Introduction

Why Do Concepts Matter in Science Policy?

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Fifty years ago, Daniel S. Greenberg (1967), responsible for the "News and Comments" section in the journal *Science,* published his well-known study, *The Politics of Pure Science.* With massive government support for research during World War II and the launch of a federal funding program after 1945, the United States had entered a new era of science policy. As a critical commentator of this transition, Greenberg exposed that the politics of science was not inherently different from any other form of politics, and included lobbying, rhetoric, and ideology. According to Greenberg, what lay at the heart of the politics of science was the scientists' claim of autonomy as a necessary precondition for the technological progress that might flow from their work. "The only difficulty," he remarked, "is that when the origins of technological developments are subjected to systematic, scholarly analysis, the question of the debt to pure research turns out to be riddled with far more paradoxes, puzzles, and uncertainties than the statesmen of pure science are generally willing to admit" (Greenberg 1967: 29).

The promise that science, if autonomous, would pay off in the long run was not easy to carry through in practice. To make the claim plausible, various communication strategies were necessary; one of them—of which Greenberg himself was not aware (Kaldewey and Schauz 2017)—was to replace the traditional term "pure science" with "basic research." Yet this was not the only problem the politics of science had to face in Cold War America: scientific expertocracy put both scientific credibility and democracy at risk; scientists and the public were confronted with the ethical dilemmas of the advanced scientific-technological world; and finally, in the ideologically tense atmosphere, political loyalty and secrecy policies became pivotal requirements for science. Science policy, therefore, was in need of narratives and rationales dealing with these tensions.

At the same time, the United States became the key player in a global system of science. Beyond federal support for research, the politics of pure science was also coupled with foreign policy. The concept of basic research was "the key node articulating American hegemony with the postwar reconstruction of science in Europe" (Krige 2006: 3). In the second half of the twentieth century, the United States not only became the most successful nation in scientific output, but also provided a conceptual language to make sense of the nexus between science and politics. This comes as a surprise because America had for a long time lagged behind Europe's science nations. Furthermore, in contrast to Europe, there was no strong tradition of a U.S. federal research policy before the twentieth century (Dupree [1957] 1986); and until the early twentieth century, the language of science and science policy was mainly British, German, and French (chapters 1, 2, and 3).

This volume is about concepts and, more generally, about language being an integral part of the politics of science. It deals, above all, with the distinction between "basic research" and "applied research." Both of these had become key concepts of twentieth-century science policy around the globe, and their distinction turned out to be a tremendously successful communication strategy for coping with conflicting demands toward science in modern societies. While the term "basic research" has often been associated with Vannevar Bush—an engineer, research manager, and science advisor—and his famous report delivered to the U.S. president in 1945, the genesis of the concept can be traced further back in history. Similarly, the general expectation that the advancement of scientific knowledge leads to technical progress and prosperity is not specific to the twentieth century; it has been present in the development of the sciences from their very beginning in early modern Europe. The history of global science policy is the history of concepts traveling through time and between cultural contexts, followed by a period of conceptual synchronization. Yet, while the concepts of basic research and applied research finally prevailed in most national science policies, their meaning and use still vary between different cultures and national settings.

Against this background, we employ a broad notion of "science policy." In a narrow sense, science policy points to a new policy field established in the course of the twentieth century, when governments became big sponsors of scientific research and thus built up special departments, agencies, and advisory boards that dealt exclusively with the increasing relevance of science to national welfare. In a broader sense, however, the term "science policy" refers to various processes of "political accommodation among science, society, and the state" (Jasanoff 1990: 250; see also Slotten 1993: 43). For example, long before nation-states became the most important sponsors of research, other stakeholders supported science by financing universities, museums, or other scientific institutes. With regard to the United States, where for a long time science had largely depended on private benefactors, Hunter Dupree ([1957] 1986)[1] identifies constitutional debates about the necessity of a national university and issues of patent policy in the late eighteenth century as an early sign of the federal acknowledgement of the importance of science, even though these initiatives were not successful at the beginning.

Dichotomies such as "pure versus applied science" or "basic versus applied research" played an important role within the development of modern science policy across national borders by building on and transforming values that had been previously conveyed in the ancient and early modern distinction between "theory" and "practice."[2] In contrast to the Western nomenclature, Marxist ideology even revived the distinction between theory and practice and turned these two terms into key concepts of Communist science policy in the decades after World War II. Such concepts, however, were never stable, and their meanings and discursive roles varied according to time and place. They are, in many respects, similar to what in intellectual history and political philosophy are known as "essentially contested concepts" (Gallie 1955/1956; Connolly 1993). In the United States, right in the heyday of the ideal of basic research in the mid-1960s, unfulfilled expectations stimulated critical debates about federal spending for basic research, particularly about whether it was appropriate to dissociate basic research from applied research.[3] In the following decades, the simplistic rationales associated with these terms lost their grip. Today, half a century later, prominent scholars perceive concepts such as "basic research" or "applied research" as old-fashioned, outdated, and ideological.[4]

The history of the basic/applied distinction is related to the history of the so-called "linear model of innovation"—a conceptualization of the relation between science and technology that asserts a causal chain from basic and applied research to technological innovation. The concept of the linear model is of relatively recent origin. It gained prominence in the 1950s and 1960s, first and foremost in economic research to grasp processes of technological change (Godin 2006). Its conceptual core, however—the assumption that pure science leads to useful knowledge, which in turn enables new technologies—is much older. For three decades now, various observers have rejected the linear model and argued that it has never been able to capture the complex linkage between science and technology (e.g., Rosenberg 1991; Stokes 1997; Pielke and Byerly 1998; Edgerton 2004; Fagerberg 2005; see also final chapter). Its decline parallels the decline of what Greenberg had called the politics of pure science. In the meantime, the debate on how science and technology are related to one another has resulted in a more general controversy in science and technology studies (STS) and in science, technology, and innovation (STI) policy studies. Many scholars state that we are now living in an era of "techno-science" and that the old hierarchy between science and technology has been turned upside down (e.g., Forman 2007). Given the vast array of critical commentators, it seems as if the very language used to describe the interactions between science, politics, and industry in the twentieth century has lost its meaning.

Today, neither scholars nor policy makers dispose of a generally approved conceptual framework to analyze and communicate the politics of science. The linear model has, notwithstanding the critiques, "not yet been successfully replaced by a new orthodoxy" (Wengenroth 2000: 28), and "a new political consensus has yet to emerge to replace 'basic research' as a central, organizing symbol" (Pielke 2012: 341). Against this background, it is no surprise that, over the past decades, new terms have been proposed again and again—"strategic research," "post-normal science," "mode 2," "triple helix," or more recently, "responsible research and innovation"—to understand how science and society interact in the twenty-first century (Flink and Kaldewey 2018). However, these terms are irrelevant outside of their respective epistemic communities. In the real world of science policymaking and in the identity work of normal scientists and engineers, most of these semantic variations are merely used as rhetorical embellishment. Furthermore, none of these recent semantic variations has proven successful in communicating science policy to a broader public.

The old-fashioned terms "basic" and "applied research," in contrast, are still frequently used by individual scientists as well as by universities and research institutions (Gulbrandsen and Kyvik 2010; Bentley, Gulbrandsen, and Kyvik 2015; Kaldewey and Schauz 2017). Not least, they have become embedded in everyday language, well beyond professional contexts.[5] With the turn of the millennium, we have witnessed the dawn of new basic research programs conducted by a number of agencies in various places around the globe. In 1997, the Chinese government initiated the National Program on Key Basic Research Project (973 Program),[6] as part of the Tenth Five-Year Plan. In 2011, the Korea Institute for Basic Science was established to support "groundbreaking discoveries in basic science research" and to "disseminate knowledge that will impact the development of society and benefit the wellbeing of humanity."[7] Last, but not least, the European Research Council (ERC), established in 2005, is the first EU institution dedicated to strictly science-driven basic research funding—and generally perceived as a huge success (final chapter). In short, the concept of basic research is still alive.

The same goes for the old idea that scientific research ultimately triggers technological innovation and thus improves national competitiveness. This narrative was reiterated without batting an eyelash, for example, in President Barack Obama's "Strategy for American Innovation" (White House 2009), or in the "High Tech Strategy" issued by the federal government of Germany (BMBF 2010). Obviously, the linear model remains indispensable for communicating science policy in the twenty-first century. Again, all of this might come as a surprise as the distinction between basic and applied research, as well as the linear model of innovation, has been essentially contested and dismissed as ideological baggage for decades, particularly by STS and STI policy scholars.

Why is this the case? To answer this question, this volume analyzes the historical legacy incorporated in the semantics of basic and applied research and investigates the functions of these terms in communicating science policy under circumstances of divergent interests, political ideologies, and ethical dilemmas.

A Symmetrical Approach to the Dichotomy

The question of why concepts such as "basic and applied research" are essential for communicating science policy has been neglected for decades by STS and STI policy studies. There are several reasons for this conceptual deficit. First, scholars traditionally concentrated on criticizing the analytical value of those categories and thereby failed to understand their historicity and discursive functions. Second, there is a general reluctance in STS with regard to the semantic aspects of science and science policy—the role of language has not been a popular topic in science studies for some decades.[8] This reluctance can partly be explained by path dependencies in the STS field: after the implementation of social constructivist approaches in the 1970s and after the "practice turn"[9] had gained momentum in the 1980s, discourses on questions of ethos, scientific ideas, and identity work were seen as acts of mere ideological purification intending to disguise the real motives and interests of scientists and engineers.

The third reason relates to how the relationship of basic and applied research is expounded in the more recent literature. In contemporary diagnoses, what seems to be at the core of attention is the increasing "pressure of practice" (Carrier, Howard, and Kourany 2008), "commercialization" (Siegel, Veugelers, and Wright 2007; Mirowski and Sent 2008), "commodification" (Jacob 2009; Radder 2010), "valorization" (De Jonge and Louwaars 2009; Bos et al. 2014), "academic capitalism" (Slaughter and Leslie 1997; Slaughter and Rhoades 2004), and "campus capitalism" (Greenberg 2007). STS scholars are traditionally engaged in criticizing the power of economic rationales in science policy. At the same time, they are deeply skeptical about the ideology of "pure science," which they suspect prevails in ivory tower academia. Therefore, hardly anyone in the field today would counter the economic colonization of research by calling for more autonomy of basic research or by claiming a science "for its own sake." It seems more opportune to propose or employ alternative notions of applied research, such as "transdisciplinarity," "translational research," "responsible research," or "science in the public interest." What is missing, however, is a reflection on whether and how these seemingly new categories reproduce the old distinction between basic and applied research. In other words, STS scholars want science to be applied, but applied in the right way—to serve, for example, the public instead of the military, civil society instead of the economy, and the patients instead of the pharmaceutical industry. This engagement—as justifiable as it may be—has made it difficult for the STS community to actually understand and explain the persistent relevance of the basic/applied distinction, as well as the way it still influences contemporary science policy. What is more, neither the realist assumption that there exists something like basic and applied research nor the opposite critical-constructivist assumption that these concepts conceal the actual nature of scientific performance is helpful for getting to the bottom of the question of how language is relevant to the politics of science.

In contrast to those STS debates, Peter Galison (2008) and Peter Dear (2005, 2012) accentuate that understanding the meanings of concepts such as pure science, as well as the relationship of contemplative and instrumental forms of knowledge, is one of the pressing problems to be addressed in the history and philosophy of science. Steven Shapin (2001, 2012), in line with this revived interest in historicizing modern notions of science, has broadened the scope to "metascience" discourses, which address the role of science and research more generally—in contrast to a focus on epistemic and disciplinary aspects of scientific discourses characterized by specific technical language. Furthermore, in his study on *The Scientific Life* in late modern America, Shapin (2008) includes the nonacademic sphere as well. He demonstrates how scientists both in academia and in industrial contexts have to position themselves and their work in a complex field that we may characterize using distinctions such as those between basic and applied research. For example, Shapin (2008: 210) presents a historically relatively new figure, the "scientific entrepreneur," and describes the tension inherent in this role: "They have one foot in the making of knowledge and the other in the making of artifacts, services, and, ultimately, money. They may or may not be aware of any 'conflict' between these aspects of their identity, but they embody drives and activities that, during the course of the twentieth century, were widely held to be in tension, and sometimes in opposition." In terms of methodology, Shapin's perspective can be characterized as a symmetrical approach that avoids any bias toward specific notions and valuations of either side of the distinction. In other words, "pure science" is not more ideological than "applied science," and vice versa. It is the tension between both concepts that is crucial. The task is thus to ask for the ideological underpinnings of the whole range of concepts relevant to the politics of science.

In a broader sense, this claim of symmetry applies, in fact, to the whole vocabulary that is significant for both scholarly and public debates. Particularly important are those concepts that Reinhart Koselleck (1972) has described as fundamental concepts (*Grundbegriffe* or *Leitbegriffe*) and those that Roy Harris (2005: viii) characterizes as "prestigious conceptual supercategories in terms of which the intellectual life of the modern world is organized." First of all, we have to think about terms that are often taken as given in the natural language, such as "science," "technology," "research," and "innovation." A closer look at this semantic field reveals a set of concepts that represents the essence or overall attributes of science and technology, such as "objectivity," "rationality," and "progress." Within this range, basic and applied research represent still another dimension of metascientific concepts, namely those terms of science policy that are mainly deployed for categorizing, organizing, and specifying the fields of science, research, and technology. Other examples of concepts fulfilling this function are "pure science," "excellence," "interdisciplinarity," "transdisciplinarity," "big science," and "strategic research." Not all of these terms, however, are used in the same dichotomous way as basic and applied research.[10]

In this volume, we want to take this methodological intuition one step further. To grasp the paradox that concepts such as basic and applied research are heatedly contested, while at the same time remain indispensable and of persistent relevance for communicating science policy, we analyze them not in analytical terms but as historical semantics. We propose to apply conceptual history (Koselleck 2002, 2004, 2006; Olsen 2012; Wimmer 2015; Müller and Schmieder 2016; Pernau and Sachsenmaier 2016) to the field of history of science and science policy. While there is a long tradition of conceptual approaches in political philosophy (Gallie 1955/1956; Skinner 1969; Connolly 1993), scholars have only recently begun to address the origins and shifting meanings of supercategories such as "science" (e.g., Harris 2005; Phillips 2015), "technology" (e.g., Schatzberg 2006, 2012), or "innovation" (e.g., Godin 2015a, b)—a trend that has hardly been noticed among the conceptual history community (Schauz 2014b).[11] For a long time, distinctions like "pure and applied science" or "basic and applied research" have been interpreted merely as the professional boundary work or funding rhetoric of scientists (Gieryn 1983, 1999; Meinel 1983; Slotten 1993; Kline 1995; Waterton 2005; Calvert 2006). More recent studies, which are synthesized and carried forward in this book, indicate that such distinctions have more complex functions and manifold meanings.[12]

Metascientific concepts emerge in public as well as in scholarly discourses across different disciplines. By focusing on the polysemy of the aforementioned concepts, we can examine how they serve as "collective symbols" (Link 1986), "boundary objects" (Star and Griesemer 1989), "travelling concepts" (Bal 2002), or "nomadic concepts" (Andler and Stengers 1987) that link different discursive groups with diverse, and often conflicting, interests and values. Conceptual history reminds us not only of semantic shifts, but also of the possibility that, at the same time, older meanings continue to exist and are revived every now and then, even though these historical references often imply an act of "invention of tradition" (Hobsbawm and Ranger 1983). Furthermore, conceptual approaches from linguistics and semiotics help us to understand that all concepts are part of broader semantic fields, including conceptual variations and related terms (Schmidt 1973; Eco 1976; Lyons 1977). Thus, it would be wrong to simply equate terms such as "pure science," "fundamental research," "basic research," or "blue sky research."[13] Rather, we have to examine whether and how such subtle semantic differences indicate historical shifts and transformations in the way we think about how science and society relate to each other.

Finally, following more recent discussions, scholars are increasingly building bridges between conceptual history on the one hand and discourse analysis or approaches to narratives and social imaginaries on the other.[14] The crucial insight from this strand of literature is that concepts are not free-floating entities but embedded in discourses, narratives, or imaginaries that in themselves are much more difficult entities to grasp. As a consequence, we aim to reconstruct how specific concepts such as basic and applied research are embedded and utilized in broader science policy discourses. The studies in this volume are therefore based on a great variety of sources: archival material from research organizations, governments, and administrative agencies; grey literature such as science policy and funding reports; journalistic reports published in newspapers and magazines; and, of course, scholarly books and articles published in scientific journals. Concerning the latter, it is important to note that it often does not make sense to distinguish between primary and secondary sources—metadiscourse about the language of science is itself rooted in a historical context. Therefore, in each chapter, the various sources are merged into only one bibliography that contains all printed sources. Archival and anonymous sources, in contrast, are specified in the notes.

Historical Semantics and Historical Shifts in Science Policy

Debates on science policy have always been embedded in historical narratives and rationales. Whereas historical references are sometimes employed explicitly, most of the time the semantic legacy of science policy concepts goes unnoticed and operates subconsciously. There is, in other words, a tacit dimension in science policy discourses that is constitutive not only for political practice but also for scholarly discourses. This becomes evident in those contributions from STS and STI policy studies that aim to demonstrate that scientific research today is no longer what it used to be, and to explain why. The 1990s and 2000s produced a bulk of literature on changing modes of research, research organization, and science policy.[15] A common denominator of this literary genre is the assumption of a fundamental transition or an "epochal break" (Nordmann, Radder, and Schiemann 2011) that sharply dissociates the way research is conducted today from the way science used to be organized in the past. For example, many scholars refer to a traditional era of science that was characterized by discipline-oriented basic research at universities, which came to an end in the 1980s. This implies a historical image of modern science that presumes continuity from the nineteenth century era of pure science to the postwar period of basic research, which is evidently very far from actual historical developments in the nineteenth and early twentieth centuries.

In addition, in the field of STI policy studies, there is a wide strand of literature about the contexts and conditions of innovation, particularly on the historical origins and variations of national innovation systems.[16] These scholars hope to gain insights from history into how exactly scientific research contributes to innovation processes. They seek to find historical answers to the question of why and when national research policies succeeded in, or failed at, stimulating innovation. According to these "innovation studies," the early twentieth century appears as a first period in which the national research landscapes were transformed and the settings for the so-called national innovation systems were shaped.

These scholarly traditions, in all their variation and heterogeneity, share an interest in developing analytic categories and typologies to describe succeeding periods of science and historically changing science policy regimes. While we are interested in the problem of historical periodization as well, we pursue a different approach. We are interested in how actors themselves perceived and conceptualized the relationship between science, technology, and politics at different points in time. A similar change of viewpoint was proposed already in 1976 by Otto Mayr (1976: 670), who discussed the science-technology relationship as a "historiographic problem": "So far we have defined 'science' and 'technology' in our own terms and have then tried to analyze their relationship through the course of history from our own vantage point. Instead, we should recognize that the concepts of science and technology themselves are subject to historical change; that different epochs and cultures had different names for them, interpreted their relationship differently, and, as a result, took different practical actions." Mayr's idea, however, did not resonate in the history of science community until the 1990s (Kline 1995: 194–195). Furthermore, Mayr concentrated on a specific debate about the division of labor between history of science and history of technology. In contrast, our aim is to deal more generally with all those categories and metascientific discourses that make sense of how science relates to its societal environment, with a focus on the nexus between science and politics. We analyze how scientists, engineers, private stakeholders, and policymakers used concepts, first to negotiate goals and organizational settings of research, and second to cope with conflicting interests and problems emanating from science and its societal applications. The primary objective of this volume thus is to reconstruct the origins, multiple meanings, semantic transformations, and discursive functions of the semantic portfolio of science and science policy.

According to Reinhart Koselleck (2004: 223), language and concepts are "no mere epiphenomena of so-called real history," but rather frame both human experience and the way in which society perceives the world. Key concepts are cognitive strategies designed to deal with reality. At the same time, concepts convey expectations pointing to desirable or, alternatively, dreaded futures. In other words, concepts are relevant for making sense of both the past and the future. They are embedded in narratives, ideologies, worldviews, and in what Sheila Jasanoff calls "sociotechnical imaginaries" (Jasanoff and Kim 2015). It is a common understanding in conceptual history that concepts have their own time structure and therefore tend to be very persistent—an assumption that resonates with other theories on cultural change, such as William Ogburn's (1964) notion of "cultural lag." The challenge of conceptual history hence is to detect gradual shifts in meanings, especially since old and new semantic dimensions coexist. A shifting societal dictionary—be it the emergence of neologisms or changes in attributions—indicates historical upheaval. Following Koselleck (2004: 263–275), the real "driver" of history is the asymmetry of experience and expectation. Ideologies, in particular, are supposed to compensate semantically for a lack of convergence between expectations and experiences (Koselleck 2006: 85).

Europe and Beyond: Science Policy in Transnational and Diachronic Perspective

This book is based on a comparative design that puts national science policies in a transnational context. At its core, it deals with a European semantic tradition that influences and finally gets itself transformed by interactions with the increasingly successful science policy discourse of the United States in the twentieth century. Furthermore, the book traces the genuinely European Marxist semantics of theory and practice—related to, of course, but not identical with the basic/applied distinction—beyond Europe by looking into how these concepts have been adapted in Mao's China. The first part comprises extensive chapters on three leading nations in science and technology: Britain, Germany, and the United States. These chapters pursue a long-term perspective by tracing the genesis and genealogy of categorizations of science back to the nineteenth century, which allow us to identify major shifts in the language of science policy. The second part consists of five case studies covering science policies in Britain and its colonies, West Germany, and, representing the Socialist part of the World, the German Democratic Republic (G.D.R.), Hungary, and the People's Republic of China (P.R.C.), all making visible how science policy discourses developed in different cultural settings after 1945. In the last chapter of the volume, the historical perspective is complemented by an overview of recent conceptual trends in the European Union's (EU) research and innovation policy, exemplifying how the basic versus applied distinction has been replaced by a pluralization of concepts that have yet to prove their structural potency.

In several classic studies, "pure science" and "basic research" have been considered concepts specifically linked to the self-image of Western democracies (Daniels 1967; Greenberg 1967; Tobey 1971; Mulkay 1976). A comparative perspective, in contrast, reveals that they have been equally applied in communist (China) and former communist (East Germany, Hungary) countries. Moreover, Germany, with its fascist past and its divided history after 1945, offers an intriguing case for analyzing how a common discursive tradition was adapted in various ideological regimes, and for putting the alleged link between democracy and the ideal of "basic research" to a test.

The contributions in this volume therewith reveal a much more variegated history of science policy in the twentieth century than the one we would expect following the ideological controversy between the East and the West—a controversy that is frequently exemplified, and at the same time simplified, by the debate between John Desmond Bernal and Michael Polanyi.[17] The literature has so far failed to problematize the ideological representation of the communist plea for "applied research" or the preference of "practice" over "theory" in the service of the technological advancement of Eastern societies and the parallel Western glorification of "basic research" as an essential part of democratic freedom.

The United States and the United Kingdom remain important cases given their global influence and pioneering roles in establishing science policy as a national endeavor in the course of the twentieth century. In fact, most of the mainstream literature on science policy focuses on the American context (e.g., Jasanoff 1990; Sarewitz 1996; Stokes 1997; Guston 2000), and most historical studies on the semantics of "pure versus applied science" and "basic versus applied research" deal either with the United States or with Great Britain.[18] While this strand of literature so far consists mostly of unconnected context-bound case studies, our comparative collection brings us closer to the goal of getting a full picture of how the basic versus applied distinction has developed in these two key countries.

The country case studies presented in this volume do not stand for themselves, but must be read as various strands of a transnational development. International exchanges and cooperations on both individual and institutional levels have characterized modern science just like personal competitions and national rivalry. This also applies, on a more general level, to modern STI policy: science nations have kept a close eye on each other. Although our collection of national case studies is not able to implement approaches of transnational history as consequently as its representatives have envisioned it (e.g., Mintz 1985; Conrad and Randeria 2002), the following synopsis intends to discuss the main findings not only in a comparative but also in a transnational perspective. The comparison of country case studies brings out the similarities as well as the national differences in science policy, which we will trace back to political settings, traditions, and the contingent history of events. The transnational perspective highlights the interdependency of nations and cultures and at least some of the processes of transfer, exchange, and mutual observations. In the Cold War period, for instance, it was the competition between East and West, on the one hand, and the asymmetrical relation between the leading nations and the other allies within the respective ideological camps, on the other, that stimulated the traveling of concepts, the adaption of role models, the production of catching-up narratives, and cultural or ideological boundary work. In this regard, transnational organizations such as the OECD acted as transmitters of conceptual transfer and as stabilizers of whole semantic fields (Godin 2005). This transnational scope thus opens up the discussion about what we call *conceptual synchronization* in science policy, in the course of which basic and applied research became the predominant concepts of the language of science policy around the globe.

Yet, in spite of conceptual synchronization and traveling concepts, there are limits of literal translation that point to persistent cultural differences. A well-known example that is pertinent in the context of the present volume is the difference between the German term "Wissenschaft," which denotes scholarly activities across all disciplines, and the English notion of "science," whose meaning was narrowed down to the natural sciences in the course of the nineteenth century (Phillips 2015). Another relevant example is the difference between "fundamental research" and "basic research," which most other languages cannot express simply because they lack the necessary linguistic nuance.[19] All in all, a comparative perspective is a big challenge for conceptual history because even small conceptual variations may indicate essential structural differences (Steinmetz 2016: 353–357). Given the Eurocentrism of the academic language, this applies especially to global comparisons. Finally, the limits of literal translation imply even more challenges for scholars as soon as the analytical language is not identical with the one of the research object—this is what Jörn Leonhard (2016: 153) calls a "translational circle." To avoid misunderstandings, all contributions to this volume refer not only to the English terms of key concepts, but as well to the original terms in the respective languages of the countries they study.

Main Findings: The Diachronic Perspective

Using a diachronic perspective, the first three chapters trace the semantic field relevant to the modern politics of science back into the nineteenth century. For quite some time, "pure and applied science" seem to have been well-established concepts for communicating science and technology to the public and to the government. The entangled histories of Britain (chapter 1), Germany (chapter 2), and the United States (chapter 3) demonstrate, however, that the uses and the meanings of these terms differ over time. In Germany, where the natural scientists entered the universities comparatively early, the pure versus applied distinction represented hierarchical ways of knowing and a respective order of disciplines since the late eighteenth century. The natural scientists embraced the ideal of pure science as professional marker, which had an integrative function within academia—this is what we call *identity work*—and, at the same time, a distinguishing one with respect to the upcoming engineering or, rather, applied sciences—a process usually described as *boundary work*. In the United States, "pure science" became idealized in the late nineteenth century. Whereas the German devotion to pure science turned into a professional strategy aligned with a hierarchical system of higher education, the American notion of pure science bore a quasi-religious meaning and was intimately connected with a critique of commercialization. Still different was the semantic trajectory in Britain, where scientists used terms such as "abstract" and "applied science" primarily to categorize different branches of the sciences. Although, in the 1850s and 1860s, the distinction between "pure" and "applied science" gained importance in the debates on higher education and therewith the positioning of the natural sciences in the universities, the term "applied science" had less pejorative connotations and thus worked as a useful promotion strategy for science by demonstrating its societal utility.

The early twentieth century witnesses the emergence of a totally new set of concepts, namely "fundamental," "industrial," "basic," and "applied research." It was the first time that the supercategory of "science" got challenged by various notions of "research." The shift corresponded with changing national research landscapes, particularly with the advent of industrial research laboratories and new types of institutions exclusively devoted to research. The new concepts of research were no epiphenomenon of this structural change; they were rather needed to renegotiate organizational arrangements and, above all, the means and ends of science in the twentieth century.

Against this background, this book challenges the common assumption that the concept of "basic research" is heir to the long tradition of "pure science" or to ideologies that glorify the scientific quest for truth. Rather, new terms such as "fundamental research" transmitted the message that science is useful, despite the fact that its outcome is not predictable. In the United States, the plea for fundamental research was driven by the critique that "pure science," conducted mainly at universities, was not able to meet the increasing demand for scientific knowledge (chapter 3). Against the background of these findings, it is not surprising that the German version of the concept of fundamental research gained importance in the Nazi period: *Grundlagenforschung* (basic research),[20] and the new term *Zweckforschung* (goal-oriented research) served as funding rationales that released research projects relevant to armament and economic autarky from the strict directives of the Nazi's four-year plan (chapter 2).

In the long run, and particularly in the United States and Great Britain, the semantic shift from "science" to "research" was accompanied by a structural shift from "science policy" to "research policy," in the course of which "research" became an expanding, multifaceted, and mundane umbrella term for heterogeneous research activities beyond the academic sphere. While science policy in the nineteenth century mainly dealt with higher education and university policy, research policy in the twentieth century widened its scope to include a much wider variety of institutions performing research. This was, however, not a linear development. In West Germany, for instance, science policy debates revolved very much around issues of higher education because *Wissenschaft,* and thereby the university, was intended to play an important role in the pursuit of democratization after 1945. Although U.S. science policy advisors put much effort into propagating programs for basic research in postwar West Germany, the relevance of this concept remained restricted to economic discourse until the 1960s. Moreover, since Germans clung to a cross-disciplinary notion of *Wissenschaft,* science policy (*Wissenschaftspolitik*) still covered a wide range of research activities, including the humanities, whereas postwar debates on research policy in the United States primarily focused on projects in the natural and technical sciences as well as in medicine (chapters 2 and 3).

In the mid-twentieth century, roughly in the decade after World War II, the term "basic research" became universally employed across borders. This semantic shift is analyzed in detail in several chapters of this book. The specific historic situation—the change from wartime to peacetime and the upcoming tensions of the Cold War—led to a revival of ideas traditionally related to the nineteenth-century ideal of pure science. These aspects are often ascribed to the ideas developed in Vannevar Bush's report, *Science, the Endless Frontier* (1945). A closer look, however, reveals how Bush's vision and the succeeding debates in U.S. science policy transformed older conceptions of science and thus considerably differ from the nineteenth-century ideal of pure science. Although U.S. experts also referred to the nineteenth-century humanistic notion of science, they aligned governmental research policy primarily with goals of national prosperity and security. Scientists, however, feared that an excessive demand for scientific applications could endanger the production of new scientific knowledge in the long run. In contrast to the concept of pure science, the advantage of basic research lay in the metaphorical use of "basic," which promised to lay the cornerstone for both the advancement of science and all kinds of societal benefits (chapter 3).

The case of U.S. science policy between the 1940s and 1960s, as analyzed by Greenberg (1967) and others, illustrates how the distinction between basic and applied research was deeply embedded in a broader debate on fundamental political values and the organization of the polity. The same goes for the situation in Europe. The exact nature of this political dimension, however, varies according to national contexts. In postwar West Germany, scientists and research organizations such as the Max Planck Society had to reestablish themselves in a radically transformed political environment (chapter 5). Here, a long tradition of basic research was invented to create an image of science that is independent and detached from worldly and political goals. This was possible notwithstanding the fact that basic research was also conducted in the Nazi period, and was actually very close to application: the institutes of the Kaiser Wilhelm Society—the predecessor of the Max Planck Society, with a focus on the natural sciences—were highly esteemed for their application-oriented research and collaboration with industry and the military. The point here is that the concept of basic research was fuzzy enough to secure the high scientific prestige of the research institutes of the Max Planck Society beyond the fascist era.

Still another political meaning is contained in the term "fundamental research" as used in British development policy in the 1940s (chapter 4). While this concept was not free from some connotations of "pure science," it primarily pointed to a specific spatial arrangement: "fundamental research" meant research into widespread issues as opposed to local research, which was about narrowly focused inquiry. When the British Colonial Office intended to modernize research institutions in the colonies, the challenge was to enhance their scientific reputation. The launch of a program for fundamental research in the colonies was thus based on the distinction between universal, internationally recognized knowledge, and more practical and technical forms of locally relevant knowledge. The objectives of this boundary work were, first, to attract renowned scientists from the United Kingdom, which should secure metropolitan supervision of colonial research, and, second, to make fundamental research a symbol for modernization of the British colonies.

The diachronic argument of this book is brought to the present time in an outlook that traces recent trends and new entries in the lexicon of science policy (final chapter). Concepts such as "frontier research" and "grand challenges" are interpreted as attempts to establish narratives and rationales for the politics of science in the twenty-first century. Despite the different metaphors and historical references, the protagonists of these semantic variations share the intention of avoiding old-fashioned dichotomies. Thus, these new concepts cannot be negated, as they seem to be purely positive and inclusive. However, it is not very likely that one of these new concepts will actually become a science policy master narrative comparable to what the linear model has been for the twentieth century. Rather, we observe a pluralization of science policy discourses, and it remains unclear whether in the long run this plurality will narrow again to one or two key concepts.

Main Findings: The Transnational Perspective

In addition to the diachronic view, the transnational perspective of this book sheds light on exchanges and interdependencies in the global field of science policy. Our focus here are the decades after World War II. In this period, we observe not only *conceptual synchronization* but also *cultural variation* with regard to how the concepts were used and filled with meaning. This is particularly evident in the three case studies on science policy in communist countries—the German Democratic Republic (chapter 6), Hungary (chapter 7), and China (chapter 8). In the 1940s and 1950s, all of these countries reorganized their research infrastructure and brought science policy in line with communist ideology.

The transnational logic of competing science policy regimes is, however, not restricted to the Cold War era. In the course of the twentieth century, science and technology had become increasingly important indicators for where a nation stood in the global order, and those nations that felt left behind were trying to catch up with the others. These dynamic processes did not start with the Cold War, but can be observed already in the nineteenth century. When Britain had to forfeit its leading role in the chemical industry, the motive of catching up with Germany was crucial in the decision to install the new Department of Scientific and Industrial Research (chapter 1). In the United States, the narrative that America lags far behind Europe concerning the abstract and theoretical sciences was reiterated again and again between the 1840s and the 1920s. The image of the United States as a nation that preferred applied over pure science and was thus dependent on European knowledge production initiated many debates about the development of American science (chapter 3).

In other words, global competition was not invented in the Cold War, but it became more visible and dramatic. The arms race and ideological rivalry implicated a harsh competition for the superior system of science and technology. Milestones such as the launch of Sputnik, the ability to create an atomic bomb, or, more generally, the number of inventions and overall economic development became important stakes in this situation of mutual observation. In the People's Republic of China, it was the successful atomic bomb test in 1964 that marked a turning point in Chinese science policy (chapter 8). As a result, Chinese science advisors declared that the phase of imitation was over. To enter the next stage—that is, to aim at catching up and finally surpassing the Western nations—they could argue for the relevance of basic research; herein lay, at least for a small group of natural scientists, a chance for a circumscribed independence. Before, as is illustrated also by the case studies on the G.D.R. (chapter 6) and Hungary (chapter 7), the relation between "theory and practice" had to be strictly framed in accordance with Marxism and the Communist Party's politics.

All the same, we also find evidence for a reframing of science policy in terms of basic and applied research in the Eastern part of the world. The process of international conceptual synchronization, however, depended on political contingencies. Hungarian economists, for example, could produce neither basic nor applied research before the death of Stalin in 1953; before, they were instructed to rely exclusively on studies from the Soviet Union, and they were not allowed access to economic data, which were controlled by the party (chapter 7). In China, the radical politicization of science was tempered after the death of Mao in 1976 (chapter 8). Of course, Marxist scientists and policymakers were trying to develop their own conceptual frameworks. John D. Bernal and Gerhard Kosel, for instance, developed an alternative to the Western paradigm of the linear model, labeled as the "scientific-technological revolution." The G.D.R. clung to this model until the 1970s (chapter 6).

Overall, the vocabularies of science policy were framed by more general sociopolitical concepts both in the East and in the West: in communist countries, key terms were "revolution" or "planning," whereas leitmotifs in the West were "progress" and "modernization." Despite the ideological antagonism, there were common denominators in science policy discourses: first, the strategy of categorizing various research activities according to a dichotomous rationale, and second, the narrative that science is aligned with technological advances. Furthermore, the notion of planning was not exclusive to socialist governments, but became increasingly important in many Western countries in the 1970s (chapters 2 and 5).

A special case to examine conceptual synchronization of science policy with international discourses is the constellation of East and West Germany (chapters 2, 5, and 6). In the 1970s, the socialist government of the G.D.R. aimed to reform science policy after some big science projects could not meet the expectations and invited criticism both from industry and scientists. Party officials concluded that new knowledge, namely basic research, was needed. To adjust the alien nomenclature to socialist ideology, they started to interpret the basic/applied relation dialectically, invented a bureaucratic way of subdividing the process from basic research to development in nineteen stages, and created conceptual hybrids such as "targeted basic research"—which were, in fact, quite similar to the Western ones. The ironic result was that the G.D.R. introduced an extreme version of the linear model of innovation just at the time when it began to lose its steam in the West.

In the Federal Republic, the process of synchronization with the U.S. nomenclature started earlier and was connected to the efforts for a successful integration into the Western alliance. A full adaption, however, turned out to be difficult. Although "basic research" was already in use, it competed with other concepts, such as pure science or independent research, which were in turn related to discourses about the democratization of postfascist Germany. Moreover, the distinction between basic and applied research was hotly debated in the 1950s and 1960s, namely for two reasons: first, the German Research Foundation stressed its responsibility for all branches of *Wissen-*

schaft, including the humanities and applied sciences. They avoided the concept of "basic research" because it seemed too strongly associated with the natural sciences. It was not until the 1970s that the concept of basic research became equally common in the humanities. Second, science policy experts complained that, compared to the United States, the Federal Republic lacked government institutions that could take on applied research. In the end, it was not until the 1970s that the distinction spread beyond the natural sciences and became the main funding rationale.

The competition between science policy regimes did not fade away with the end of the Cold War. An outlook into twenty-first-century science policy reveals that the United States is still a crucial reference point for STI polices around the world. The final chapter of this volume focuses on the European Union to get a picture of how transnational science policy is in search of a new language. In this context, it is conspicuous that European science policy is strongly aligned to the goal of establishing Europe as a key player in the global competition, while at the same time building not on its own tradition but on genuinely American narratives. This ambivalence of EU research policy is best illustrated by the European Research Council's (ERC) introduction of "frontier research" as a new term substituting outdated notions of "basic research." The frontier metaphor is deeply rooted in the history of the United States and thus is a good example of how concepts travel across time and across borders. The same goes for the concept of "grand challenges," the origins of which can be traced back to debates about supporting the computational sciences in the United States in the 1980s against the background of the "Japanese challenge." The European Commission adopted this concept and transformed it into the idea that the role of science is to "tackle societal challenges."

From Epistemology to the Politics of Science

Finally, our book demonstrates that the distinction between basic and applied research is not primarily related to epistemic properties of different types of research. Rather, it deals with a variety of essentially political problems. Many dimensions of the politics of science have been touched on above: the funding and (re)organization of national research activities, the political symbolism of key concepts and metaphors such as "the frontier," issues of higher education, the long-lasting function of professional identity work of scientists and research institutions, global competition in technological developments, and national security issues. These were not abstract problems, but rather, especially in the Cold War period, issues with high relevance for individuals, scientific communities, and science in general. In the heyday of the McCarthy era, U.S. scientists were exposed to political attacks when they took a critical stance on the ideal of basic research. To some degree, they were thus forced to opportunistic politicking (chapter 3). The Hungarian and Chinese cases demonstrate that the question of how experts positioned themselves toward issues of science policy turned into a question of loyalty and sometimes even into a question of life or death (chapters 7 and 8).

Related to, but not identical with, the political problems are questions concerning ethical dilemmas and responsibilities, which arose from the sometimes destructive effects of science and technology. Especially in the aftermath of the two world wars, most urgently after the atomic bombs were dropped on Hiroshima and Nagasaki, the concepts of applied and pure science unfolded critical debates on the question of how to deal with failures and risks related to science and technology (chapters 1 and 2). With the beginning of the twenty-first century, there seems to be a shift in this longstanding debate. After a period of bureaucratic solutions, such as technology assessment and risk analysis, in the 1980s and 1990s, this aspect is now being framed as a question of democratization of science policy. The very recent concept of "responsible research and innovation" is a popular example, which tries to redefine such issues (Rip 2016; Ribeiro, Smith, and Millar 2017; Flink and Kaldewey 2018). However, even this bureaucratic construct conveys in its very name a semantic pair—"research" and "innovation"—that reminds us that the distinction between basic and applied research is still part of our conceptual vocabulary.

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of science and politics, particularly with the contemporary pluralization of science policy discourses and how they transform the identity work of scholars, scientists, and policy makers.

Notes

1. It is telling that Dupree was digging for the roots of U.S. federal policy just at the time when science policy became highly significant for the U.S. government and the new policy field needed to be legitimized.
2. The early modern distinction between theory and practice, in turn, is related to several semantic traditions from antiquity to the Renaissance. Most important here is the influential tradition of debating the relative values of "vita activa" and "vita contemplativa" (Kaldewey 2013: 191–247).
3. This discussion is well documented in editorials and comments in *Science* (Abelson 1964, 1965, 1966a, 1967; Klopsteg 1965; Greenberg 1966; Reagan 1967). The debate heated up when the Department of Defense published the "Project Hindsight" study, questioning the utility of basic research (Abelson 1966b; Sherwin and Isenson 1967). This study was later countered by the TRACES study, which in contrast argued for the continuing relevance of basic research for technological development (Thompson 1969). The Project Hindsight vs. TRACES debate has often been referred to by science studies scholars (e.g., Kreilkamp 1971; Stokes 1997; Asner 2004; Hounshell 2004; Elzinga 2012).
4. See, for example, the critique as formulated in a variety of studies representing quite different factions in the field of science studies: Latour 1993; Gibbons et al. 1994; Oreskes 2003; and Douglas 2014.
5. For instance, a random analysis of more recent articles on science and technology in the *Süddeutsche Zeitung,* a widespread and influential German newspaper, supports the assumption that basic and applied research are still the dominant concepts in the public discourse: "Leid im Labor," 10 August 2016; "Saatgut für die Welt," 24 September 2016; "Der Staat finanziert, die Wirtschaft kassiert," 22 October 2016; "Revolution in der Zelle," 10 December 2016; "Künstlich intelligent," 1 January 2017; "Intelligenztest für Autos," 14 January 2017.
6. See the self-description on the website of the Ministry of Science and Technology of the People's Republic of China, retrieved 29 May 2016 from http://www.most.gov.cn/eng/programmes1/200610/t20061009_36223.htm.
7. See the self-description of the Institute for Basic Science, retrieved 27 July 2014 from https://www.ibs.re.kr/eng/sub01_01_01.do.
8. Exceptions are studies by linguists or scholars of communication studies situated at the margin of the STS community (e.g., Harris 2005; Perren and Jennings 2005; Ceccarelli 2013; Perren and Sapsed 2013).
9. The "practice turn" is a label introduced by Schatzki, Knorr Cetina, and Savigny (2001) to summarize recent developments in contemporary theory. In retrospect, several studies that have been influential in the field of science studies can be sub-

sumed under this label (Latour and Woolgar 1979; Knorr Cetina 1981; Latour 1987; Pickering 1992).

10. For a more elaborated discussion of concepts that promise to yield important insights into the role of language in the politics of science and technology, see Schauz 2014b, Flink and Kaldewey 2018, and the website of the CASTI Research Network, http://www.casti.org/.
11. This introduction cannot give an overview that covers all the diverse approaches dealing with concepts, symbols, or metaphors. Moreover, it must be noted that scholars in history and philosophy of science and science studies have already developed a particular interest in metaphors, their epistemic role in knowledge production, and their symbolic functions for public debates on certain research fields, especially biology and genetic research (e.g., Blumenberg [1960] 2010; Keller 1995; Maasen, Mendelsohn, and Weingart 1995; Maasen and Weingart 2000; Brandt 2004; Vaccari 2008; Borck 2013; Surman, Straner, and Haslinger 2014). So far, however, this strand of literature has not included metascientific concepts.
12. See Lucier 2009, 2012; Clarke 2010; Bud 2012, 2013, 2014; Gooday 2012; Pielke 2012; Kaldewey 2013; Schauz 2014a, 2015; Lax 2015; Roll-Hansen 2017; Sapir 2017. Several of these authors have continued their work and are represented in this book (chapters 1, 2, 3, and 4) .
13. This kind of substitution is, for example, seen as unproblematic by Calvert (2004: 254), who traces different meanings of "basic research" in language and practice, but ignores the historical dimension of these meanings.
14. The discussion about how to reconcile conceptual history and discourse analysis, however, is restricted so far to German authors (Busse 1987, 2016; Steinmetz 1993: 30–44; Reichardt 2000; Bödeker 2002; Wiehl 2003; Konersmann 2005; Kaldewey 2013). For relevant approaches focusing on narratives and imaginaries, see Castoriadis (1975) 1997; Anderson (1983) 2006; Bal 2009; Koschorke 2012; and Jasanoff and Kim 2015.
15. See, to list just some of the most cited texts, Funtowicz and Ravetz 1993; Gibbons et al. 1994; Slaughter and Leslie 1997; Etzkowitz and Leydesdorff 2000; Fuller 2000; Ziman 2000; Nowotny, Scott, and Gibbons 2001; Slaughter and Rhoades 2004. Extensive reviews of this genre of literature have been provided by Godin 1998; Shinn 2002; Elzinga 2004; Hessels and van Lente 2008; and Schiemann 2011.
16. See Lundvall 1992; Nelson 1993; Rosenberg 1994; Freeman 1995, 1996; and Mokyr 2002. More recently, scholars aim to demonstrate that we deal here with an emerging scientific field (Fagerberg 2005; Fagerberg and Verspagen 2009; Fagerberg, Martin and Andersen 2013). For a critical perspective, see Godin 2009, 2012.
17. The most cited publications associated with this debate are Bernal 1939 and Polanyi 1940, 1962. See Douglas 2014 for a short report on this debate related to the problem of how to define "pure science." For the economic underpinnings of Polanyis's understanding of pure, independent science and the intellectual background of the British debates, see Nye 2011: 145.

18. For the United States, see Daniels 1967; Hounshell 1980; Kline 1995; Lucier 2009, 2012; and Pielke 2012. For Britain, see Gieryn 1983, 1999; Bud and Roberts 1984; Donnelly 1986; Clarke 2010; Bud 2012, 2013, 2014; and Gooday 2012.
19. In the early twentieth century, "fundamental research" emerged in the context of industrial research and applied sciences, both in the United States and in Great Britain. Although the meanings of fundamental and basic research were overlapping in many respects at first, the two concepts grew apart after 1945, when basic research was transformed into a concept that primarily referred to academic research in the natural sciences (chapter 3).
20. While the English terms "fundamental research" and "basic research" often bear different meanings (chapters 3 and 4), the German term *Grundlagenforschung* does not allow for such differentiation.

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