoption of a model is a ritual of legitimation—a way of complying with the standards of legitimacy of what an organization should appear to have (Brunsson 2000).

These elements of rational organizational life are induced in organizations (Scott 1987) through a process "rooted in conformity" and "in the taken-for-granted aspects of everyday life" (Zucker 1983, 5). The adoption of seemingly rational models in organizations is the result less of internal adaptation to locally understood problems and locally devised strategies than of the engagement with professional intermediaries—consultant, standard-setters, and prescribers of organizational methods of all kinds—and state organizations, which codify, carry, and prescribe these norms across the organizational field (Greenwood et al. 2002; Scott 2008). They induce norms and ideas about appropriate practice, and promulgate rational myths as they do (Scott 1987).

This process of collective institutionalization of models across populations of organizations verifies in the case of risk management, where a multiplicity of organizations, faced with increasingly hostile publics and demands of accountability, turn to risk as a logic of managing the threats to their own legitimacy and existence (Rothstein 2006). Measuring and

analyzing risk is an effective technology for organizations facing uncertainty and risks to their reputation (Power 2004; Power et al. 2009). The organizations that formally embrace risk assessment and risk management are precisely those that manage social problems incorporating high risk of failure and legitimacy attacks (Saint-Martin and Allison 2011; Rothstein and Downer 2012; Huber and Rothstein 2013; Mazmanian and Beckman 2018). The limit of rationality there is less that actors are not as rational as they pretend to be, but rather that they embrace formal conventions and schemes for managing risk under the normative pressure of professional networks (Hayne and Free 2014), without actually adapting their practices. Risk management formulas tend to become void, legalistic rituals to demonstrate attention to risk and rational responses to threats, with limited impact on what organizations actually pay attention to and how they process these threats (Power 2007). Clarke's depiction of disaster management methods as "fantasy documents" is most explicit about this (Clarke 1999). Worst of all, it may direct their attention away from harder-to-detect problems and challenges and toward more conceivable, codified, and measured problems (Power 2007; Rothstein et al. 2006).

The advantages of such a sociological, new institutionalist approach is that it provides a criterion to understand when and where rationalization operates in practice—the kind of diffusion of norms and ways of doing things that is described under the notion of institutional work. This work can apply to any rationality, or what the field calls *institutional logics of action* (Thornton et al. 2012). So it helps to treat symmetrically the different coalitions of actors that engage, with their own register of rationality, in the enterprise of legitimizing an organization.

There are limits, though, to the way that it approaches the organizational production of rationalities. First, this strain of work does not provide any external benchmark through which one may understand that one logic of action takes precedence over another. It is, in fact, not very interested in confrontation and conflict among rationalities and their proponents. New institutionalists overlook an important condition of legitimacy of organizational forms and rules: the fact of corresponding to the substances of the situations from which it is abstracted, or to actual values prevailing in the society (Selznick 1996; Stinchcombe 1997; Scott 2002).

Second, in new institutional scholarship, organizations tend to be described as recipients of models circulating in organizational fields and

professional networks, hardly as sites of articulation or even invention of such rational forms. The various logics of conformation and imitation are particularly effective to analyze the adoption of rational forms, less their initiation. A federal organization like the EPA would more likely be a prescriber and authorizer of organizational forms than a recipient of norms stemming from its environment in this framework—sending us back to the original question of the origin of its credibility and authority in articulating modes of reasoning and deciding.

Design, Controversy, and Legitimacy

Rational decision-making seems to make sense, thus, as the result of either of two contrasting processes. We end up with a choice between considering it as the reflection of an organization's strategic behavior in interinstitutional power games, or as ritualistic and symbolic of its belonging to an organizational field (Meyer 1984); or between a process in which "organizational managers look out," or the "society looks in" (Suchman 1995, 577). In both cases, what counts as rational knowledge seems to be given. Not much seems to be happening in terms of production and validation of rational forms of knowledge; and conversely, rational knowledge does not seem to have much performative effects on bureaucracies, their legitimacy and autonomy to act and govern. To better analyze the active work on knowledge forms and the shaping of legitimate institutions, in its political context, we need to abandon the alternative metaphors of strategic rationalization and mindless imitation, to assume instead that knowledge, and science, partakes in the design of bureaucracies—understood as the purposeful forging of an organization for the legitimate administering of public problems. Design, in short, is rationality forged in response to a state of controversy.

Research on design in political science developed in the United States in the 1980s (Howlett 2009; Howlett and Lejano 2013) to investigate the rational composition of policy. It investigates the crafts and methods pertaining to "the process of inventing, developing and fine-tuning a course of action" for public policies (Dryzek 1983, 346). It builds on Herbert Simon's notion that the construction of alternative courses of action is a fundamental pattern of social action (Simon 1969). It considers how the behaviors of actors involved in politics and policymaking is controlled or steered to achieve predefined choices. It also assumes that there is a craft to it, which

can be taught and equipped (Alexander 1982; Linder and Peters 1984, 1987; Weimer 1993; Considine et al. 2014). The field has long been animated by a dispute as to whether design could indeed be guided by an instrument's so-called blueprints or instead should be considered a more contextual and pragmatic activity (Dryzek 1983; Junginger 2014). But overall, its roots are in the rational and instrumental tradition of policy studies (Howlett and Lejano 2013; see also Lascoumes and Le Galès 2007). This rational orientation can be seen in the way in which the question of bureaucratic design is treated in the literature: as a question of defining administrative procedures and rules to achieve substantive goals (Weimer 1995). Design is, in this version, an intention-based theory of institutional change (Goodin 1996).

Bureaucratic design has a both a material and symbolic dimension. Materially speaking, the design of the bureaucratic institution involves its programmation, so that the organization produces the kind of outcomes that are legitimately expected from it. This definition of design brings us back to the concerns of some of the earliest students of organizations. Most of the early theorists of organizations were interested in studying formal organizations (Blau and Scott 1962), governmental or industrial ones (Arellano-Gault et al. 2013), and looked for the implications of the formal rules, processes and roles that visibly defined them and helped them coordinate people (Barnard 1968), on the internal life of organizations and on their capacity to make collective decisions and act purposely. Early theorists approached formal organizations, particularly public bureaucracies, as a device that is programmed and structured to act (March and Simon 1958; Bittner 1965). Their objective was to understand what gave them this capacity to act in a coherent and unitary manner, looking first and foremost into the "operative codes" and "universalistic formal rules" that make the organization (Parsons 1956, 63). Of course, scholars of organizations have subsequently discovered that formal rules do not define and regulate the organization alone. Informal rules, organizational cultures, and transorganizational coalitions are as important. But design is precisely about controlling the roles, cultures, and forms of political coordination between the diversity of bureaucratic actors—assembling the organization—so that it produces expected outcomes (Dowling and Pfeffer 1975; Stinchcombe 2001).

Design generates the material elements of administrative organization through which a public image of the agency and of its action is formed. The models, frameworks and other norms of action applying across the

various parts of the organization, formally or informally, enhance its credibility in various ways. They provide a vocabulary to represent the work of the agency as one that is able to determine the necessary rules, standards or *decisions* for society (Laroche 1995). They legitimize the organization, because they project a rational image of practice, mimicking the orderliness of science (Power 2016). By showing which generic, abstract actor is included in the governance of an issue, these designs structure the political image of the agency, as a more or less democratic, participatory body (Moffitt 2014). Designs work as a *bureaucratic screen* between internal practices and the agency's audiences, offering them a rationalized representation of what's happening inside and of how the agency is administering things, to legitimize it. They are the instruments to expose the inner workings of the organization and subject them to the evaluation of audiences (Power 2007). They help focus, and control, the attribution of dispositions to the agency and the definition of its overall character (Selznick 1949; Dowling and Pfeffer 1975; Suchman 1995; Carpenter 2010). They form a narrative of rationalization that legitimizes new actions and performs the future of the organization (Brown 1978).

The link between design and legitimacy is better understood by factoring in the structural condition of controversy. As Schön and Rein (1994) have shown, design is a response to uncertainty and the controversy it generates. These scholars were inspired by an emerging set of questions in the field of urban planning, about so-called wicked problems: problematic situations that lack structure and boundaries and are not amenable to standard treatment (Rittel and Webber 1973). These situations are characterized by a dissolution of the fact/value distinction, and irreducible disagreement about policy means and/or ends. Taking inspiration from the work of architectural design and approaching design as a process and form of knowledge (Cross 1982; Weick 1993), Schön and Rein identified what they call "design rationality": They see "a policy designer who constructs, in some relatively protected forum, a representation of a policy or program that will be sent out, upon its completion, into an actual policy environment. As the representation of the policy object takes shape, the policy designer's seeing/moving/seeing reveals new meanings, goals, and criteria, some of which are found to be mutually incompatible, requiring the framing of new problems, opportunities, or dilemmas" (Schön and Rein 1994, 86). Between comprehensive rationality and chaos (Cohen et al. 1972), design resembles

a pragmatic process of inquiry into the right techniques to solve a problem in a contentious policy environment (Evans 2000; Sanderson 2009; Dalsgaard 2014). From their perspective, design is a dialectical process of experimenting with a form and adjusting its shape depending on the results of the trials,[9] to bring structure to controversial problems. Controversies stimulate the construction of new bureaucratic forms. They stimulate the reflexivity of those who aim to administer, such as bureaucrats and their scientific advisers, leading to changes of pre-formed institutional practices and contents (Riles 2004).

Risk issues are wicked, unstructured problems (Hisschemöller and Hoppe 1995), in which the limits of knowledge compound with the diversity of interests and viewpoints in the society. These situations of uncertainty invite disagreement about hazards and their causes, but also about the legitimacy of institutions, administrative instruments, and official expertise (Martin and Richards 1995). In a risk policy controversy, not much time elapses between the moment when the purely scientific question emerges and when institutional factors underpinning the issue are pointed to (Nelkin 1984; Tierney 2014). In these contexts of irreducible disagreement, what administrations know, where they collect information and opinions from, and who is included in their actual mode of governance get incriminated, whether they augment or minimize risks, is always disputed. Administrative governance, the perceived credibility of the administration to deal with problems, becomes particularly hard to establish and defend (Douglas and Wildavsky 1983; Stone 1989; Bovens and Hart 1996). Bureaucratic design ensues.

The Sciences of Bureaucracy

In this book, I approach bureaucratic design as an iterative process of formal, purposive assembling of an organization to counter controversies and enhance its credibility as a producer of legitimate outcomes. Science plays an important role in the institution of legitimate bureaucratic forms, precisely because its practitioners perform the structuring of problems, and assembling elements of knowledge to obtain an outcome. Design relies heavily on the competences, rationales, and propositions of those scientists who are closely involved in policy, such as the various risk experts whose work will be at the center of this book. They are an integral component of

the process by which conflicting actors and viewpoints, both among the audiences of the bureaucracy and internally, are described and framed in an integrated and legible decision-making process.

Here, I capitalize on a whole strain of research in science and technology studies (Hackett et al. 2008), as well as its demonstration of what one may call the organizational ingeniosity of science. From Shapin and Schaffer's seminal work on experiment and demonstration, in which the scientific method is defined as a set of "patterns of doing things and of organizing men to practical ends" (Shapin and Schaffer 1985, 15), to Collins's study of the alignment in informal networks of experimental replication (Collins 1974), through Star's ethnographic analysis of the construction of shared infrastructures of information (Star 1992, 1995; Star and Ruhleder 1996; Bowker and Star 1999) and John Law's research on scientific "modes of ordering" (Law 1994, 20), science and technology studies have generated a great deal of resource to understand how science works to align people with incommensurable views on shared perceptions and common choices. Looking behind science, and the task of demonstrating and proving, one finds the creation of common standards of information and of generic criteria of facticity to bring people together in joint spaces of interpretation.

This is in fact what students of risk assessment and other decision-making sciences have shown: The conception and application of standard procedures for cost-benefit analysis helps depersonalize decision and create an impression of objective, regular, and replicable knowledge (Porter 1995), in keeping with expectations of efficiency, impersonality, and rule-based functioning at the heart of the American bureaucratic paradigm (Barzelay and Armajani 1992). These forms of mechanical objectivity respond to the questioning of the choices and criteria of professional communities that oversee administrative decisions. Analyzing risk, costs, and benefits in an orderly sequence and organizing the respective role of expert judgment and administrative pronouncements form a "dominant script," thanks to which regulators have achieved a form of objectivity (Kysar 2010). These policy sciences generally aim to settle debates and make issues decidable (Fischer 2000). Their practitioners maintain a tight relation between the sciences' disciplinary ambition to know, describe, and model the world and the organization of administrative knowledge and techniques.

Design is comprised of two main practices. The first practice is the creation of what one may call a knowledge representation (Star 1995), defining

common objects of attention (risk) and the forms of knowledge that are necessary to know this object, as well as the remaining uncertainties. Design involves the construction of a scheme, comprised of various mutually exclusive but plural knowledge rubrics. If assembled, these elements of knowledge can produce an objective image. These rubrics are "'black-boxes' whose authority might be invoked automatically, avoiding further open and indeterminate negotiation," and "deleting the ambiguity" inherent in knowledge (Wynne 1992, 748). This first dimension is cognitive and results in the formalization of bureaucratic knowledge.

Second, from this knowledge representation derives organizational roles and identities. Assembling knowledges is assembling the people that embody or carry this knowledge. This second design practice involves the definition of linkages and boundaries between carriers of this knowledge, articulating their work through rules and procedures (Fujimura 1987; Strauss 1988) to align them on common elements of information, and hopefully decision. This second aspect is more regulative and materializes by the emergence of *bureaucratic technologies*: the processes through which a bureaucracy succeeds in producing legitimate outcomes, the accepted "if-A-then-B" kind of algorithms based on which it can create an internal discipline (Landau 1992).

Such design practices are prevalent in administrations that host and use analytical disciplines, from risk analysis to systems, policy, or cost-benefit analysis (see chapter 1). These designerly sciences (Cross 1982) are at the source of the bureaucratic assemblages that will be discussed in multiple chapters in this book—the various frameworks, models, and integrated decision-making schemes that agencies such as the EPA embrace, as they seek to articulate the criteria of the various conflicting actors engaged in risk controversies. They enshrine what one could call the science of a bureaucracy—the expertise of an organization that learns how to reinvent its mode of government amid constant conflicts about the environment, risk, and its legitimacy to administer them.

Assembling a credible bureaucracy does not depend on the willingness, capacity, and rationality of a unique and detached designer. Rather, it involves competing networks of actors that form in the course of controversy to shape the knowledge, technologies, and image of the organization. They typically take shape during moments of intense controversy surrounding the agency—moments when its institutional life is threatened

and where its operations and forms can be modified. They define what is at stake in the controversy, analyze the positions of people comprising the controversy, and give the ways of articulating them, as well as the organizational forms and frames to adopt for that purpose.

Schön and Rein identified a unique "design rationality," but there may be different responses to different sorts of controversy. I broaden their approach to consider that design is comprised of a variety of rationales depending on the way uncertainty is interpreted. This extension is necessary to take into account the fact that different traditions are at play in the modeling of institutions (Linder and Peters 1995). Notwithstanding the supposed uniformity of the organizing concept of risk (Jasanoff 1999; Power 2004, 2007, 2014; Rothstein et al. 2006; Rothstein and Downer 2012), it seems appropriate to consider that the generic issue of risk has generated a variety of bureaucratic designs that have taken form over time and competed with one another. These plural designs and distinctive relations to uncertainty, express the variety of material rationalities that Max Weber talked about. The EPA is an agency that harbors several of these.

A scientistic, *predictive* design finds the origin of uncertainty in a lack of knowledge, to be reduced through the search for more accurate and precise information. In organizational terms, it translates into algorithmic, sequential modes of assemblage, in which the successive consideration of a defined set of information is logically conducive to a policy. It involves a minimal set of actors, and an almost machinelike assemblage in which science leads to or dictates policy, illustrated by linear science-to-policy sequences. But controversies, as indicated in this chapter, generally involve doubts or disputes concerning the values and policy goals that should be pursued. Facing such structural uncertainty, a *decisionistic* rationale may appear, embodied by a more modular assemblage involving calculation of risk on the one hand *and* imposition of a choice criterion on the other hand. They mutually support each other, and no sequential order is clearly established.

Two other designs may be employed in the face of uncertainty. *Commensuration* is a form of assemblage that is motivated by the instability of preferences about safety, both outside and inside the agency. Uncertainty is not a problem of knowledge but of unclear characterization of one's utility function and goals, and it translates into disputes about the prioritization of risks in comparative, commensurative frameworks. Where controversy is rooted in the impossibility to agree on values, nonalgorithmic assemblages

emerge (Majone 1992; Thacher and Rein 2004; Shapiro 2011). Instead, a *deliberative* design emerges from these controversies that are due to irreconcilable visions of the world and conceptions of what counts as risk. From that perspective, the ideal bureaucratic design is one that orchestrates the collective articulation of these views.

Whichever design predominates, it has a deep, legitimizing function for embattled administrations. It describes people defending heterogeneous criteria of what is a risk and what matters, incorporating them into an abstract order. The frameworks composed by the specialists of analysis and decision-making embody a constitution of sorts, showing how the organization articulates the views of those involved, both internally—among its scientists, lawyers, and political officials—and beyond itself, with varied audiences of environmental policy and regulation—scientists, NGOs, communities, industry groups, other agencies, executive or legislative principals. Frameworks thus displace controversy.

Once instituted, design may become an object of controversy, as audiences of the agency take this screen as the reality, and problematize its effects. The process of design is iterative, as this book will show through giving the history of the risk assessment–risk management framework—how it took form, how it was reflected in the EPA, and how it subsequently became a component of the controversy about the agency and its capacity to handle uncertain issues. One assemblage leads to another, as controversy forces the agency to reinvent its knowledge, technologies, and the overall image of how it acts.

Organization of the Book

A central proposition in this book is that the EPA is an agency that is structurally embedded in controversy. This configuration involves a constant evaluation of the credibility of the knowledge and regulatory measures adopted by the agency to address what appears as uncertain, risk issues on which its various audiences are frequently, if not systematically in conflict. The EPA's proposed standards are contested and debated time and time again before producing any sort of effect. They are subjected to variegated and often opposing demands and moralities. Controversy materializes by the multiple trials, formal and informal, to which the agency is subjected. These trials include court judgments, hearings in Congress, reviews of

decisions and programs by the White House and its various offices and political parties and associated think tanks, and public campaigns by public or private interest groups. They express a fundamental state of dispute about the environment and its problems and widely diverging sets of knowledge, criteria, and values to apply in environmental matters. This state of dispute reverberates inside the agency, because the diversity of its various program offices and its professional groups inside each of these offices, make it difficult to construct and impose integrated visions of risks.

At the same time, the EPA is remarkably effective at organizing itself, inventing modes of assemblage of the actors that take part in the resolution of environmental problems. The chapters of this book recount how a variety of designs were activated, depending on who coalesced in and around the EPA bureaucracy, to bring together people with otherwise conflicting views of risk. The book offers detailed histories of each of these designs and design networks, corresponding to successive moments in the political life of the EPA. It offers a political history of rationalization, showing how rational decision-making tools and their proponents actively contribute to shaping the legitimacy of an organization to administer the environment and hazards, in a political configuration of controversy.

Chapter 1 goes back to the history of risk analysis to show that it is an academic and professional field that, at its heart, is a form of design science that responds to political demands emerging from embattled institutions to help govern controversial situations.

Chapters 2 and 3 recount the emergence of two early bureaucratic technologies in use at the EPA—or at least in parts of the agency—and the controversy in response to which they emerged. The first is risk assessment guidelines and the use of what came to be known as *default assumptions,* which help to compensate for the lack of data and to define thresholds above which an intervention is thought of as legitimate and force a decision. It is the first design to have taken form at the EPA, at the end of the 1970s, amid the growing scientific and regulatory controversy surrounding regulatory measures for cancer-causing chemicals. This design has benefited from the work of toxicologists, biologists, and statisticians that embraced the goals and missions of the EPA, and it was the first sketch of a mode of articulation between scientists and policymakers, or between calculations and policy choices. Chapter 3 traces the development of a technique of risk-ranking as part of the attempt to control diverging estimations of risk

made by separate offices of the agency. Differences between these estimations produced an inconsistency that typically caused the EPA's work to be challenged. This time, economists and policy analysts led the reflection on the necessary designs, and worked to generalize it in the agency, without astounding success.

Chapters 4–7 focus on the risk assessment–risk management framework, its conception, and institutionalization in the EPA. The framework is an integrated design for risk-based decision-making using elements of both the knowledge deposited in risk assessment guidelines, and elements of economists' risk-ranking approach. This integrated design emerged in the agency first, but it took its final form in RAFG because the NRC became the center of the configuration in which the authority of regulatory agencies, and their right to use science for decision-making was debated. The set of concepts presented in RAFG in 1983, I argue in chapter 4, inaugurated a particular period in the agency, precisely because it provided for ways to ideally articulate the two preceding bureaucratic technologies—quantitative risk assessment and risk-ranking—in an integrated scheme that combined multiple approaches to risk: scientific calculation of hazards, definition of policy criteria to address remaining uncertainties, and comparison and prioritizing of these issues. Chapter 5 shows how instrumental this emergent design was for the EPA administrator to construct a legitimate image of the work of his or her administration. The way in which the administrator extended the framework to include a more deliberative design of risk communication shows just that. Quantitative risk assessment, risk-ranking, risk communication: each of these designs was institutionalized in the agency, changed the organization, and framed subsequent conflicts about the missions, powers, and procedures of the agency. This is what chapters 6 and 7 discuss.

Chapters 8–10, finally, recount how the risk framework unraveled, as it no longer offered protection against new controversies. Chapter 8 charts the relative marginalization of the risk-ranking design under the first administrator appointed by a Democratic president, for whom it was of little use in a configuration in which the main conflict engaging the agency concerned environmental justice and ecological restoration, not risks. Chapter 9 explains how the early risk-assessment mechanism devised in the 1970s lost its emphasis in the context of renewed controversies over the EPA's ability to produce consensual estimations of risk. The chemical industry and its

allies systematically pleaded for methods to reduce uncertainty and predict risk. Finally, chapter 10 shows how the agency has become the site of different designs—more holistic and pragmatic at once—in response to the controversies manufactured by opponents of the decisionistic design institutionalized in the agency over the years. The promotion of a formalism in terms of *problem formulation* attests that the EPA nevertheless retains the capacity to give shape to its own mode of administrative action, in a context in which it fails to design what science to use and how to forge protective standards, as today's situation precisely illustrates.

The Science of Bureaucracy

Risk Decision-Making and the US Environmental Protection Agency

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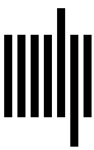

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