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Abstract

The independence of research is a key strategic issue of modern societies. Dealing with it appropriately poses legal, economic, political, social and cultural problems for society, which have been studied by the corresponding disciplines and are increasingly the subject of reflexive discourses of scientific communities. Unfortunately, problems of independence are usually framed in disciplinary contexts without due consideration of other perspectives' relevance or possible contributions. To overcome these limitations, we review disciplinary perspectives and findings on the independence of research and integrate them in the outline of an interdisciplinary research programme.

If you do not have the freedom to choose the subject of your research, the chances of discovering something of importance will already be limited. If your choice of methods is restricted as well, these chances are reduced even further. And if, at last, you are not allowed to disclose the results because they are inconvenient for some, many, or even all, it might be best for you to discard your research altogether – and for those who fund your research, too. This is what we have to prevent.

(Quote from an Interview with Nobel Laureate Stefan Hell, Forschung & Lehre 2019, our translation)

1. Introduction

The independence of research is a key strategic issue in modern societies. Science has become a major source of wealth and is increasingly seen as a possible source of solutions to survival problems of contemporary societies. This has turned research capacity into a major base of power for actors in the

‘knowledge society’; as a consequence, attempts to instrumentalize science and neglect its autonomy have grown. At the same time, the growth of science and the dynamics of its research technologies have turned it into a very expensive enterprise. It comes as little surprise that the question as to who should be able to influence research and how influence can be exercised without damaging the productivity and integrity of research becomes more important.

Current political struggles have made the independence of research take centre stage. The discourse on ‘fake news’ coincides with attempts by some governments to limit the independence of research (Goldman et al. 2017, Barnett and Wiber 2018, Rectors' Conferences 2018, Enyedi 2018). Even in countries with a broad societal consensus on the necessity to maintain academic freedom the actual extent of this freedom and the ways in which it should be maintained is subject to continuous negotiation, which is e.g. illustrated by legal challenges to some higher education reforms in Germany (Gläser and von Stuckrad 2013: 86, Zechlin 2017). In analyses of research as a source of power, the independence of research from the state and industry is often seen as advantageous because political and economic interests are seen as ‘corrupting’ science (Lave et al. 2010), while independence from ‘the public’ (whatever it may be) and civil society actors is considered problematic because stakeholders with legitimate interests get disconnected from research (Brown et al. 2006; Frickel et al. 2010). Among researchers, there is an increasing concern about becoming dependent on incorrect or unreliable findings, whose growing number may disorient or slow down the knowledge production of scientific communities (Kern 2012, Byrne 2019).

Dealing with the independence of research appropriately poses legal, economic, political, social and cultural problems for society, which have been studied by the corresponding disciplines and are increasingly the subject of reflexive discourses of scientific communities. Unfortunately, these perspectives are unevenly developed and insufficiently integrated. Problems of independence are usually framed in disciplinary contexts without due consideration of other perspectives’ relevance or possible contributions. Therefore, the aim of this paper is to overcome the limitations of disciplinary perspectives by turning the independence of research into an object of interdisciplinary study.¹ We begin by identifying relevant disciplinary perspectives and findings on the independence of research (2) before integrating them in the outline of an interdisciplinary research programme (3).

¹ This paper is the result of a string of discussions the authors had among themselves and with participants of several workshops. We are particularly grateful to Martina Franzen, Fabian Hattke, and Simone Rödder, who contributed ideas in the discussion process.

2. The independence of research: disciplinary perspectives

In the most general sense, the independence of research refers to the extent to which an actor in science is free from influences that alter its choices. Actors are completely independent if there are no such influences, or if they are able to resist such influences. They are completely dependent if other actors make all their choices for them. Neither extreme is likely to occur empirically, i.e. independence is always a matter of degree. It is important to note here that there is no reason to assume that beyond a minimum that guarantees the functioning of the science system, more independence is always better. This very general idea of independence has been specified by the disciplines for investigations in their respective conceptual frameworks. Hereinafter, we consider how sociology, economics, the philosophy of science, legal studies and the history of science conceptualise the independence of research, which problems of independence they address and which gaps in disciplinary knowledge exist. We conclude this section by an account of reflexive discussions of threats to independence by scientific communities in the social sciences, sciences, and medicine.

2.1 Sociology

Sociology specifies independence as the autonomy of actors.² Actors are never fully in control of their own conditions of actions because they are always embedded in sets of relationships with other actors and thus interdependent. Within these constellations of interdependence, some actors intend to change others' behaviour by exercising influence. Autonomy refers to an actor's handling of such influences and is considered as the degree of control over the formation of goals and the choice of approaches to achieving them that remains with an actor who is influenced by others (Gläser and Schimank 2014).³

Autonomy thus is a property of all actors in the science system including individual researchers, research groups, research organisations (e.g. universities), and funding agencies. Although studies of these types of actors have rarely considered their autonomy explicitly, several recurrent topics of

² At least it does so in its various action-theoretical or practice-theoretical strands. Luhmann's (1995) systems theory/ theory of societal differentiation describes the independence of research with two concepts. The autonomy of a system describes a defining property: systems are autonomous because they operate according to their own structure and logic, which means that they cannot be systems if they are not autonomous. This dichotomous understanding leaves little to be explored because if systems are investigated, their autonomy is logically implied. The dependence of a system on other systems is conceptualized as the structural coupling between societal sub-systems. This coupling is not a threat to autonomy (and thus a system's existence) as long as systems can maintain their autonomy by playing off multiple dependencies against each other. Only one-sided dependence (dependence on only one other system) may threaten a system's autonomy (Stichweh 2014).

³ This idea can be extended to sets of interdependent actors such as markets or communities. The autonomy of such an actor constellation could be understood as the extent to which external dependencies leave the way in which this actor constellation 'functions' (its basic social order) intact (Gläser and Schimank 2014).

science studies can be interpreted as addressing the autonomy of actors in science (Table 1). These topics mostly consider a specific relationship and the effects of dependencies on research.

Among the various actors influencing researchers, companies have received the most attention. The study of ‘academy-industry relationships’ does not usually differentiate between the types of channels through which researchers might be influenced. Industry funding of university research and university-industry collaborations are often merged, probably because they are very difficult to distinguish by the standardized questionnaires commonly used by this research. Researchers investigating the influence of pharmaceutical companies on drug studies found “that study outcomes were significantly different in privately funded versus publicly funded drug studies” (Krimsky 2013: 569, for the evidence see e.g. Bekelman et al. 2003; Schott et al. 2010a, b). One of the causes of the funding effect is bias, which is defined as “the use of a method, data collection, data analysis, or interpretation of results that, in the consensus view of scientists of a discipline, tends to yield results that distort the truth of a hypothesis under consideration” (Krimsky 2013: 568). Furthermore, collaboration with industry was found to slow the diffusion of new knowledge but not to limit it (Evans 2010a, b). Empirical studies also confirmed that collaboration with industry makes researchers withhold their data from colleagues, although other reasons like the wish to maintain a competitive advantage may lead to the same result (Blumenthal et al. 1997).

Dependencies on the state are rarely discussed. Recent studies focus on the alignment of state and industry interests and discuss effects of state influence similar to those of industry influence, with the interesting additional twist of the production of ignorance (Frickel et al. 2010). For example, Kleinman and Suryanarayanan (2013) studied the “Colony Collapse Disorder” – a honey bee colony’s sudden loss in its adult population. They demonstrated that the dominant “toxicological epistemic form” underlying the regulatory paradigm for insecticides exclusively focused on lethal doses of individual insecticides for individual honey bees and thus “ignored - meaning that it failed to study, indeed could not study or would not consider seriously possible evidence of the effects of low or ‘sublethal’ levels of insecticides” (Kleinman and Suryanarayanan 2013: *ibid*: 497-498). An interesting gap in studies of researchers’ dependence on the state concerns the exclusion by the state of its own or foreign researchers from the communication within their scientific communities through travel restrictions (but see Varma and Sabharwal 2018).

Effects of researchers’ and universities’ dependence on the military, which merit separate treatment due to the specific interests and governance tools of this sector of the state, have been mostly investigated from a historical perspective (see below, section 2.5), not least due to the problems of gaining access (Rappert et al. 2008: 731-732). A sociological analysis shows how weapons researchers consider their secure jobs and research funding as well as their freedom to choose approaches to

problem solving as sufficient compensation for their lack of choice of research problems and severe restrictions to their communication (Sutton 1984). This and other studies indicate shifts of researchers' identities that make their goals coincide with the expectations of their sponsors (Gusterson 1995, 2003).

<i>Actors whose autonomy is considered</i>	<i>Influence exercised by</i>	<i>Effects discussed</i>
Researchers	Industry	Thematic changes, changes in quality, biases towards clients' interests such as publication bias, creation of areas of ignorance, diffusion of new knowledge, secrecy
	State	Thematic changes, biases towards the state's interests, creation of areas of ignorance, diffusion of new knowledge
	Military	Research topics externally defined, severe restrictions to communication, exclusion from scientific communities
	Civil society actors	Thematic changes, changes of research approaches (for instance, respect for animal rights)
	Scientific communities - through peer review - through north-south collaboration	- Thematic changes, e.g. towards mainstream research or risk avoidance - Impact of North-South collaborative research funding on topic selection by researchers from the South, limited recognition of Southern researchers, exclusion from scientific communities
Universities	Changes in publication behaviour, changes of collaboration patterns	
Funding agencies	State and scientific communities	Degree to which funding agencies can develop independent strategies or are 'captured' by scientific communities or other actors
Universities	State	Degree to which universities can develop independent strategies, changes in research profiles

Table 1: Foci of science studies related to the autonomy of actors in science

Another, more recent line of research investigates the exercise of influence on research by civil society actors. Its focus is on the channels available to these actors and the ways in which civil society actors (e.g. social movements or patient organisations) can influence the directions or approaches of research (Brown et al. 2006, Panofsky 2011). It is important to note that some of these actors, namely many

patient organisations, are themselves dependent on pharmaceutical companies that may fund, steer and sometimes even found them (Moynihan and Bero 2017).

Among influences emerging from scientific communities, peer review has been extensively studied, and has been found to favour risk avoidance and mainstream research (Chubin and Hackett 1990, Travis and Collins 1991: 336). However, recent studies of funding programmes for 'breakthrough' research suggest that these effects can be avoided if reviewers are instructed accordingly (Heinze 2008, Luukkonen 2012). Another dependence relation under investigation is the dependence of researchers in the Global South from those in the Global North. International funding appears to force some researchers in the Global South to adapt their research topics to expectations of funding agencies or preferences of collaborators in the Global North (Gaillard 1994, Moyo Okwaro and Geissler 2015, Beaudry et al. 2018: 166-167). Studies by Rafols and colleagues point to divergent priorities of researchers in the Global North and the Global South, which create situations in which researchers must adapt their research topics to priorities of the Northern elites if they want to become part of their communities' global discourses (Chavarro et al. 2017, Wallace and Rafols 2018, Ciarli and Rafols 2019). The perception of this tension has led to discussions about centre-periphery relationships in several scientific communities (see below, 2.6).

The dependence of researchers on their universities has been investigated mostly in the context of evaluation systems for research performance affecting the autonomy of researchers. This research yields only indirect hints on effects, which is mainly due to the problems of causally ascribing changes to evaluations (Gläser and Laudel 2016: 129-134, Gläser 2017).

The shift from recurrent funding of research to a split funding mode of recurrent funding for universities and competitive project funding for researchers triggered an interest of science studies in the role of funding councils, which became important actors in the science system (Rip 1994). Comparative studies found the autonomy granted to funding councils by the state to vary considerably across national science systems (Braun 1998). The causal link between this varying autonomy and the funding councils' impact on researcher autonomy has not yet been studied.

Finally, higher education studies have discussed the impact of higher education reforms on the autonomy of universities (Schimank 2005, Enders et al. 2013). The numerous analyses, which mostly focus on European higher education systems, have yet to provide a clear picture of how 'New Public Management' (NPM) reforms change university autonomy. Although the various changes in higher education laws formally enhance university autonomy, the picture is much less clear for the factual autonomy of universities (Capano 2011, Enders et al. 2013, Whitley and Gläser 2014). Studies of researchers' responses have demonstrated that they perceive new influences and respond to them in

various ways including resistance, symbolic compliance, actual compliance, and others but the consequences of these responses for the content of research have not yet been clearly established (Gläser and Laudel 2016: 129-135).

The focus of sociological studies on mostly dyadic relationships between actors has left several themes underexplored. First, there has not been enough research on the overlap and interaction of influences. Researchers often respond to the situations created by interactions and overlaps of dyadic relationships rather than influences exercised by just one actor. The processing of multiple dependencies has rarely been empirically investigated in science studies. Recently, it has been taken up by the “authority relations”- perspective (Whitley et al. 2010; Whitley et al. 2018) but there is still far too little empirical research on the integration of dependencies in the situation of researchers.

Secondly, there is also insufficient research on the impact of competition on the autonomy of researchers. Funding competitions are often established as means to influence researchers, e.g. to make them improve research quality or turn to particular topics. They may also be institutionalised as means to distribute scarce resources. So far, no attempt has been made to distinguish different kinds of competition and their impact on the autonomy of researchers.

The task of empirically establishing changes in the autonomy of an actor as an effect of influences implies two interesting methodological challenges. First, it is important to determine not only the formal autonomy of an actor – the autonomy granted by formal institutions – but also the actual autonomy an actor has in specific situations. For example, it has been observed that senior university management often refrains from using the decision rights assigned by higher education reforms (Gläser and Von Stuckrad 2013, Weyer 2018). This is why the formal autonomy of an actor is a poor proxy for their actual autonomy, and that studying only legal changes (Reale and Potì 2009, Hüther 2010) provides an inappropriate picture. However, the actual autonomy of an actor in specific situations is difficult to determine.

A second methodological challenge arises with the attempt to determine the aggregate effects of researchers’ individual adaptation to influences on their research. Although we know that researchers are influenced and can be confident about some of the individual-level effects, the ways in which these micro-level effects lead to macro-level changes in knowledge are yet unknown because until now we lack the methods to identify and causally ascribe macro-level epistemic changes.

2.2 Economics

Economics studies actors engaged in strategic, often competitive interactions with one another. Among these competitions, the dominant focus is on markets, a focus which entails the assumption

that actors have at least some autonomy.⁴ The study of actors embedded in competitions implies two perspectives that can be applied to the independence of research, namely the study of influences on goal formation and the study of the process of competing.

Goal formation

The formation of goals by actors in science can be considered as self-organised within scientific communities, occurring in a framework of commercialisation (industrial application of science), or occurring within an impact framework of general societal usefulness. Economics has studied goal formation of researchers with a special focus on effects of commercialisation on the individual level. These research interests and findings overlap with science studies' investigation of academy-industry collaboration. Topics include the relationship between patenting and publication activities as well as the impact of academy-industry relationships on thematic changes (towards more applied research) and on secrecy or delayed publication (Azoulay et al. 2009, Hottenrott and Thorwarth 2011, Czarnitzki et al. 2015). The impact of commercialisation expectations on universities has not received comparable attention.

There are no findings yet on the consequences of a generalised societal impact expectation on researchers or research organisations, probably because these expectations have been inscribed in evaluation systems only recently. Thus, it is not clear yet whether causal effects can be identified at all. However, the expectation to identify societal impact raises a fundamental question about the public funding of science because from the perspective of economics, the main justification for public funding of science is that applications and beneficiaries of research are not yet identifiable (Nelson, 1959).

Process perspective

The process perspective asks how being engaged in competitions with each other affects the independence of researchers. This question addresses a strong overlap of the sociology of science and the economics of science, which both study competitions. Applying sociological theories of exchange to science, sociologists formulated models of science being based on an exchange of findings for

⁴ The economics subfield of business and management studies have a strong focus on the autonomy of those who are managed, i.e. of employees and organisational units. In both cases, autonomy is considered as something granted by management. An important contribution of these studies is the principal-agent perspective, which has been developed in economics (Jensen and Mecklin 1976) and has later been applied to science policy (Braun and Guston 2003). The principal-agent perspective asks how agents tasked by principals can use their autonomy to 'shirk' their tasks. The applicability of these considerations to researchers has yet to be established. The autonomy of units that act in markets (e.g. a firm's subsidiaries) is seen as increasing the units' ability to respond to changes in markets, which ultimately increases their performance. These considerations resonate with discussions of university profile building (Schiene and Schimank 2007, Meier and Schimank 2010, Laudel and Weyer 2014), of university research groups as "quasi-firms" (Etzkowitz 2003) and of researchers managing their individual research portfolios (Gläser and Laudel 2007, Gläser et al. 2010).

recognition (Hagstrom 1982) or competent feedback (Storer 1966). Other approaches resembled models of capitalist accumulation (Bourdieu 1975, Latour and Woolgar 1982). These ideas were later taken up by the “new economics of science“ (Dasgupta and David 1994, David 1998a, b), which describes science as a “winner takes all“-competition in which only the first contributor of new knowledge is recognized.

A second, probably more important basis for the study of competition in science is the increasingly competitive allocation of resources for research. These competitions differ in the degree to which they are endogenous to the scientific community or installed by external actors. Many competitions for resources combine endogenous and exogenous elements, while others are exogenous only. The latter competitions differ from the traditional competition for recognition in science in that they may be considered as contests where contestants compete for a given prize in a zero-sum game. An extensive literature in economics shows that contests induce societally wasteful “rent seeking” behaviour and often are not in society’s best interest (Tullock 1980; Hillman and Samet 1987; Van Long 2013).

The process perspective provides opportunities to explore the transfer of ideas from the study of markets and innovations to the multiplying and changing competitions in science. The number, kinds, and scopes of competitions in science have increased, and are still increasing in many countries, in the context of NPM governance reforms. Some competitions are based on new measures to compare contestants. For example, quantitative measures of reputation and performance are increasingly used, which may trigger adaptive behaviour and discriminate against certain types of research. At the same time, traditional competitions e.g. for project funding create increasing pressure on participants because success rates keep decreasing. Again, there is an interesting overlap with sociology’s interest in “quasi-markets” in higher education, i.e. in competitions that resemble markets to some extent but do not meet the definition of markets (Le Grand and Bartlett 1993, Barr 1998, Dill et al. 2004, Teixeira et al. 2004).

Questions about competitions in science that may be asked from an economics perspective include:

- Under which conditions does competition in science increase the diversity of research by stimulating differentiation? This question is based on the observation of product differentiation in markets for goods with few suppliers, who strategically decide about product differentiation. This model might be applicable to competitions in science with relatively few suppliers (e.g. universities). The relevance of product differentiation for competition in science has yet to be determined.
- What role does the competition of funding agencies play for competition in science? Monopsony (markets with a single buyer) also occurs in competitions for research funding, e.g.

in performance-based funding of universities and in funding competitions in which all competitors can apply with only one funding agency. Economics has found that monopsony leads to an exploitation of suppliers (e.g. workers in labour markets). The impact of monopsony on the diversity of research, competition and innovation has not yet been studied.

- Do path dependencies and lock-ins occur that reduce diversity and innovation? In competitions with a homogenous demand, suppliers who meet this demand become rewarded, which increases their ability to outcompete alternative approaches. Cumulative advantages and network effects may strengthen mainstream research and reduce diversity.
- How do new competitors enter a funding competition, and what role do they play in these competitions? In markets, radical innovations are often introduced by new suppliers. These observations raise questions about 'barriers to entry' in competitions in science, how they are related to the independence of researchers/competitors, and possible effects on scientific innovations.
- How does increasing competition affect the openness of science? The inherent conflict between science being based on free access and autonomous utilisation of scientific findings on the one hand, and being overlaid by market structures and competitions that suggest secrecy, on the other hand, has primarily been studied with regard to the impact of intellectual property rights (patents, material transfer agreements) covering research inputs (Murray and Stern 2007, Murray et al. 2016; see also section 2.1) and secrecy (David 1998b). The possible contradiction between open data policies and policies increasing the competitiveness of the science system remains to be investigated.

2.3 Philosophy of science

While 'independence' is not a technical term in philosophical discussions about science, philosophy of science has developed a multitude of perspectives that are related to the independence of research. Among these, the contributions from research ethics, from the political philosophy of science and from social epistemology stand out as most seminal.

In research ethics, independence plays a role in the discussion of misconduct, bias and professional integrity. Research ethics as a type of professional ethics starts from the assumption that the social role defined by a particular profession is associated with particular kinds of role responsibilities which in turn require the implementation of specific norms or ethical principles. Specific principles suggested for research ethics include striving to eliminate personal biases, as well as non-interference with scientists' opportunities to pursue new avenues of research and criticize existing views. (Resnik 1998, 2007, 2009). The exact relation of such ethical imperatives with different forms and levels of independence in science awaits further philosophical research.

Within the political philosophy of science, independence figures in the form of debates about scientific freedom. Wilholt (2010, 2012) identifies and discusses three types of argument.

The first is an argument from autonomy, based on the thesis that humans must be free to investigate the world because it is one of the basic prerequisites of a self-determined life to be able to freely gain knowledge. This very basic argument provides grounds for opposing interference with an individual's efforts at knowledge generation. However, additional reasons are needed to defend the claim that principles of freedom and independence ought also to hold within a collective (state-sponsored) and coordinated enterprise of research.

Such are provided by the epistemological argument (in Wilholt's terminology), which states that to allow individual scientists the widest possible freedom is the most efficient way to ensure that the sciences give us as much as possible of the kind of knowledge that we as a community are hoping to get from them. Classic articulations of the argument (like Mill's, 1992 [1859]) typically start from a reference to the fallibility of the human quest for knowledge. It is impossible to decide in advance which theory, which methodological approach, which research project is the one to achieve the next major breakthrough - and which one is a wrong track or a dead end. An inquiring community should therefore never put all its eggs in one basket (or only few baskets). A variety of different approaches creates the best possible conditions for success. And this variety, so the argument goes, can best be created by granting individual freedom. From the perspective of contemporary social epistemology, this problem is related to the problem of describing the roles of different dimensions of freedom and independence for an efficient distribution of cognitive labour within a research community (Kitcher 1990, Holman and Bruner 2015).

The third argument on Wilholt's count is a 'political' argument according to which the purpose of freedom of research is to guarantee the political independence of the sciences. It is widely recognized that the formation of political preferences is already part and parcel of the democratic process. Its preconditions therefore include independent sources of knowledge. In a world in which we have to rely increasingly on the sciences for information on politically relevant substantive issues, their political independence becomes a significant factor.

Other authors have emphasised how science should be dependent on societal values in a democratic society, and how the integration of the value of knowledge with moral and political values could be achieved (Kitcher 2001, Kourany 2010). Kitcher proposes, as an "ideal of well-ordered science", that priorities in research ought ideally to be set like a collective of well-informed discussants would set them in an ideal conversation situation. The way to come close to this ideal, he argues, is not to give

free reign to scientists but to implement social procedures that approximate the operation of such collectives, in the form of groups of citizen representatives (Kitcher 2011).

In the area of social epistemology, independence is discussed as a functional prerequisite of objectivity. The formerly influential idea that objective science needs to be independent from all extra-scientific value interests has come to be gradually abandoned. Of particular influence in this regard have been arguments that methodological decisions in the inductive sciences are always incomplete without considerations of how serious a mistake would be, and that therefore scientists are morally obligated to take the consequences of accepting a hypothesis into account (Douglas 2000, 2009) or, in a variant of the argument, that they need of necessity do so lest methodological choices remain underdetermined (Wilholt 2009, Biddle and Winsberg 2010). The debate has also focused on the question whether certain kinds of values can be considered as 'epistemic' and delineated from more problematic value influences such as ones of a moral or political character (Rooney 1992, Longino 1996, Steel 2010).

There has also been a shift towards a more social account of objectivity. Objectivity is not considered at the level of the individual researcher anymore because it seems difficult to explain in what sense individual researchers can be objective. Instead, the discussion focuses on procedures by which collective-level objectivity is achieved. Thus, Helen Longino (1990) identifies transformative mutual criticism as the core of procedural objectivity and investigates the kinds of features that epistemic communities must have in order to achieve it. In this context, scientific pluralism is considered as important for collective-level objectivity, which can be linked to independence as a condition for pluralism. Collective level epistemic effects of social rules have recently also begun to be studied by philosophers using formal models and computational methods. Kummerfeld and Zollman (2016) have attempted to show that in a completely autonomous scientific community scientist may become conservative and risk-averse, thereby arguing that exogenous institutional constraints may be beneficial for scientific progress.

Philosophers concerned with social epistemology (often combining this perspective with aspects of the political philosophy of science) have often worked with a case-based methodology and examined extra-scientific influences within particular, defined areas such as the increasing commercialisation and commodification of scientific research (cf. Radder 2010), the politicised arena of climate science (Frisch 2013, Winsberg 2018), the interplay between methodology and social interests in medical science (Solomon 2015, Stegenga 2018), or the contested knowledge claims of environmental science (Elliott 2011).

Philosophical research on all these topics is ongoing and likely to contain more fuel for future debates. Controversial questions that are likely to inform philosophical research related to the independence of scientific research in the near future include the following.

- Perceived independence seems to be an important factor contributing to the trust invested into research results by the public. At the same time, it has been suggested that to maintain credibility in the face of an apparent gradual loss of public trust in science (and other institutions of the open society), science needs to become more responsive and accountable to public needs. Thus, which is the key to science's credibility: more independence, or less?
- Given the emerging consensus amongst philosophers of science that the value-free ideal for scientific research is unrealisable, does this mean that the independence that is necessary for epistemically productive research should also include a free play of value influences? Or is there a way to delineate acceptable from unacceptable value-based methodological decisions (a task that has been dubbed the "New Demarcation Problem")? The urgency of this problem has increased since 'researcher degrees of freedom' have started to be linked to questionable research practices (Simmons et al. 2011).
- Both the epistemic and the political benefits of scientific independence are linked to its assumed tendency to facilitate pluralism and a diversity of approaches – including a propensity to foster mutual criticism, dissent and controversy. But recent research has drawn attention to the phenomenon of 'manufactured dissent' in the sense of efforts (motivated by particular interests) to undermine scientific knowledge claims by means of producing apparently scientific contrarian views (Oreskes and Conway 2010). This has prompted some philosophers of science to attempt to articulate criteria by which to identify 'epistemically detrimental dissent' (Biddle and Leuschner 2015), while others insist that all controversy must be welcomed regardless (de Melo-Martín and Intemann 2018). So, are there limitations to the epistemic and political benefits of pluralism and dissent and is it possible to delineate them on principled grounds?

2.4 Legal studies

Reconstructing the perspectives of legal studies on the independence of research faces two problems. First, the law does not state empirical facts but formal normative positions. It is codified in highly abstract texts of law that become concretised in their application to cases. Legal studies link the normative statements of the law to the empirical effects that follow from their application to societal processes. It is this link between the 'ought' of the legal structure and the social reality that creates the connectivity between legal studies on the one hand, and social sciences and humanities, on the other hand.

Secondly, most legal structures are national structures, which is why legal studies belong to the fields with the strongest national orientation. Although there are internationally comparative legal studies, legal scholars predominantly communicate within their countries on these countries' laws. This is why in the following we present the specific perspective of German legal studies on the independence of research. Introducing an internationally comparative perspective is beyond the scope of this paper but remains an important task for future research (see below).

German legal studies conceptualise the independence of research as “freedom of science” (in the all-encompassing German sense of “*Wissenschaft*”, i.e. including the social sciences and humanities).⁵ This freedom is encoded in the German constitution with the statement “The arts and sciences, research and teaching are free” (our translation). The constitutions of some of the federal states additionally guarantee the freedom of higher education institutions or their right to self-governance.

The fundamental right of freedom of science is differentiated to three dimensions. First, there is the understanding of the freedom of science as a *personal* defensive right (*status negativus*), i.e. the right of the individual to reject incursions, by the state or other actors (Britz 2013: Rn. 11, Weingart 2014). The rulings of Germany's constitutional court add to that defensive right the positive right (*status positivus*) to have means for the conduct of free research and the task of the state to enable free science by providing personal, financial and organisational means (BVerfGE 35, 79/114f., Weingart 2014).⁶ Although this interpretation is still formulated as a personal right to freedom of science, it also introduces an organisational understanding of the freedom of science, which leads to the guarantee of freedom for higher education institutions mentioned above. This understanding constitutes a second dimension of the right of freedom of science. It implies the obligation of the state to provide an adequate *organisational structure* for free science.

The intermingling of personal and organisational interpretations of the freedom of research is expressed in rulings by the constitutional court according to which university professors must have the majority of votes on matters of university self-administration that are relevant to sciences decided upon in their universities.⁷ However, the constitutional court also declared that the state must “provide

⁵ We are indebted to Hauke Brettel, who pointed out that criminal law also becomes relevant to the freedom of science for two reasons. First, criminal law protects the freedom of medical science by protecting it from corrupting influences by sanctioning the entanglement of professional activities with personal interests (Kindhäuser et al. 2017: 299a, Rn. 75f.). Secondly, criminal law contributes to the protection of life or human dignity, which are higher-order interests that may constrain the freedom of science. For example, data protection is to some extent secured by criminal law, and the criminal law protects citizens by prescribing the deletion of data on previous conviction or some material used in criminal proceedings. These regulations limit the access to data and thus the freedom of research.

⁶ We apply the reference style for German court rulings. BVerfGE 35, 79/114 f. stands for Rulings of the *Bundesverfassungsgericht* (Federal Constitutional Court), Volume 35, pages 79 and 114f. “Rn.” denotes a recital that provides the precise location of an argument on a page.

⁷ This is a position that Germany's Federal Constitutional Court has consistently upheld since its first ruling in 1973 (E53, 79ff).

functional institutions of free university science” (BVerfGE 136, 338 Rn. 55, BVerfGE 139, 148 Rn. 68, our translation), or that the individual freedom of science may be constrained in the interest of the “functional capability of higher education institutions” (BVerfGE 126, 1 Rn. 55, our translation). Although the voluntary self-coordination of scientists within universities shall take precedence over heteronomous decisions by university management (BVerfGE 126, 1 Rn. 56, for a discussion see Britz Rn. 91), the boundary between individual freedom and the organisation’s functional capability remains open to interpretation, and the functional capability of organisations is independently protected.

The third dimension refers to the societal sub-system of science as an institutionalised system of action with specific functions (Britz 2013: Rn. 68, Rn. 15 ff.). This meaning has a textual reference in the wording of article five of the constitution, which declares “science” rather than the “scientist” to be free. According to the constitutional court, this fundamental right also protects “the functional capability of the institution of ‘free science’ as such” (BVerfGE 35, 79/120, our translation).

Against this background of current discussions, several questions arise that merit further study. A first question concerns international comparisons: How effective are different systems of law in protecting the freedom of science? From the German experience and international comparison at least three overlapping approaches can be distinguished, namely the constitutional protection of the freedom of science, the protection of the independence of higher education institutions, and the protection of freedom of speech (see above and Pritchard 1998, Karran 2007, Weingart 2014). Empirical analyses of the effects of these different legal arrangements can add to a deeper understanding of intended and unintended consequences of each of them.

This comparative approach needs to be combined with multi-level studies that address the personal, organisational and systemic level of legal protections for the freedom of science. In the German context, the current legal balancing of decision rights between universities’ senior management and professors is of particular interest. Recent rulings invoke a balance between the rights of university professors to self-coordinate and the functional capability of higher education institutions without being able to draw on empirical evidence, which means that these rulings are based on unfounded assumptions. The comparative study of effects of legal arrangements on the individual researcher, the research organisation and the science system in society is thus both of theoretical interest and of political consequence.

2.5 History of higher education and science

The independence of science, or academic freedom, has been addressed historically from multiple perspectives, three of which will be addressed here: the history of the idea and the legal practices of academic freedom; historical studies of science and scholarship in dictatorial regimes; and

contemporary historical studies of the uses of scientific expertise in a variety of policy areas, including health issues and climate change.

Histories of the idea and practices of academic freedom

The idea of freedom in science and scholarship is a long-standing topic in the history of universities. Work on the issue in the history of philosophy, political theory and law has focused primarily on the varied and changing meanings of, arguments for, and justifications of the limits of such freedom, variously defined. Recent work by historians has recognized that the question “freedom for whom?” is central; this means that the idea of academic or scientific independence cannot be considered separately from the changing social makeup and political status of scientific activity and academic institutions over time. Seen in this light, using the term ‘academic freedom’ in reference to Medieval or early modern Europe is anachronistic; not individual rights, but privileges granted to academic or religious corporations by the Pope or secular authorities were in question (see, e.g., Schwinges 2008). As universities in continental Europe became state institutions in the seventeenth and eighteenth centuries, corporate privileges became legal rights to conduct certain academic activities, mainly teaching and administration, that were granted or assigned by rulers to officials in their service (Stichweh 1991; Clark 2006). In contrast, scientific activity outside universities, which was essential to the rise of modern science, was governed by conventions of court life or a “gentlemanly” elite (Biagoli 1993; Shapin 1995). In such circumstances, scientific independence and even the truth value of scientific observations and opinions depended on financial independence or patronage relationships.

Discussion of the modern period is complicated by semantic issues that are themselves indicators of historically rooted differences in the situation of higher education and the sciences in different locations. That is why the expression ‘academic freedom’ is difficult to translate into other languages. Indeed, its common usage even in English – and the absence of the term ‘science’ from the expression itself – are artefacts of historical circumstances in the United States, to be discussed below. In French, the commonly used terms are ‘liberté des sciences or des recherches’; in German the word is ‘Wissenschaftsfreiheit’. Whether or not all of these terms are in fact equivalent depends on meanings of the term ‘science’, which have changed over time.

An example of this point is a historical fact that is rarely acknowledged in America-centric scholarship: Academic freedom – here: *Wissenschaftsfreiheit* – first became a constitutionally guaranteed right in the constitutions of the North German Confederation and the Habsburg empire (both 1867) (Müller 2008). The relevant provision, first formulated in the abortive German constitution of 1849, translated literally, reads: “Research (*Wissenschaft*) and its teaching *is free*“ (our translation and emphasis). This seemingly ungrammatical declaration suggests that the provisions’ authors (many of whom were themselves

professors) considered academic teaching and research to be a unified activity. The status of scientific and scholarly research outside academic settings was addressed in subsequent legislation but remains a source of legal difficulty at many levels. If we ask “freedom for whom?” in this case, what was formulated as a constitutional right was (and remains) in effect primarily, though not entirely, a means of securing the power and status of the people in a position actually to exercise such rights, mainly full professors. Moreover, since professors remained civil servants, as they had been since the early modern period, their apparently guaranteed freedom could be limited or revoked when political regimes changed (see below).

In the United States, academic freedom has never been a basic constitutional right, but has been treated in the courts and in public debate as a special case of freedom of speech (Herbst 2008). The term itself came from the German *Wissenschaftsfreiheit*, and the principle still includes freedom of inquiry, but its meaning was modified in many other respects when it was adapted to the American context (Metzger 1978). Since universities in America can be either private or public institutions, tenure is guaranteed to faculty members by civil contract and other legal arrangements, but not by public law. Public opinion did not take kindly to any claim of special rights for academics in any case. The legal situation changed during the Cold War, when discrimination against leftist academics was prominent (Wang 1999, 2002). The Supreme Court declared for the first time in 1957 that academic freedom was protected by the US constitution (Herbst 2008, 325). Nonetheless, proponents of academic freedom in the US remain on the defensive, both against critiques from the left and from conservatives arguing that universities have become bastions of left-liberal conformity (Gross and Simmons 2014).

Science in the dictatorships of the twentieth century

Examples of ideologically corrupted science in dictatorships are often cited to legitimize the superior value of science in democracies. Challenges to simple causal connections of this kind began already in the 1970s and 1980s; since then hundreds of studies of the sciences and scientific institutions under Nazism have appeared (for early overviews see Walker and Renneberg 1994; Szöllösi-Janze 2001; for research at Kaiser Wilhelm Institutes see Heim et al. 2009; for analyses of Nazi-era science policy see Flachowsky 2008 and Nagel 2012). Work on the humanities has been part of this trend throughout (Hausmann 2002; Elvert and Nielsen-Sikora 2008; Bialas and Rabinbach 2007).

The current consensus among historians on this topic can be put briefly in four points:

(1) The dismissal of thousands of scholars and scientists of “non-Aryan“ descent or left-wing political views that began in 1933 was not a direct attack on science and scholarship as such, but part of the Nazi effort to purge the German civil service, although some Nazis thought that this alone would suffice to “cleanse” German universities of liberal ideology (Grüttner 2005). The dismissals show that

constitutionally guaranteed freedoms could be revoked under certain political conditions. However, many disciplines were barely affected, because people of Jewish descent had not been present there in any case (Ash 2008).

(2) Initiatives to produce “ideologically correct” science such as “German Physics” came not from above, but from reactionary antisemitic scientists seeking to resolve internal battles, e.g. over relativity theory, by political means (Gordin et al. 2003).

(3) Contrary to older accounts claiming that Nazism was opposed by nature to modern science, research funding increased in the Nazi era, particularly in fields perceived to be most relevant to Nazism’s policy goals: “racial hygiene“ (Deichmann 1995; Proctor 1999; Weiss 2010), weapons research (Neufeld 1995; Heim et al. (2009), Section IV); and the forced resettlement of Slavic peoples to create “living space“ for folkishly defined “Germans“ in Eastern Europe (Heinemann and Wagner 2006; Fahlbusch and Haar 2010). Scientists were not forced to engage in such work, but willingly participated – some scientists even helped to develop such policies – or opportunistically represented existing research as relevant to current political priorities. Comparable results have emerged from more recent work on Mussolini’s Italy and Franco’s Spain (Gómez et al. 2015).

(4) Murderous human experiments in Nazi concentration camps and the appropriation of organs of victims of the killing of the physically or mentally handicapped for medical research (Kunz 2004) show how far the enablement of science by politics could go. Here, too, scientists were not forced to participate, but did so by choice.

In contrast to Nazi Germany, the campaign to produce “ideologically correct science” under Communism came from above in the late 1940s, initiated by Politburo First Secretary *Kommissar* Andrei Zhdanov in coordination with Stalin himself, who intervened at times to assure appropriate results, most notably in the case of Lyssenkoism. But such campaigns could not have succeeded without the participation of scientists, who saw institutional advantages in playing “games of Soviet democracy” (Krementsov 1997, chap. 6; Kojevnikov 2004, Chap. 8). And yet, the Soviet nuclear weapons program took place at the same time under the personal direction of Lavrenti Beria, head of the secret police (Holloway 1994; Kojevnikov 2004, Chap. 6); “ideologically correct” science served no purpose in this context. The simple fact that Stalinist science encompassed *both* Lyssenkoism and Pavlovism *and* first-class nuclear and rocket science and mathematics appears difficult for many to accept, even today.

The belief that dictatorships produce only poor-quality science or ‘pseudoscience’ is still widely shared, but as these examples show, high quality science was supported by the dictatorships of the twentieth century, when it appeared to serve their interests (Walker 2012, 375).

That democracies, too, have chosen to limit academic freedom in certain circumstances is shown by policies enacted in the new German states established on the territory of the former East Germany following German unification. These states passed higher education ‘renewal’ laws that in essence required professors in East German universities to reapply for their former positions, based on a distinction between professors hired under the previous regime (*Professoren nach bisherigem Recht*) and professors under the new law (*Professoren nach neuem Recht*) (Ash 1997, 98 ff.). These professors had to undergo political and moral assessments of their past behavior by so-called ‘honour’ committees. Those who had served in higher party positions, had worked for the State Security Police or who had behaved in a manner deemed dishonourable could be and often were dismissed. In such cases the constitutionally guaranteed freedom of science and scholarship was deliberately suspended in order to carry out a political purge of the teaching staff; newly appointed professors from the West were not subjected to such evaluations.

Recent historical studies of scientific expertise

In recent years, critical historical studies have appeared documenting recruitment of scientific expertise by large corporations to carry out studies intended to counteract the scientific basis of specific policies. Well-known cases in point are studies of the relation of smoking and cancer (Proctor 2012), and research purporting to counter claims that climate change results from human activity, especially the use of fossil fuels (Conway and Oreskes 2010). In fact, the corporations involved understood that the government’s and related research claims were sound, since their own earlier contract research had also shown this. Their purpose was not actually to refute public health or climate policy claims derived from established science, but to sow sufficient doubt about them to delay or prevent implementation of policies considered harmful to short-term corporate interests. Such tactics have increased pressure on publicly supported scientific bodies to engage in policy advocacy in their own right. Whether scientific independence is actually possible in such circumstances is an open question.

Less well studied by historians of science are the reasons why such tactics succeed. To answer such questions it is necessary to go beyond science and consider the history of American egalitarian civic culture, for example the media’s self-imposed requirement to report “both sides” of any debate, even when a consensus of informed scientific opinion is clearly present. This convention is itself rooted in the widely shared belief that well-founded expert opinions should have equal standing with ordinary peoples’ intuitive judgments, even if these turn out to be nothing more than self-interested wishes. The apparent success of such tactics seems ironic in an age in which economic efficiency based on supposedly objective calculations is supposed to trump all else in both the business world and the policy sphere.

What can be concluded about scientific independence or academic freedom from these varied historical perspectives? A necessary causal connection between the freedom of science, constitutionally guaranteed or not, and high-quality research results appears to be as difficult to sustain as the claim of a necessary causal link between unfree regimes and “pseudoscience”. Relatively autonomous research has been possible even in unfree societies.

In order to provide proper historical perspective, perhaps it is time to historicize the term “autonomy” itself, in particular to ask how claims to institutional “autonomy” have functioned as cultural codes for the establishment and maintenance of power relations within the research establishment. Reframing the question this way means asking not whether scientific independence has existed or not, but in what political circumstances what kinds of (limited) autonomy have been granted for what reasons to whom, and above all what academic/scientific power holders have actually done with the (limited) autonomy granted to them. In this respect the history of science and higher education intersects with sociological approaches. A historical approach is distinguished from others by the insistence on situating cases of academic freedom, or unfreedom, in their specific times and places. In some cases at least, this can mean making an effort to historicize bad science on the same terms and with the same methods as epistemically robust science.

2.6 Self-reflections by research communities

Scientific communities in the sciences, social sciences and humanities have reflected on two aspects of their dependence. First, there is a growing concern about the dependence of communities’ epistemic judgments on incorrect information. Secondly, the dependence of researchers in the Global South on theories, approaches, and preferences of scholars in the Global North has come under scrutiny.

Beginning with the first concern, many fields in the sciences and social sciences have begun to reflect upon a loss of trust in published results. Problems include

- errors in publications that spread through scientific communities (e.g. Vaughan et al. 2017)
- results that cannot be reproduced for a variety of (partly unknown) reasons (Ioannidis 2005, Baker 2016),
- bias in the presentation of results, which can be understood as “any tendency which prevents unprejudiced consideration of a question” (Pannucci and Wilkins 2010: 619). Interpretation bias is discussed in the medical sciences as “spin”, which is defined as “reporting practices that distort the interpretation of results and mislead readers so that results are viewed in a more favourable light” (Chiu et al. 2017: 11, Lieb et al. 2016, Stoll et al. submitted).
- fraud, i.e. the falsification of results (Hesselmann et al. 2017, Byrne 2019).

These phenomena directly bear on the independence of research with regard to both their causes, which are conceptualised as individual producers losing their independence, and their consequences, which are increasingly discussed as threats to the independence of scientific communities.

Causes of the perceived upsurge of publications that cannot be trusted vary and are unevenly researched. They can, however, jointly be conceptualised as conflicts of interest (COI). The field in which discussions about financial COIs have been most prominent is medicine, which has a long tradition of reflecting upon independence due to both the nature of physicians' professional practice – where the norm of independence can be traced back to the Hippocratic Oath – and the long-standing issue of influences on medical research exercised by industry.

Medical researchers define COI as “a set of circumstances that are reasonably believed to create a substantial risk that professional judgment of a primary interest will be unduly influenced by a secondary interest” (Thompson 2009: 137). In this approach, the independence of a researcher is conceptualised as the opportunity to realise the primary interest of extending reliable knowledge for the patients' benefit. This primary interest can be impeded by secondary interests such as personal gains like money or prestige, the interest to comply with external pressure, or the interest in seeing one's preconceptions confirmed. Three kinds of COI have been discussed in medicine and other fields of the sciences and social sciences:

- A researcher's independence and thus their realisation of primary interests can be endangered by external pressures, e.g. by demands from or contractual obligations to pharmaceutical companies, by the pressure to publish or to meet demands from employers. These conflicts of interest have also been investigated by the sociology of science and economics (see 2.1 and 2.2). They may lead to the suppression (non-publication) of findings that contradict interests of clients or publications that are biased towards clients' interests (publication bias). For example, numerous studies found that industry funding is associated with higher chances of outcomes furthering industry interests, although causal ascription to industry influence is difficult in most cases (Krimsky 2013).
- Researchers may consciously sacrifice their primary interest in order to advance their status, career, or income. This practice is the focus of a wide-ranging discussion on questionable research practices like “HARKing” (hypothesising after results are known, Kerr 1998) and “p-hacking” (the selection or transformation of data in order to produce statistically significant results, Head et al. 2015). These practices respond to a pressure emerging from the preference of editors, reviewers or researchers for statistically significant results (Stanley 2005, Doucouliagos and Stanley 2009). In other words, some scientific communities develop a

collective secondary interest in findings that *seemingly* contribute most to the rapid progress of science.

- Researcher independence may also be constrained if researcher allegiance, which is understood as the adherence of a researcher to a theory or approach, turns into epistemic prejudice that overrides the primary interest. Researcher allegiance, which so far has been studied most extensively in psychotherapy outcome research (Munder et al. 2013), is a ubiquitous phenomenon because all researchers have an allegiance to the theories and approaches that form their scientific perspective. However, allegiance may turn into a strong interest in confirming the superiority of theories or approaches regardless of the available evidence. This interest may lead to prejudice without any external influence (Lieb et al. 2016).

The most important *consequence* of these COIs is the proliferation of unreliable publications, which is currently discussed by several scientific communities in the sciences and social sciences. The experience that published results cannot be trusted may accumulate and erode the implicit trust in colleagues' findings, which is one of the foundations of the communal production of scientific knowledge. Building research on findings that later turn out to be incorrect may slow down or misdirect a community's knowledge production, both of which waste scarce resources (Byrne 2019). This is why scientific communities attempt to introduce regulations that prevent unreliable publications. A by now well-established rule prescribes the declaration of COIs (Fontanarosa and Bauchner 2017).⁸ More recently, the pre-registration of studies and the publication of registered reports have been introduced in order to prevent the retrospective adjustment of study designs (Zarin and Tse 2008, van 't Veer and Giner-Sorolla 2016).

A second major concern of an increasing number of scientific communities is the dependence of scholars in the Global South from those in the Global North. In the sciences, this dependence is discussed mainly in terms of unequal power in research collaborations (e.g. Binka 2005). Discussions in the social sciences and humanities focus on the role of the Global North as the sole source of dominant theories and approaches (Connell 2006, Keim 2011, Acharya and Buzan 2017) and on the mechanisms that reproduce the Northern dominance in these communities (Tickner and Wæver 2009, Keim 2011, Landau 2012, Maliniak et al. 2018, Kreimer 2019: 3). The elaboration of mechanisms (curricula

⁸ The effects of the disclosure of COI on recipients of potentially biased information is inconsistent. Experimental research shows that recipients of such information tend to adjust their behaviour insufficiently, not at all, or in the wrong direction (Cain et al. 2005: 5-6). Those who provide information and disclose their COI also adapt. They may feel justified in providing biased information once they disclosed their COI ("moral licensing") or strategically exaggerate the bias in order to achieve an effect despite disclosure (Cain et al. 2005: 6-7, Sah and Loewenstein 2014). In the only experiment directly related to research, Chaudhry et al. (2002) sent articles to two groups of readers of the *British Medical Journal*. They found that "BMJ readers reported that data showing the impact of pain from herpes were less interesting, important, relevant, valid and believable when the authors were employees of a fictitious pharmaceutical company compared with an ambulatory care centre" (ibid: 1392).

worldwide dominated by Northern theories and approaches, PhD programmes of the Global North dominating postgraduate education, leading journals being dominated by scholars from the Global North and so on) makes a convincing case that the emergence of theories in the Global South and their diffusion are more than difficult under current conditions. In any case, the communities in question (our examples refer to sociology and international relations) are still in the process of taking stock. First actions taken include attempts by leading international relations journals to prevent bias in the selection of manuscripts for publication.

3. Opportunities for integrating disciplinary interests

In the preceding discussion of disciplinary interests in the independence of research we already commented on some overlaps that emerge because several disciplines study the same empirical phenomenon (e.g. competition in research, the influence of industry on research, bias in publications) or conceptualise independence similarly (e.g. as autonomy, which is understood as the ability to resist external influence). In this section, we go one step further and demonstrate that many of the disciplinary perspectives on research can be integrated under the two main themes of social and epistemic independence. The first theme, which cuts across many disciplines, is the social independence of researchers, research organisations and scientific communities in constellations of actors influencing each other. The interdependence of actors in science and their opportunities to influence each other affect individual and collective epistemic choices and thus the dynamics of science. In relation to that, a second theme addresses the epistemic independence of researchers and scientific communities. This independence is affected not only by relationships between actors but also by the interdependent epistemic judgments of researchers and their scientific communities.

3.1 Social Independence of researchers, research organisations and scientific communities in heterogeneous actor constellations

This understanding of independence dominates the public discourse and many scientific approaches to the independence of research. The history of science, legal studies, economics, sociology and philosophy contribute specific perspectives on the influence of actors inside and outside the science system on researchers' problem choices, and on the effects of changed problem choices on the dynamics of science.

An interdisciplinary perspective could start from the observation that over the last decades, structures and processes of research funding, attempts by external actors to influence research and the legal conditions for research organisations and researchers have changed significantly in many countries.

These changes have transformed the competitive structure of science and the major organisational environment of research, i.e. universities.

The competitive structure of scientific communities is shaped by the competition for recognition as a competent member of the knowledge-producing collective and by the competition for the opportunity to maintain that status by continuously contributing to the community's knowledge. These competitions are driven by the identity of researchers as members of international scientific communities that collectively advance a shared body of knowledge. In order to maintain their identity, researchers must have at least some measure of success in the two competitions. The competition for recognition has increased because the growth in membership of scientific communities outpaces these communities' ability to respond by internal differentiation. The competition for opportunities to continuously conduct research has increased considerably over the last decades due to the relative and absolute scarcity of both positions in academia and research funding.

At the same time, the introduction of NPM in the higher education systems of many OECD countries has included the creation of competition between research organisations. The resulting multiple competitions in which researchers are implicated (Krücken 2019) affect the independence of researchers, who might have to adapt their research in order to succeed. If individual adaptations to competitive pressures become aligned, the diversity of research on the macro level of scientific communities would decrease.

The transformation of universities raises the question as to how they can fulfil their role of protecting the autonomy of their academics after higher education reforms that were informed by ideas of NPM. While the actual impact of these reforms on university autonomy varies, the legal status, the regulation and the funding of universities have certainly changed, which affects both universities' interest in protecting the autonomy of their academics and their capabilities to do so.⁹ For example, the scarcity of recurrent funding for universities opens them to external influences on long-term directions of their research, e.g. via externally funded research centres or via endowed professorships. Of particular interest is the question whether the inter-organizational competition puts an increasing pressure on universities to push their individual scientists to adapt their research agendas to those criteria which are crucial for organizational success but not necessarily guarantee 'good' science.

The increasing interest in utilising science for political or economic interests may lead to conditions under which whole scientific communities can become dependent on political priorities or economic interests. For example, such a situation may occur when all sources of funding for a scientific

⁹ A similar question can be asked about funding agencies.

community are aligned to a unitary political or economic interest. Large-scale dependencies can also occur when actors can exercise control over access to empirical objects or data that are essential for a community's knowledge production. In both cases, the direction of research of a whole community might change.

Finally, we pointed out the increasing attention being paid to centre-periphery relations within scientific communities. The dependence of researchers in the Global South on those in the Global North is enjoying increasing attention. So far it has been treated in isolation from the other aspects of social independence or dependence. However, it needs to be put in the context of multiple competitions and international relations.

Research on conditions for and consequences of the changing social independence of actors in the science system faces two methodological challenges. The disciplinary perspectives we reviewed agree that the independence of an actor is a complex phenomenon, namely the emergent effect of the actor's processing of their multiple dependencies. How the resulting degree of independence can be comparatively measured is not clear at all. It might be worth moving from measuring 'the independence' of an actor to autonomy profiles which describe an actor's dependencies on relevant members of the actor constellation. The comparative assessment of effects of a changing independence is similarly challenging. It requires the identification and comparative description of changes in the direction and diversity of research as well as their causal ascription to specific changes in independence.

3.2 Epistemic independence

The epistemic independence of research refers to the independence of epistemic judgements, which again can be considered at individual and collective levels of research. Although the dependence relations discussed in the previous section are of interest precisely because they mediate the influence on epistemic judgments of researchers and scientific communities, epistemic independence needs to be looked at separately because it is also affected by factors beyond the influence of actor constellations discussed above.

The topic of independent epistemic judgments was introduced by Robert Merton with the norm of "organized scepticism", which demands "[t]he temporary suspension of judgment and the detached scrutiny of beliefs in terms of empirical and logical criteria" (Merton 1973 [1942]: 278). In addition to this sociological perspective, philosophical research on individual and collective-level or procedural objectivity, and recent research on researcher epistemic prejudice in the sciences lead to new research questions.

So far, epistemic prejudice has primarily been considered as an attitude of single researchers that leads to distorted publications. It seems worthwhile to widen the question and to include the research practices preceding publication. To what extent can researcher prejudice affect the design of empirical investigations, i.e. lead to violations of methodological standards? And if this is the case, how well is peer review suited to identify biased research designs or biased reports of research in publications that are caused by researcher prejudice? After all, picking up such biases is one of the main purposes of peer review.

A second possible extension of the investigation of epistemic prejudice would include the level of scientific communities. Kuhn's (1962) account of normal science includes the possibility that allegiance to a paradigm may prejudice researchers against "anomalies", i.e. findings that do not fit that paradigm. More generally, one could ask if, under what conditions, and with what consequences a community's allegiance to the 'mainstream' of its research may turn into prejudice that excludes alternative approaches and reduces the epistemic diversity of its research. In a similar vein, other collective tendencies like fashions or scientific/intellectual movements (Frickel and Gross 2005) warrant an investigation of the conditions under which allegiance may turn into prejudice with its resulting biases.

Another collective-level phenomenon of epistemic independence concerns the cumulative effect of publications that cannot be trusted. If we consider the independence of scientific communities as the ability to maintain their knowledge production processes (and through these processes, collective-level objectivity of findings), this independence can be endangered if the increase of unreliable publications endangers a community's generalised trust in the usability of contributions. How do practices of acquiring others' research results change if this trust is lost, and how do communities respond to the perceived loss of independence of their epistemic judgments? This question has been already asked for the spread of secrecy of scientific findings (David 1998b) but must be extended to biased contributions in general. If trust in members' findings is lost, the current practice of integrating findings in one's own work cannot be upheld. For example, more research might be ignored, and the collective progress of communities slowed, because only publications from a few core journals are trusted.

Investigating conditions for and effects of individual and collective epistemic prejudice poses two major methodological challenges. The first challenge is measuring prejudice at all. It is the nature of prejudices in general, and epistemic prejudices in particular that they are not recognized as such by those who believe in them. Researchers are not aware of their epistemic prejudices and let them influence their actions without noticing. Dana and Loewenstein (2003) and Moore and Loewenstein (2004) summarise research according to which bias is more frequently the result of motivational

processes that are unintentional and unconscious. This challenge to measuring prejudice might be overcome by drawing on sociological methods of frame analysis and psychological research on implicit bias. In close connection with the problem of identifying prejudice, the identification of its effects, i.e. of spin and other biases in publications, is a challenge that requires the collaboration of the social sciences with the investigated scientific communities because only they can assess the content of their publications.

3.3 Questions connecting the two themes

At the intersection of the two perspectives developed in the preceding sections, two theoretical and political questions can be asked. First, the negotiation of social independence in heterogeneous actor constellations may affect the independence of epistemic judgments of researchers and their scientific communities (Figure 1). This raises the question as to how the independence of researchers and scientific communities relates to the objectivity of their judgements. More specifically, we can ask how the increase in competitions and their interactions and the alignment of funding with political and economic interests contribute to the proliferation of COIs and, through them, to the proliferation of unreliable published findings.

Changing conditions of research are linked to epistemic judgments of researchers and their communities by a very complex causal path. It includes changing authority structures in science and a changing competitive structure, which lead to changing research and publication practices. Together with traditional biases due to researcher allegiance, these changes cumulate in growing proportions of publications that communities perceive as biased or fraudulent. Responses by communities to this situation include new regulations prescribing the declaration of financial COIs, the publication of data, the registration of study aims and designs prior to an empirical investigation, and the sharing of data from which conclusions are drawn ('open science practices'). Since these rules are designed to influence researchers' behaviour, they raise a second question at the intersection of the two perspectives developed in the preceding sections. How do the new regulations reduce the independence of researchers by prescribing data sharing, cementing study designs in an early stage of research, or forcing researchers to declare how their research was funded? Possible unintended consequences of these restrictions for the independence of epistemic judgments await investigation. Can regulations lead to adverse effects because they reduce the flexibility and creativity of research, or make researchers avoid collaboration with industry?

Finally, the two themes of independence also meet in a topic that has scarcely been researched but is becoming increasingly important, namely the influence of religious, ideological or cultural contexts on the independence of research. This influence can be exercised by interest groups that communicate

expectations concerning research or by norms that apply to aspects of research (e.g. norms concerning human embryonic stem cells). It can also be realised by researcher allegiance, i.e. by researchers adhering to beliefs that are at conflict with the primary interest of extending reliable knowledge (Munder et al. 2013, Lieb et al. 2016, Smith and Blazeby 2018).

Some religious, ideological and cultural groups appear to strengthen their interest in research. The investigation of the consequences of this process, in a historically comparative perspective, has become an important topic for science studies.

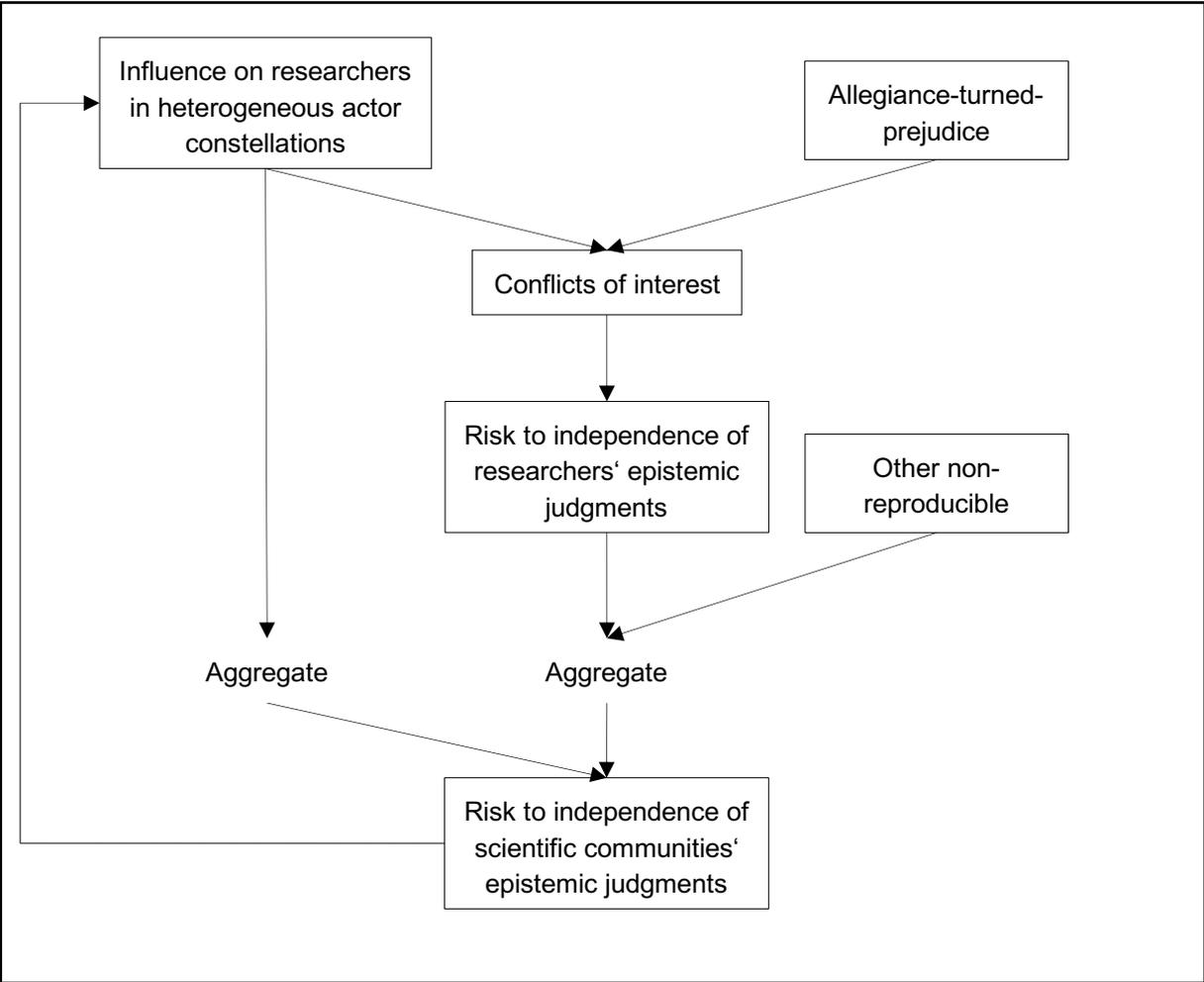


Figure 1: Link between influence in heterogeneous constellations of actors and independence of epistemic judgments on individual and community levels

Conclusions

From this review of disciplinary perspectives on conditions and effects of the independence of research and the identification of topics on which disciplinary perspectives converge four conclusions can be drawn. First, the independence of researchers, research organisations and scientific communities is an important intermediary for influences on research content. It constitutes an “obligatory point of passage” (Callon 1986) for influences on the content of research.

Secondly, the disciplinary perspectives share the methodological challenge of empirically determining the independence of actors in science and its epistemic effects. The ‘measurement’ of an actor’s (in)dependence from other actors in the science system, the (in)dependence of an actor’s or a scientific community’s epistemic judgments, or the effects of this independence on the research content is not yet well supported by methodologies of the disciplines engaging with the problem.

Thirdly, the independence of research has nevertheless proven its usefulness as a “boundary object” (Star and Griesemer 1989) for the collaboration of disciplines engaged with the subject. We demonstrated how the abstract concept of (in)dependence is specified for the purposes of different disciplines, and how it can support the collaboration of disciplines that all contribute important partial insights in the conditions and effects of the independence of research.

Finally, the value of our boundary object extends beyond the usual collaboration of disciplines in that it also supports the collaboration between scientific communities studying the independence of research and scientific communities experiencing threats to the independence of their research. Both partners can benefit from this collaboration. Scientific communities concerned about threats to the independence of their research can utilise systematic research on these threats, their effects, and effects of communities’ responses to perceived threats. Researchers studying independence can in turn benefit from support for their investigation of epistemic consequences of the (in)dependence of research.

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