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ARTICLE

Beyond Scientificity:

Extensions and Diffractions in Post-Normal Science's Ethos

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Abstract

Eighty years have passed since Merton's famous publication of "a note on science and democracy," outlining the scientific ethos via four sets of norms, namely communism, universalism, disinterestedness, and organized skepticism (CUDOS). Merton's rationale was that the implementation of this ethos was instrumental in realizing science's institutional goal: "the extension of certified knowledge." Throughout the ensuing decades, Merton's conception has been at the center of heated debates in the emerging field of science and technology studies. It has also been addressed by empirical studies with a view to determine the scale at which CUDOS was supported by scientists themselves in explicit terms and/or conformed to in their actual practice. Some of these studies also make room for the possibility that CUDOS might have evolved throughout the past decades, incrementally adapting the norm sets. This article contributes to such empirical endeavors. Building on ethnographic work at a technology assessment (TA) institute, I find that a distinct shared ethos is tangible in TA's post-normal science practices—in collaborations with non-scientists as well as with "pure academics." A reconstruction of TA's distinct ethos from my empirical material results in the delineation of a post-normal scientific ethos, comprising "extended communism," "diffracted universalism," "diffracted disinterestedness," "extended organized skepticism," "diffracted originality," and "extended relevance." These "extensions" and "diffractions" have ramifications for the organization of post-normal science and its interaction with academia, publics, and polities.

Keywords

scientific ethos, CUDOS, post-normal science, technology assessment, epistemic communities

INTRODUCTION

When Robert K. Merton set out to map the ethos of modern science in 1942, "that affectively toned complex of values and norms which is held to be binding on the man of science," he defined four sets of institutional norms, namely communism, universalism, disinterestedness, and organized skepticism, abbreviated as CUDOS. He noted that these imperatives had not been codified but could be

"inferred from the moral consensus of scientists as expressed in use and wont, in countless writings on 'the scientific spirit' and in moral indignation directed toward contraventions of the ethos." They were "transmitted by precept and example," "reinforced by sanctions," and internalized by the scientists as their "scientific conscience" (Merton 1942: 116-7). Some later scholars have expanded the CUDOS set by discussing further components (e.g., "originality" as mentioned by Merton himself in later texts, cp. Stehr 1978), while a vast amount of ensuing science studies painted a more mundane picture of science as practice and culture, characterized less by distinct institutionalized imperatives than by individual strategic action—one need only recall Latour's 1984 "Portrait of a Biologist as a Wild Capitalist," Ziman's 2000 depiction of post-academic science in "Real Science," or Shapin's 2008 historical treatise on "The Scientific Life" as a "Moral History of a Late-Modern Vocation." Other scholars have highlighted the diversity of epistemic cultures (Knorr-Cetina 1999), thus drawing the unity of science into question. Commentators have summarized this turn towards a "New Sociology of Science" as a move to depict science as "just another P game," competing for power, prestige, and prosperity (Hooker 2003: 72), and to "deny that scientists have an ethos of their own and that they engage in a distinctive cultural activity" (Bunge 1991: 525). In more recent studies, interest in an internal scientific ethos seems to have been replaced by analyses of individual pragmatic coping strategies, disciplinary differentiation, and externalist explanations.

At the level of science policy, the situation has developed in equally ambivalent terms: on the one hand, a series of university reforms culminated in so-called full autonomy—providing for plenty of opportunities for self-regulation along an inherent ethos. On the other hand, these reforms went hand in hand with new modes of university governance, introducing managerial and entrepreneurial approaches in academia via target agreements and evaluation schemes, as well as strategic missions for all research via new funding schemes. Economic utility has become an important point of reference, complemented by missions to tackle society's grand challenges. As a result, the distinction between basic and applied research, as well as between private and public research, has blurred, and the contract between science and society has been put up for re-discussion (exemplarily: Hessels et al. 2009). But even if speaking of a scientific ethos nowadays comes with an antiquated pathos, there are good reasons to pay renewed attention: while a lot has happened in the scientific community and its relationship to society since the 1940s, the importance of internal ethical norms for an effective self-steering of science has never been explicitly denied. One could assume that within science itself, a new adapted ethos has emerged, taking into account the changing (or diversifying) character of science and the changing (or diversifying) position of science(s)-in-society. Such an alternative ethos need not be a set of unreconcilable counter-norms as proposed by Ziman (2000) for post-academic science; it can also be understood as an extension or incremental adaptation that builds on Merton's CUDOS. The programmatic writings of post-normal science theorists (Funtowicz and Ravetz 1993) seem to side with this latter option.

The following contribution revisits Merton's outline of the scientific ethos against this background. More specifically, I ask how the scientific ethos outlined by Merton in 1942 is being invigorated and possibly adapted in contemporary post-normal science contexts (exemplarily: technology assessment) that come with distinctly new functionalities, including but also transgressing the primary rationale of "exten[ding] certified knowledge" (Merton 1942: 117). I thereby combine the Mertonian outline of a scientific ethos and his conception of science as a distinct social system with a focus on practices and the thesis of a further differentiation of science. I do not argue for a fading of scientific ethos, but rather for its (local) adaptation in post-normal science contexts. In such contexts, the boundary between science and society is bridged via distinct practices, but within these practices it is at the same time reinvigorated and becomes even more relevant.

Before presenting my own research in more detail, I will give an overview of the state of discussion about Merton's ethos of science with a view to literature that addresses historical change in science (including general shifts as well as selective differentiation) and related change and specificities in the prevalent ethos. The presentation of these approaches and findings directly links to some methodological remarks on researching scientific ethos and allows for introducing my own empirical case and approach. A consecutive section summarizes the results of my study. In the final section, I discuss these findings with a view to my general research question. The aim of this contribution is not so much to define a concrete list of post-normal science norms, but rather to better understand post-normal constellations, which require a high degree of context sensitivity, reflexivity, and reactivity and demand that practitioners deal with partly contradictory imperatives on a daily basis. Last, but not least, I hope to illustrate that a distinct (if partly fuzzy, partly ambiguous) institutional ethos also plays a formative role in contemporary post-normal settings.

OPERATIONALIZING CUDOS FOR THE RECONSTRUCTION OF VARYING EPISTEMIC CULTURES

Merton's ethos of science has been both heavily referenced and criticized during the past decades. For the task at hand, I do not aim at discussing the context of its formulation (see e.g., Turner 2007) or the history of its scholarly uptake. Instead, I want to focus on its productive operationalization in empirical investigations of contemporary scientific practice and culture. In doing so, I start from the general assumption that it is worthwhile to focus on the workings and character of a distinct scientific ethos and methodically feasible to reconstruct aspects of it. I thus go with Merton's theses that (a) the scientific system is in some respects differentiated from other societal subsystems, thus exhibiting some autonomy and specificities, that (b) it is nevertheless to be understood as a *social* subsystem and thus suited for sociological analysis, and that (c) it is to be understood as a social *subsystem*, implying that science and social structure are not randomly associated. All three of these theses have become central cornerstones of science and technology studies, including the sociology of scientific knowledge, the anthropology of science, and ethnographies of scientific fields as well as theories of and discourses on science-in-context (from systems theory to socio-cultural histories of science).

I also stick to Merton's initial presentation of CUDOS that takes norms (or "institutional imperatives") as pars pro toto for ethos, including norms, cultural values, mores, ideas, standards, and imperatives.[1] These are not necessarily codified but "expressed in the form of prescriptions, proscriptions, preferences, and permissions," "legitimatized in terms of institutional values," "transmitted by precept and example and reinforced by sanctions," "in varying degrees internalized by scientists (…) fashioning their scientific conscience," "scientific mind," or "superego" (ibid.: 116). Giddens and Sutton (2013) define norms as "rules of behaviour that reflect or embody a culture's values, either prescribing a given type of behaviour or forbidding it," thus constituting one element of science understood as a socio-cultural system. Within the "New Sociology of Knowledge," scientific culture, socialization, and mindset have mostly been researched in the plural.[2] I argue that this was only in

[1] Merton's outline stays slightly fuzzy in this respect; the subtle differences between ethos, mores, norms, imperatives, and standards are not addressed. For the context at hand, I want to note that ethos does not refer to just any "rules of the game," but to collectively held moral ideals that serve as guidelines for individual actions and their appraisal for "a man of science."

[2] Flecks's thought styles (1994[1935]), Snow's (1961) Two Cultures, Becher's (1989) academic tribes, Knorr-Cetina's (1999) epistemic cultures, Meyer and Molyneux's (2010) epistemic communities, or the German school of higher education research into socialization and enculturation taken up by scholars like Arnold and Fischer (2004).

exceptional cases a move to question a joint normative basis of science that was distinct from other social systems; in most cases, the plurality of cultures to be reconstructed was rather a methodological necessity as the distinct characteristics of a culture and the cultural dimension of science as such could only be reconstructed in comparative ways, necessitating the comparison of more than one "tribe" or "field."[3] Still, these juxtaposed tribes and fields were seen as, in principle, comparable and thus of a sufficiently similar kind. The anthropological approach helped to better understand and research normative systems or "an individual's normative orientation" that were neither "fully knowable, since many of a social system's norms remain latent until they are challenged or violated" (Anderson et al. 2010). Anderson and colleagues (2010) thus recommend ethnographic or anthropologic approaches, but they note that "[n]one of these approaches has been used specifically and deliberately to investigate the normative structure of science [as such]" (ibid.: 373). The discourse on Mertonian norms still runs somewhat in parallel to a discourse on epistemic collectives and cultures, with both discourses necessarily addressing normative repertoires and structures of science, but unfortunately not joining forces in reconstructing a shared scientific ethos. Mertonian norms are instead being researched mostly via quantitative, hypothesis-testing surveys. These tend to test explicit support for or perceived adherence to CUDOS, resulting in "exact numbers," with the unsolvable problem that "Merton relied on simple labels to represent broad normative principles, but (…) such labels are subject to widely differing interpretations."

Interestingly, the quantitative studies make room for differences between proponents of different disciplines, career stages, or age groups, and thus for the possibility that the scientific ethos and its role might differ in some details within the scientific landscape and across historical times. This adaptation is admittedly in some conflict with Merton's initial socio-political ambition to argue against "a random association of science and social structure" and for an unquestionable and somewhat exclusive fit between *the* ethos of science and a distinct socio-political order (namely democracy). Merton's original ambition requires us to assume essentiality and immutability on the part of science and its ethos, at least to some extent. It seems irreconcilable with later, more relativistic stances. But this relativistic turn in itself might have something to do with fundamental changes in scientific ethos.

LITERATURE ON ALTERED OR DIVERSIFIED SCIENTIFIC ETHOS

This empirical study is certainly not the first one to bring the role and distinct character of collectively held norms in a scholarly field to the fore. It is also not the first one to address their historical dimension. Especially in the context of concepts that denote widespread paradigmatic change in science, the stability of norms over time is put up for discussion. The list of usual suspects includes conceptions of Mode-2 science (Gibbons et al. 1994), post-normal science (Funtowicz and Ravetz 1993), Open Science / Science 2.0 (taken up e.g. by Cohoon and Howison 2021; and Bucchi 2014), and technoscience (Forman 2007; Nordmann et al. 2011) as well as triple helix (Etzkowitz and Leydesdorff 1997), post-academic, and post-industrial (Ziman 2000) research. Moreover, historical incidences like the "Climategate" controversy prompted debates about adequate scientific norms and

[3] Or the comparison of one's own unconscious conceptions with those of a different field. Already in 1944, Feibleman specifies in this vein: "The ethos cannot be felt by the individual as existing in himself, and it is rarely felt by him as existing in his own social group. It can more easily be apprehended explicitly by individuals from social groups of which they are not members. The flavor, the qualitative aroma, of a social group is more easily detected by foreigners simply because it is fresh (odors make a strong first impression) and because the foreigner is not apt to be full of preconceived acquaintance with the details of the organization of the social group."

role sets (Grundmann 2013; Bray and von Storch 2017; Brüggemann et al. 2020; Cohoon and Howison 2021). Pertinent empirical investigations build on diverse methodological approaches, from questionnaires[4] to documentary analysis,[5] from mixed methods[6] to ethnographic work[7] and action research,[8] targeting various (post-)academic settings[9] and national contexts.[10] Some authors target rhetorical strategies; others study the explicit endorsements of norms; yet others investigate self-reported behavior or aim at reconstructing implicit, tacitly held beliefs. In many cases, these various themes blend in one way or another. Nevertheless, the different methodological approaches all have to deal with the fact that implicit norms, explicit endorsement of norms, and observable/reported behavior relate to each other, but are still different things—or, put differently, the violation of a norm by an individual or even collective action alone, as might be observed in qualitative studies or reported in quantitative surveys, does not necessarily negate its existence. In his theory of social structure, Merton himself has made room not only for the case of conforming to given cultural values and institutional means of their implementation, but also for deviating from them by mode of innovation, ritualism, retreatism, or rebellion (Merton 1996[1938]: 132-152). Recent empirical investigations into CUDOS—especially the hypothesis-testing quantitative sample—thus mostly support Merton's ethos as they find that the majority of respondents subscribes to CUDOS and reports on adherence to CUDOS in scientists' behaviors. But they also face methodological difficulties, as they cannot fully translate high subscription and observation numbers alone into a final prove of CUDOS.

The situation becomes even more complicated, if the deviation from the norm seems to become the rule and if deviant behavior is not sanctioned in dissident collectives. Such might be the case with shifts in ethos along fundamental shifts in scientific culture and function in general or with the formation of alternative sub-cultures and sub-communities. Evidence of such cases is mostly presented in qualitative studies. Ziman (2000) prominently characterizes the proposed historical shift from academic to post-academic science as an "undramatic revolution" (ibid.: 68) and thus refers to a fundamental shift in scientific culture in general. Ferretti and Guimães Pereira (2021) discuss the DIY movement as an opt-out of the established system and its ethos. In both variants, new norms can still be depicted as adding to and coexisting with (rather than superseding) the classic set. They can conflict with the classic set or represent its unproblematic extension. Especially in the former case (but to some extent also in the latter), the resulting pluralization of norms (and, even more importantly, primary values) results either in ethos ambivalence in which choices have to be made (consciously or unconsciously) on a constant basis—ambivalence stretching the dimensions of action as well as identity and sometimes referred to as "work," "struggle," or "trouble" in other literature[11]—or in further differentiation within science relating to differing ethos regimes, thus fragmenting (cp. Bucchi 2014) or "unbundling" (Macfarlane 2011) the "republic of science" (Polanyi 2000).

[4] E.g., Macfarlane and Cheng (2008); Anderson et al. (2010); Bray and von Storch (2017); Bieliński and Tomczyńska (2018); Kim and Kim (2018); Ferretti and Guimarães Pereira (2021).
[5] Holten (2010), Kønig et al. (2017); Grundmann (2013); Cohoon and Howison (2021); Henze (2021).
[6] Anderson et al. (2010).
[7] E.g., Maxwell and Benneworth (2018); Koehrsen et al. (2020).
[8] Temper et al. (2019).
[9] E.g., Holten (2010) for the US Bioeconomy Institute; Kønig et al. (2017) for post-normal Science documents.
[10] E.g., Macfarlane and Cheng (2008) for the UK; Anderson et al. (2010) for the US; Bieliński and Tomczyńska (2018) for Poland; Kim and Kim (2018) for South Korea.
[11] Another kind of ethos-related "struggle" Anderson et al. (2007: 11-12) label as "dissonance": it arises in an academic milieu in which observed "normal" behavior does not align with one's principled basis for one's decisions.

In some cases, authors also advocate the integration of existing, initially incompatible ethos into one consolidated form by parts of a collective. Etzkowitz (1998), for instance, argues that a new persona of entrepreneurial scientist successfully supersedes the classic academic persona, albeit not being taken up by all scientists. He sketches experiences of conversion in individual scientists' biographies that suggest:

> the transmutation of ambivalence—the opposition between two principles, one primary, the other secondary—into consonance and the reformation of ideological elements into a consistent identity. Entrepreneurship is made compatible with the conduct of basic research through a legitimating theme that integrates the two activities into a complementary relationship. For example, scientists often say that monies made from commercializing their research will be applied to furthering their basic research interests (ibid.: 827).

Similar judgments of successful integration also resonate in historical conceptions like that of "renormalization" by Metlay (2006) or the configurations of the "heterogenous engineer" of the technoscientific "seamless web" (Law 1987) and the "scientific entrepreneur" in Shapin's (2008) "moral history of a late modern vocation."

Accounts of fundamental shifts in ethos go hand in hand with the acknowledgement of new functions of and roles for science in society, adding to and competing with a primary rationale of "exten[ding] certified knowledge" (Merton 1942: 117). New functionalities and roles are sought in roughly two respects: Whereas technoscience as well as triple-helix, post-industrial, and post-academic science span the boundary of the public and the private, of basic and applied research, and of epistemic and engineering practices, and they meet increasing calls for "delivering economic returns" as well as "social responsibility" and "responsiveness," other emerging modes of science such as post-normal and transdisciplinary science span the boundary between scientific research and societal decision-making by engaging diverse publics and addressing diverse polities, following calls for evidence-for-policy and participatory decision making. The new functions and roles—if subscribed to and integrated by the pertinent scientific communities—are likely to result in new institutional imperatives. Public engagement practices as well as policy advisory practices react to and come with their own values, quality criteria, norms, and fallacies (as well institutions, communities, roles, and identities). Clark and Majone (1985), for example, suggest "adequacy," "value," "effectiveness," and "legitimacy" as qualitative criteria for science-for-policy. Policy scholars such as Weimer and Vining (1999) or Pielke Jr. (2007) define distinct roles in advisory practice that link to distinct contexts, paradigms, and standards (like avoiding "stealth advocacy" as "issue advocate"). In their analysis of "the ethos of post-normal science," Kønig and colleagues (2017) enlist explicit codes suggested by proponents of post-normal science and suggest the five-letter acronym TRUST[12] to denote the normative sets of Transparency, Robustness, Uncertainty management, Sustainability, and Tolerance. As post-normal science is understood to draw on normal science, "both CUDOS and TRUST will be intertwined in this practice. Therefore, PNS needs to confront, deliberate, and balance norm conflicts such as disinterestedness versus accountability and transparency; universalism versus pluralism and democratization" (ibid.: 22).

In all these cases, the social sciences and humanities (SSH) play a critical role not only as topical experts, but also as boundary experts in charge of organizing public engagement, making sense of the public discourse, or relating meaningfully to political contexts and reflecting on engagement and

[12] "Whereas CUDOS (recognition) is what one achieves by complying with the norms and values of normal science, TRUST (the public trust in science advice) is what can be regained by the ethos of PNS." (Ibid.: 21).

advisory practices. Still, Merton's original outline does not provide us with a position on a potential ethos of SSH. Nor does any of the above cited contributions directly address a potential differentiation of ethos within the academic landscape along the "two cultures" (Snow 1961).[13] The lacuna could be explained with the specific view of the Mertonian ethos to grasp a universal scientific ethos beyond all disciplinary fragmentation and therefore to render a discipline-specific formulation of ethos meaningless, if not counterproductive. The discipline-specific aspects of scientific ethos would then be addressed under a different label, not as "ethos of science" but as (field-specific) "epistemic cultures," or as an "ethos of intellectuals" in the case of the humanities and arts, thus fragmenting the theme along separate discourses. Another option is that a distinct SSH ethos is seen as simply not relevant enough to be researched. The missing search for a valid arts and humanities ethos certainly has important repercussions in the context of multidisciplinary collaboration. It furthers the risk of "epistemic domination by technological disciplines in both funding streams and research content" (Maxwell and Benneworth 2018: 2) within mission-oriented research programs like the European Horizon 2020 program; it also impoverishes the general discussion of scientific ethos, for example when it comes to more recent takes on "universalism" or "disinterestedness."

RE-CONSTRUCTING AN ETHOS OF TECHNOLOGY ASSESSMENT PRACTITIONERS "FROM WITHIN"

In the following section, I report on findings from a project conducted at the Institute of Technology Assessment (ITA) at the Austrian Academy of Sciences. Technology assessment (TA)—like other inter- and transdisciplines (cp. Kastenhofer et al. 2011)—has been institutionalized only some 30 years after Merton's treatise on the scientific ethos, first with the foundation of the Office of Technology Assessment at the United States Congress in 1974, and later (from the 1980s onwards) with the creation of several technology assessment facilities at European parliaments, universities, and academies of science. As "an analytic and democratic practice that aims at contributing to the timely formation of public and political opinion on societal aspects of science and technology" (van Est and Brom 2011), TA represents a post-normal or Mode 2 science—especially when performed at an academic institution. It subscribes to a bifold focus on both scientific research and advisory practice. With its meanwhile longstanding tradition and high degree of institutionalization, TA can serve as a valuable case for researching institutionalized imperatives. Targeting transdisciplinary practice at ITA allows for addressing the question of whether there is such a thing as a distinct ethos of post-normal science. To do so, I build on "research from within" (Sikes and Potts 2008; Trowler 2011) performed at ITA, dedicated to questions of successful policy advice.[14] ITA was created in 1994 as an institute of the Austrian Academy of Sciences (cp. Nentwich and Fuchs 2021). It operates based on basic funding (covering 16% of the research projects and all general costs), competitive research funds (38% of the research projects, funded by the European Commission, the Austrian Research Promotion Agency, or the Austrian Science Fund) and commissioned research (46% of the research projects, cp. Kastenhofer et al. 2019). Research is commissioned by public entities like Austrian ministries, the Austrian and European Parliament, or the Austrian Chamber of Labour. For want of a better term we will call these funding institutions "clients"; in most cases, the client and its publics are also the main addressees of the project results, while society at large is the targeted beneficiary.

[13] Some quantitative surveys include a disciplinary split in their analyses. But they do not make room for a specific adaptation of the CUDOS set beyond differences in levels of endorsement for the various disciplines.

[14] "Policy Advice at ITA," Pol[ITA], 2016-2018 (cp. Kastenhofer et al. 2019; Bauer and Kastenhofer 2019; Kastenhofer and Bauer forthcoming).

Our "research from within" included all scientific staff at ITA[15] in one way or another: as project members with various tasks, as interviewees, and as participants in internal workshops and group discussions. It also addressed collaboration partners and clients via a series of interviews.

The in-depth interviews, group discussions, participatory observations, and "observing participation" touched upon internalized imperatives and normative conflicts carried by TA practitioners and led me to reconstruct these in a secondary analysis with a view to Merton's CUDOS conception.[16] As mentioned above, scientific norms as part of epistemic cultures are "never fully knowable" and become tangible only in distinct situations, such as "when: (a) one enters the social system for the first time (…); (b) one moves from the social system into a related but different arena (…); (c) in times of environmental change (…); and (d) when violations or the potential for violation of latent norms leads to more deliberate articulation of the norms"[17] (Anderson et al. (2010: 374). In all of these cases, tangibility is effectuated by situations of cultural "estrangement." Reconstructions of epistemic cultures have highlighted this situation and built on it, acknowledging that such estrangement can either take place during socialization, enculturation, and initiation of "novices," when scientists switch fields and thus epistemic cultures (including their distinct "institutional imperatives"), when individual scientists violate prevailing norms, or when the science system undergoes changes that lead to the estrangement of established participants. Moreover, ethnographers of science can make use of their own socialization "outside" the field they study and thus confront themselves and scientists they encounter in the field with contrasting norms, mores, and illusions.

This analysis also makes use of situations of estrangement that render ethos more tangible. With a "research from within" approach, it cannot rely on cultural estrangement based on differences between the epistemic cultures of the ethnographers and the ethnographed—as both were part of the technology assessment field when the project was conducted. Still, the material reveals several sources of estrangement *within* the field that obviously motivated interviewees to refer to aspects relating to ethos in a broad sense. Moreover, the set of interviews I will focus on here[18] relates to distinct lines of advisory work conducted in close collaboration with other research institutes as well as with clients from polity. Parts of this work included participatory activities with stakeholders and/or publics. Five in-depth interviews addressed TA practitioners (mostly the projects' principal investigators); another ten interviews addressed collaboration partners (with universities as well as with one small service enterprise) and clients (governmental agencies, ministries, and the like). The interviews thus depict the relationship between TA, "normal science," politics, and publics, especially their relative functions, roles, and norms.

[15] Ca. 20 TA practitioners from diverse academic backgrounds, ranging from biology and chemical engineering to sociology and philosophy (see also Kastenhofer and Bauer, forthcoming. TA projects are performed in varying interdisciplinary teams and combine scientific research with advisory activities.

[16] Moreover, it brought identity struggles to the fore that are summarized and discussed in Kastenhofer and Bauer (forthcoming). A consecutive internal project took an even closer look at TA and normativity ("TAN: TA and Normativity", cp. Nierling and Torgersen 2020).

[17] The latter situation is frequently related to Durkheim's (1995) notion that "the significance of a norm is indicated by the extent of moral outrage or indignation that ensues when a norm is violated" (quote taken from Brey & Storch 2017).

[18] The empirical material covers four project lines (PL) of TA work at ITA: the first centers on a distinct socio-political issue related to technological innovation (PL1), with a primary view to gathering expertise and fact finding; the second centers on serving public interests via providing the respective client with high quality information (PL2); the third centers on the governance of a distinct technoscience (PL3); the fourth centers on a distinct participatory method, adapted to various contexts (PL4).

As mentioned before, the relevance of collective normative referents in TA came to the fore in an empirically grounded way (Corbin and Strauss 2008) only *throughout* the completion of the field work. Instead of directly asking participants about their normative stance (a move that would have ignored the fact that collectively held norms are only partly explicit and become tangible only in specific situations), I developed an increasing sensitivity for normative issues in my field work and searched empirical material *ex-post* for sections that relate to a collectively held ethos. With this analytical step, it was essential to choose the right level of abstraction, distinguishing between the field's main objectives, its normative dimension, and its tools to realize these objectives. I looked out for instances of normative comments, (moral) satisfaction, and minor or major (moral) outrage, sampling along emotions as well as content. Codes included normative ambivalence, disappointment, controversy and conflict, stories of success or failure, attributions of quality, and functionality of TA activities. The resulting references were analyzed with an aim to reconstruct the kinds of ethos that underlay the various statements. Thus, a distinct perspective on the workings of ethos in TA was established. Moreover, by including interviews with TA practitioners as well as with collaborating scientists and TA's clients/addressees, the material provided insights into views from the inside as well as the outside. The results were summarized in close reference to Merton's CUDOS, outlining specificities and amendments, hinting at additional functionalities of TA that relate to its close interaction with polities and publics.

THE POST-NORMAL ETHOS OF TA AND ITS SOCIAL FUNCTIONS

"Extended" communism

In Merton's original conception, the norm of "communism" refers to sharing "the substantive findings of science" as "a product of social collaboration" with the scientific community or "scientific fraternity" (Merton 1942: 122). He also notes that "[t]he scientific communism of the scientific ethos is abstractly incompatible with the definition of technology as 'private property' in a capitalistic economy" (ibid.: 123). When revisiting this conception, two aspects are conspicuous: first, the realm in which scientific findings ought to be shared has expanded, so as to encompass society at large. In parallel to Merton's partly epistemic, partly moral legitimation of communism (collaborative input warrants sharing of output), recent open science movements and open innovation strategies argue not only that communism is an epistemic prerogative, but also that public investment in science warrants sharing its results; similarly, recent post-normal science asks for an "extended peer community" along an epistemic and moral rationale (more robust findings for better risk governance in society). I borrow the attribute of extension from this literature. Secondly, the discrepancy between scientific communism and industrial secrecy still serves as a bone of contention in contemporary TechnoScienceSocieties (Maasen 2020). With an increasing convergence of scientific and engineering practices and a consecutive clash of ownership cultures, it poses not only a moral but also a practical problem.

As for the practice of TA, communism *beyond* the scientific community has played a central role from its very beginning. Not only is informing polity part of its raison d'être in all contexts where TA is institutionalized as parliamentary TA or as an advisory body to governments; informing publics or society at large is also perceived as a central duty of TA. This ethos is present in TA proponents' substantive propagation of open science and in institutional codes of conduct and publication strat-

egies. It was also voiced by TA practitioners in our internal project. One interviewee depicts TA practitioners as "experts not only for producing, but also for communicating knowledge" and highlights that they hold the respective expertise as well as the resources (I PL3/3).

With communism beyond the scientific community, additional values come into play, including: extended transparency, accessibility of reports for the lay public ("the visions and recommendations that are developed [in participatory exercises] get published as such; they are publicly accessible. Transparency is the best impact we can achieve."), balanced provision of information, reader friendliness for lay participants, and time pressured decision makers. A lot of effort is dedicated to alternative formats (the "Dossier" and "Infogramm" series), modes, and contents of exchange with a view to foster engagement and prevent bias or power imbalance as best possible.

> In project [X] we work with information videos and these are very difficult to prepare; because they must not be manipulative, but should provide balanced information in a concise way. (…) And they should also be funny. (I PL4/6)

> Everything should be kept short and crisp, with a very pragmatic approach. Because nobody has time to read. I understand that this bothers the scientists. (I PL4/3)[19]

> We need condensed versions, not lengthy treatises. The higher in the political or ministerial hierarchy, the more confined is the appetite for reading. (I PL3/2)

With close contact between clients and TA practitioners in some advisory projects over longer periods of time, communication often becomes a two-way street resulting in an ongoing dialogue and collaborative networks that expand over time ("[this participatory method] is an intelligent synapse between customers, citizens, affected populations and experts." I PL4/3), so much so that TA practitioners emphasize that some projects "are not projects, but processes" (I PL3/3, I PL3/2).

On the other hand, industrial property rights and military secrecy pose fundamental problems for TA. Emerging technological innovations such as bio- and nanotechnology applications or military drones are themes highly relevant to, but not fully accessible to, technology assessment activities. If participatory methodologies are patented or licensed, they are not fully available in innovation regimes. As a result, TA's service to liberal democracies is restricted and options for responsible innovation are hampered.

"Diffracted" universalism

Since Merton confidently wrote that "[t]he acceptance or rejection of claims entering the lists of science is not to depend on the personal or social attributes of their protagonists; their race, nationality, religion, class, and personal qualities are as such irrelevant" (Merton 1942: 118), ensuing sociologies of science have seen constructivist, relativist, positionalist, and epistemological turns. As a result, the initial formulation has not been discarded as an institutional imperative, but it has been refined in many respects as an epistemological presumption. TA practitioners' accounts reflect their awareness of these more recent epistemological refinements, but they also add aspects that come with the post-normal ambition to contribute to the solution of societal problems and with the resulting close interaction with distinct publics, polities, and persons. The insights of TA should not only answer to

[19] Internally, the institute's advisory formats are also referred to as "two-pagers" or "four-pagers."

standards of truth, but also to standards of cultural and social robustness ("[When interacting with participants, I also have to be aware that] I am a woman, of my age, from a specific cultural background"). It does not suffice to "be universally right"; TA should also foster a climate of mutual respect and be heard and considered in highly contextual decision-making processes. Whereas Merton sees universalism "rooted deep in the impersonal character of science," the success of TA has very person-centered components. Thus, TA's ethos differs in some respects from normal science, a difference that I suggest can be considered a "diffraction"[20] (a term borrowed from physics and mobilized of late by feminist science and technology scholars such as Karen Barad or Donna Haraway)—the original ideal picture of universalism is diffracted by additional layers or lenses of post-normality and Mode 2. Such diffraction of a normal science ethos can cause occasional conflicts in collaborative projects. In interview I PL1/2, a collaboration partner reflects on a past difficult project:

> [T]here were some really academic partners, really interested in statistics and so on; and there were some partners from the [agency X] and so on, which were mainly interested in other kinds of questions. I can remember very difficult discussions (…) the partners from the social sciences, well, first they were academics so they had to publish - and to publish something new and rather academic, and not always policy-oriented; and so they [decided] to develop a model that they wanted to test with hypotheses and so on; (…) these were kinds of things that were not so easy for us to use because it's not always really relevant for policy-making. (…) I understand that you want all these questions to help your model, but now we have a [participatory] method, we are here for one day and you cannot expect that [the participating citizens] will answer all these questions. (PL1/2)

Whereas TA practitioners do not defy universalism, they are also committed to including publics and achieving political impact. Other than having a quest for universal truths, they must answer to mostly national remits and depend on local specificities. Very importantly, the impact of TA relies on local political windows of opportunity, or on what has been labeled as "Kairos" in literature on Mode 2 science (Holten 2010) or post-normal science (cp. Ferretti and Guimarães Pereira 2021). References to such "Kairos" are omnipresent in the interviews. Sometimes developments at the TA institute coincide with demands from polity to get input on pressing issues, resulting in a productive collaboration. Other times, no political decisions are pending and there is no interest in input from TA. Sometimes an issue is already addressed at the transnational level, and it is TA's role to raise the local polities' awareness of this issue and thus co-create demand for political discussion and expert input. In these processes, local specificities (the national public discourse, the institutional landscape, individual decision makers, and government personnel) play an important role as do personal contacts (knowledge about TA practitioners' expertise, personal trust, and sympathy), as one collaboration partner from polity puts it:

> [I]t is good to know someone personally, not having to write [formally] to the institute's director to explain one's problem; if I know an expert in this or that field of expertise, I can address him/her informally or we meet accidentally at a conference and can chat about current issues and developments. (I PL4/4)

[20] My initial choice was to speak of "bounded universalism," but rather than putting universalism in its place, "diffracted universalism" goes with changing conceptions of and strategies for safeguarding a robust relation between research subjects, research objects, and claimed truths; in other words, to achieve transpersonal, generalizable formulations, the research as a person has to be taken into account rather than made irrelevant. This methodological move is paradigmatic in most qualitative sociological or ethnographic research.

"Diffracted" disinterestedness

The fate of the institutional imperative of disinterestedness in post-normal science seems very similar to that of universalism. Again, the more recent social epistemology of science as well as recent shifts in innovation regimes have added some tweaks to how we perceive the relation between science and interests, without discarding the whole norm as such. Disinterestedness still counts as a cornerstone of basic science, albeit leaving room for exceptions and relativizations. The ethos of disinterestedness is complemented by calls for making unavoidably persevering interests transparent (e.g., when clinical trials are funded by the pharmaceutical industry or when academics hold shares in private companies) or by claims that interests are not necessarily a bad thing and that epistemic, private, and public interests are not necessarily at odds. Such developments also relate to new practical ontologies of science, reconfiguring the relation between "pure" and "applied research," as exemplified by new funding program rationales that target specific research qualities like responsibility or specific outcomes like fostering economic competitiveness or sustainable development. But throughout all these shifts, disinterestedness has remained as a (albeit "diffracted") cornerstone of science's institutionalized ethos.

The practice of TA relates to the above-mentioned shifts in two ways: as a *Mode 2 practice*, it is intrinsically but also explicitly oriented towards societal values pertaining to a "socially responsible technology policy."[21] Projects address issues such as privacy, security, inclusion and empowerment, justice, equality, health and environmental risks, sustainability, democracy, and good governance (cp. Kastenhofer et al. 2019), and TA practitioners occasionally transcend the role repertoire of normal science by acting as agenda setters or issue advocates (cp. Bauer and Kastenhofer 2019). TA is thus invested in serving the public good as opposed to partial and private interests or an ignorance of public interests. As a *post-normal science*, TA is directly confronted with lay clienteles, and thus with the danger or "possibility of exploiting the credulity, ignorance, and dependence of the layman" (Merton 1942: 125). It also interacts directly with stakeholders and decision makers. Against this backdrop, the normal peer review processes institutionalized for scholarly communication and scientific project approval do not suffice. The more it becomes a matter of course that TA is not practiced in an interest-free setting and, in many cases, confronted with highly controversial issues and antagonistic stakeholder camps, the more TA practitioners seem to experiment with additional approaches to quality control, expose their work to extended skepticism (see next section), and thus safeguard a healthy relation to vested as well as public interests.

Moreover, the interviews with principal investigators at ITA and with their clients show that safeguarding autonomy is central in the public assessment of their authority and the legitimacy of their policy advice. Both groups of interviewees state that the institute being independent (from stakeholders and private money) and ITA's impeccable reputation to open-mindedly strive for the public good is just as important as the topical, interdisciplinary, and methodological expertise held by its staff members.

> Together with [our client] I was in [X] at this council where the first attempts had been presented on how to address [this technology] in technology assessment. And [our client] said instantly that ITA should be in charge. That we needed an independent institution, especially independent from industry, that was also accepted and approved of by the general public. That this was of utmost importance. (I PL3/4)

[21] ITA mission statement, https://www.oeaw.ac.at/en/ita/the-ita/mission-statement, retrieved 14 Dec. 2021.

In some cases, ITA was selected by clients to outbalance an otherwise industry-driven innovation process; in other cases, ITA was selected because of its extramural affiliation (that is, not with the same research organization at which the technology at stake was being developed). ITA's relatively closer tie to polity than other research institutes and existing personal contacts also figured in some selection processes.

The English term "at arm's length" maybe best depicts the sensitive juggling acts at the institutional and individual level that come with this kind of "diffracted" disinterestedness. While one PI thought it was very important to keep individual interactions with clients as formal as possible (opting for the polite and distanced German "Sie"), another PI interacted on amicable and informal terms; but both interviewees shared a high awareness of keeping the balance between distance and interpersonal proximity, between abstinence and engagement. They were aware that any breach in this dimension could harm their own and their institute's reputation, possibly irreparably. This attitude also implied gaining the potential clients' attention for a specific issue, but not elucidating too much interest; motivating further research calls, but not necessarily applying for funding in the same call; aiming for presence in the public media, but not at all costs; or refusing what got pejoratively called "acceptance research" ("Akzeptanzforschung")—activities that were merely meant to foster public acceptance of technological innovations; and, last but not least, it implied a good deal of constant individual and collective reflection on the role of stakes and stakeholders in TA processes as well as methodological experimentation with how to involve stakes and stakeholders in participatory processes.

Interestingly, all collaboration partners and clients seemed to tacitly agree on this role set and interaction rituals with almost no exception. The ethos of a disinterested science, be it normal or post-normal, was shared by all, and its functionality and instrumental necessity in innovation governance was unquestioned.[22]

"Extended" organized skepticism

The previous sections already brought up the need for an "extended skepticism" by way of an "extended peer review" of "extended facts." Extensions pertain to the dimensions of TA work to be scrutinized, the organization of review processes, and the selection of reviewers. Scientific and social robustness as well as social and political relevance are addressed; review takes place not only during project submission and the publication of outcomes, but also throughout the project's implementation by internal and external advisory boards; reviewers and board members stem from multiple disciplines and, in some cases, from outside of academia. With extended advisory boards, the function of safeguarding quality goes hand in hand with informing societal actors and establishing expert networks. This extended functionality goes with TA's remit to produce more than mere facts (see also the next section).

> It is our ambition to develop visions [during this participatory exercise], but also to establish a respectful interaction, empowerment; we define distinct quality criteria [for this process], we write scripts collaboratively, [A] supported us a lot with [project X], [B] reviews them internally (…) With project [Y] we decided on having an additional external project board,

[22] Only once did a TA practitioner ponder that the respective ministry might not have understood why ITA did not submit a proposal to the very call it had advised the ministry to launch.

> representing addressees and other topical research institutions. We had a meeting every three months [with these relevant actors]; we also invited them to review the texts we prepared internally for communicating our results to the public and to give feedback. (I PL4/6)

Internal and external advisory boards perform extended review throughout the whole process; they also give feedback on the accessibility and applicability of results and at the same time serve as relay stations to further distribute outcomes and secure impact beyond the research community. Thus, skepticism is partly extended, partly diffracted, and related to functions other than quality control.

"Diffracted" originality and "extended" relevance

After Merton's 1942 publication, two further suggestions for institutional imperatives in science have been put forward quite prominently: relevance and originality. One might argue that these categories are not on the same level as communism, disinterestedness/autonomy, or organized skepticism, as they represent knowledge qualities rather than institutional qualities. Together with the objective to produce "true knowledge," they serve as criteria for peer review (or organized skepticism). Scientific output should thus be "new (i.e., original), true (i.e., scientifically sound), and interesting (i.e., relevant)." Nevertheless, these additional categories shall be taken up here because they also serve to illustrate how normal and post-normal science differ in fundamental orientations.

With the double ambition to produce facts and to advice society and polity, originality sometimes takes the back seat. In some cases, societal decision makers are reminded of already established scientific facts, such as climate change and the urgency to take adequate steps. In other cases, their existing appraisal of a situation is simply proven right. In these situations, addressees can respond with disappointment, as they had awaited astonishing new insights from an academic institute like the ITA. Such disappointment was reported by our interviewees especially in relation to participatory projects. The client had expected revolutionary findings while the TA practitioners had sought something completely different, something that they thought more important to establish relevance and impact in the respective context: establishing mutual trust and understanding and finding new and creative ways of interaction. One client concludes after the participatory exercise that (disappointingly, but expectedly):

> public participation has two dimensions: one is certainly useful, namely when it comes to trying new things out, to see where people are affected, and the like; the other dimension, thinking things through is an individual process, richness of ideas is not higher in the populace; really good, well thought through ideas do not come from there. (I PL4/3)

Thus, participatory processes seemed not easy to sell and sometimes even triggered conflicts with academic peers.

> [t]here was this event in Florence where we discussed some first results with a group of experts and we invited [two very well-known experts]. I discussed with them and they were both critical about the results. [The academic expert] was critical in the sense that she said, 'Well, I didn't learn much. (…) nothing new, and we don't need that; we really now need some focus, a specific answer, and this is not enough!' So, she was really disappointed, she said, 'Well, it was a waste of time for me to [come]!' and so it was really hard; [The practical expert] said, 'Okay, it was interesting, but in a way these are things that we could more or less expect.' And so he also had the feeling that it was a lot of effort for quite interesting results, but not that

> new for the policy-making. (…) it's something related to these participatory processes which are not easy to sell. (I PL1/2)

Thus, TA's ambition somewhat differs from both purely academic and political expectations. This "diffraction" is most easily explained with TA's efforts for more than epistemic relevance, namely for societal impact. Even before societal impact began to be a quality criterion applied within research evaluation exercises, it was very common for TA practitioners to measure the worth of their work with a view to changing society for the better and making the world a better place (cp. Hessels et al. 2009). This orientation towards impact is also perceptible in our interview series. Interviewees discard project reports as byproducts, not because they concentrate on "high impact" journal publications, but because they envision other, more effective ways to change societal perspectives and make-ups, e.g., by including publics and decision makers directly in the process as participants or as advisory board members, or by establishing mutually trusted and engaged expert networks and commissions. They lighten up when recounting how they got initially skeptical stakeholders on board with their process and could convey to them the value of the quality they strived for, in many cases by participating in person rather by rational argument alone.

DISCUSSION: TA'S POST-NORMAL ETHOS

This qualitative analysis of TA practitioners, their collaborators, and clients' take on TA practice has illustrated first and foremost that the classic ethos of science as depicted by Merton 1942 still figures centrally, even in a post-normal science field like TA. This outcome confirms other studies, especially those with a quantitative approach. The analysis also shows how institutional imperatives of science like disinterestedness (and thus the differentiation of science as a social subsystem from other social subsystems such as politics or economy) are stabilized by expectations and necessities from publics and polities, in line with discussions about boundary organizations and boundary work bridging the science-policy divide. Second, this analysis has shown that some changes from a normal to a post-normal science regime can be captured as extensions of the classic ethos, including: "extended" communism, "extended" organized skepticism, and "extended" relevance. Such extensions have already been put forward by early theorists and proponents of post-normal science (Funtowicz and Ravetz 1993) in cases of high epistemic complexity, high scientific uncertainty, and high societal risks. Third, the presented analysis points to some fundamental shifts that cannot be captured adequately as mere extensions. I have labeled these as "diffractions": "diffracted" universalism, "diffracted" disinterestedness, and "diffracted" originality. Taking a step back, orientation towards societal relevance and impact seems to be the strongest and most ubiquitously related to such diffractions. As the quest to change the world for the better has permeated scientists' ambitions and scientific research programs, holding on to academic ivory towers as strongholds of fundamental universalism, disinterestedness, and relevance has become ambivalent at best.

This ambivalence is not unique to late modernity, but it does affect the science system at an unprecedented scale. The advent of knowledge societies has not only altered the quantitative presence of science, but also multiplied its roles and functions in society (cp. e.g., Hessels et al. 2009) beyond the mere "extension of certified knowledge." This multiplication of function has gone hand in hand with the emergence of new epistemologies and ontologies and has necessitated adaptations in science's institutional imperatives. Post-normal scientists like TA practitioners seem to have come to terms with this new, partly extended, partly diffracted ethos and its new ambivalences, but open

questions and conflicts arise in collaborations with normal science as well as with clients and addressees. How should societal impact be assessed (cp. the discussion in Mitchell et al. 2015; Miettinen et al. 2015; Schäfer et al. 2021)? How should trade-offs between scientific originality and societal relevance, and between scholarly communication and communication to/with publics, be taken into account? And last, but not least, how should post-normal science and late-modern polities deal with values, norms, and interests, while adhering to evidence-based standards of decision making (cp. exemplarily Nierling and Torgersen 2020)? If post-normal sciences' ambition is to contribute to changing the world for the better—whose world and who's better? In these respects, post-normal science not only depends on a strong internal ethos nurtured by political awareness, ontological scrutiny, and debates about quality. It also depends on an effective and resilient democratic system that helps with delivering answers to these questions, be it by securing the accessibility and transparency of relevant information (e.g., on emerging technologies and applications), by furthering participatory decision making,[23] or by providing adequate boundary-spanning organizations between science and policy (like arm's length advisory bodies, structures, and guidelines). With every attempt at establishing a new TA facility in yet another nation state,[24] these critical aspects come to the fore.

Finally, there remains much room to discuss whether a post-normal science ethos still represents an ethos of science *in a strict sense*. Opinions will, inter alia, depend on the definition of science applied to this question. Is the label "science" reserved for an institution that focuses solely and uncompromisingly on the "extension of certified knowledge"? Or does the label encompass activities and practices that follow a dual ambition like extending certified knowledge AND constructing a new world "atom-by-atom" (technoscience), or providing relevant expertise to decision makers and civil societies (post-normal science)? If following the latter route, a differentiation of such technoscientific or post-normal science spheres from other societal spheres is still possible (as I tried to showcase), but the corresponding extended and diffracted normative set comes with additional ambiguities and contradictions. If an adapted ethos were not in place or did not result in sufficient self-regulation, the alternative would be to install (additional) political measures to guarantee the realization of the additional functions. We have seen such moves, if not from polity in a strict sense, then from an emerging hybrid science policy ecosystem. Initiatives such as Ethical, Legal, and Social Implications (ELSI) research and, consecutively, Responsible Research and Innovation (RRI) have been implemented in major funding initiatives of the European Commission; assessment guidelines for research projects and research organizations have been adapted to include new dimensions such as public outreach and societal relevance; and many funding agencies now request open access publication formats. One might conclude that the belief in science's self-regulation has waned and with it the belief in an (effective) ethos of science. Other recent developments point to yet another direction: more and more scientists raise their voices to intervene in the unfolding climate catastrophe, calling for immediate political action as concerned scientists. Similar moves could be observed during the unfolding COVID-19 pandemic. With that, an era might be approaching in which "nothing in science makes sense except in the light of humanities' survival," to adapt Dobzhansky's famous dictum, and all institutional resources, including science's ethos, would re-orient *within* science towards this overarching goal. With that, another era could dawn, not one of post-normal science, but of "survival science," with probably yet another institutional and normative constellation.

[23] Albeit with this aspect, a tension between direct democracy and representative democracy, and between public consultation organized by governments and parliamentary decision making, has to be noted.
[24] TA is currently undergoing a phase of worldwide expansion, furthered by the GlobalTA network and initiative (https://globalta.technology-assessment.info/, last accessed 6 June 2022).

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