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Accounting for field-specific research practices in surveys

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Introduction

Establishing macroscopic effects of macro-level phenomena in science or science policy requires identifying macro-level change and causally ascribing it to the phenomena in question. The standardised survey that obtains data about a sample of a larger population is one of the few instruments that can be used to observe macro-level change. However, the utility of standardised surveys in science studies is limited by an interesting constraint. Standardised surveys cannot capture the variation of research practices and of the epistemic conditions of action under which they occur.

Since research practices and epistemic conditions of action overlay, and most likely modify, most causal relationships in the sciences, social sciences and humanities, this constraint severely limits our ability to explain macroscopic change. It is difficult to overcome because the sociology of science has not yet produced a theoretically informed comparative framework from which abstract descriptions of practices and conditions can be derived and operationalised for standardised surveys. The only systematic comparative framework so far has been proposed by Whitley (2000 [1984]). However, the dimensions he proposes for the characterisation of scientific fields – functional interdependence and technical task uncertainty – do not sufficiently differentiate between research practices and are difficult to operationalise (Gläser et al. 2018).

Being aware of the causal importance of research practices and epistemic conditions of action but having nothing to draw on for their comparative description, scholars who conduct standardised surveys usually ask for the names of disciplines or fields respondents work in (e.g. Su 2013). This approach enables descriptive comparisons rather than causal analyses. For example, it is possible to observe that effects in physics are different from effects in chemistry. However, the difference between effects cannot be explained because this would require causally linking effects to properties of research practices in physics and chemistry.

Letting respondents self-assign to disciplines or fields also constrains statistical analyses because they are limited to higher levels of aggregation. While it is possible for respondents to self-assign to small and epistemically homogenous fields, this is likely to reduce the number of cases to levels that are too low to support statistical analyses. Thus, respondents would need to be re-aggregated to disciplines or sub-disciplines, which include too much variance of research practices. For example, the disciplines physics, chemistry, biology, and informatics all include theoretical fields that may be more similar to each other and to mathematics than to the experimental fields in their own discipline.

These problems could be overcome if research practices and epistemic conditions of actions could be described theoretically, and if these theoretical descriptions could be operationalised as standardised questions. A theoretical account would categorise research practices and research conditions across disciplines and fields according to theoretically relevant properties, which would also increase the numbers of cases for each type of field. It could link survey-based studies to theory and thus support explanations. The overall task, then, is to develop and to operationalise for standardised surveys a theoretically grounded comparative framework for research practices and epistemic conditions of action under which they occur. The aim of this paper is to offer a first step by reviewing epistemic conditions of action identified in qualitative studies, suggesting how they may affect causal relationships studied by surveys, and discussing opportunities to ask standardised questions about them.

Epistemic variables and their possible impact on causal relationships

Epistemic variables describe conditions of knowledge production that are shaped by the objects, methods, and knowledge researchers use (Gläser and Laudel 2015: 315-316). Although they do not constitute a mainstream research interest of science studies, epistemic conditions of action have been the subject of theoretical and empirical interest. Early discussions of properties of knowledge addressed the role of theory structures (Kaplan 1964: 298; Nagi and Corwin 1972, Rip 1982) or the degree of codification of knowledge (Zuckerman and Merton 1973 [1972]). The role of material properties of research has first been highlighted by Actor-Network-Theory (Latour and Woolgar 1986 [1979]; Callon, 1986). However, Whitley's (2000 [1984]) theoretical account and Knorr-Cetina's (1999) comparison have for a long time remained the only attempts to explore the variation of epistemic conditions of action. More recently, interest in epistemic variables as explanatory factors has grown (Gläser et al. 2010; Laudel and Gläser 2014; Whitley 2014; Gläser and Laudel 2015; Franssen et al. 2018).

Epistemic conditions of action are 'non-social' because the morphology and dynamics of materiality and knowledge cannot be sociologically explained. However, their impact on researchers' actions can be captured by identifying the social elements of situations and actions shaped by them (Gläser and Laudel 2015). In order to demonstrate the possible impact of epistemic conditions of action on causal relationships investigated by surveys, I list epistemic conditions of action identified in previous studies, the intervening variables mediating the formers' impact on researchers' actions, and possible modifications of causal relationships (Table 1). For the discussion of causal relationships, I assume two common purposes of surveys, namely studies of the impact of governance instruments on research and studies of academic careers.

Interactions between some of the epistemic conditions of action listed in Table 1 have been observed (Gläser et al. 2010) but cannot be discussed here due to space limitations. Ideally, I would also show how findings by surveys depend on these epistemic variables but this is impossible due to the situation described in the introduction. Since surveys collect data across fields with varying epistemic conditions of action, the latter constitute unobserved heterogeneity.

The resource intensity of research – the amount and kind of equipment, material, and infrastructure necessary to produce a contribution – affects careers and the impact of governance on research because it creates specific dependencies on funding in general and on project funding in particular. For example, the sensitivity of resource-intensive research to performance-based funding is low at German universities because the project grants researchers need are at least an order of magnitude larger than the sums allocated by universities (Gläser and von Stuckrad 2013). The dependence on grant cycles (and the latter's rigidity) may affect opportunities to implement long-term research plans, i.e. the cognitive career of researchers, as ERC grantees' discussion of alternatives to their ERC grants (Laudel and Gläser 2014) and problems of early career researchers who intended to set up experiments for Bose-Einstein condensation indicate (Laudel et al. 2014b).

Table 1. Epistemic conditions of action, intervening variables and their possible influence on causal relationships studied by surveys

Epistemic conditions of action	**Intervening variables**	**Possible modifications of causal relationships**
Resource intensity	Dependence on project funding	Sensitivity to performance-based funding, sensitivity to the split between recurrent and project-based funding, opportunities to implement long-term research plans
Dynamics of theoretical and methodological knowledge	Devaluation of knowledge	(International) mobility of postdoctoral researchers
Degree of codification of knowledge, Role of personal perspectives in decisions on problems and approaches	Mutual dependence of researchers, degree of competition	Dependency on priorities of scientific communities, dependence on peer review
Decomposability of research processes	Specialisation, division of labour, collaboration, number of parallel projects	Opportunities to respond to pressure by switching between projects, dependence of performance on group size and group structures
Typical duration of research processes	Fit of research processes and funding or evaluation cycles	Selection of positions, uptake of long-term projects

The dynamics of theoretical and methodological knowledge affects the rate at which knowledge researchers hold becomes devaluated, and thus the necessary rate of acquiring new knowledge. In the case of methodological knowledge, this has specific consequences for organisational mobility (Laudel and Bielick 2018). This is why postdoctoral mobility has a specific function for the accumulation and diffusion of knowledge in some fields.

The degree of codification of knowledge "…refers to the consolidation of empirical knowledge into succinct and interdependent theoretical formulations" (Zuckerman and Merton 1973 [1972]: 507; see also Cole 1983). This variable captures two aspects, namely the extent to which a field's theories have clear structures and the degree of standardization of the field's language. The role of personal interpretation in problem formulation and construction of empirical evidence describes the extent to which the formulation of problems and the construction of empirical evidence are guided by the community's knowledge and standards (i.e. the 'interpretive flexibility' of this knowledge) versus the researcher's ideas. The two properties seem inversely related but there is some counter-evidence concerning the importance of personal interpretation in approaches to (extremely codified) mathematical proofs (MacKenzie 1999), which is why the clarification of this relationship requires further research.

Both variables affect the mutual dependence of researchers and the degree to which they compete with each other because a higher degree of codification respectively low role of personal interpretation makes researchers formulate similar problems, which in turn means that contributions are highly relevant for others and that researchers compete for priority (Gläser et al. 2018). These dependence and competitive relationships influence researchers' dependence on priorities of their scientific communities, and on the peer reviews through which priorities are established. The former property affects the extent to which governance measures that deviate from community priorities are likely to affect the directions of research (Gläser forthcoming). The dependence on peer reviews affects opportunities to advance an academic career by conducting non-mainstream research.

The decomposability of research processes – the extent to which a research process can be broken down into separate operations – affects the social structure of the ways in which contributions are produced. It is the basis on which specialisation in parts of the research process (e.g. preparing objects, measurement, data analysis) is possible, which in turn makes possible a division of labour and collaborations based on that division. Research groups and networks are likely to become producers of contributions if specialisation and division of labour are advantageous. If research processes can be decomposed, it also becomes easier for researchers to conduct several projects in parallel. These structural variables affect the number of projects worked on in parallel as well as the dependence of research performance on group size and group structures. The higher number of parallel projects enabled by high decomposability provides researchers with more flexibility when responding to governance changes (Gläser and Laudel 2007; Gläser et al. 2010), and enables 'patchwork strategies' for early career researchers who want to develop scientific innovations (Laudel et al. 2014a).

The typical duration of research processes is partly due to characteristics of research objects (e.g. growth and reproduction dynamics of organisms) and the uncertainties in research processes (e.g. the necessity of longer phases of trial-and-error searches). It creates particular matches and mismatches of research processes and funding or evaluation cycles because publishable findings might not be available when needed for applications. Postdocs might choose positions according to the likelihood of experiments yielding publications during their stay (Laudel et al. 2018), and long-term projects might not be taken up because contributions cannot be produced within required time frames (Laudel and Gläser 2014).

How can epistemic conditions of actions be measured?

The epistemic conditions of action whose relevance was argued in the preceding section are not easily identified with standardized questions. The crucial problem is that researchers do not think about their research process in terms of these epistemic conditions of actions. The sociology of science generalizes properties of research in a context that is different from the abstractions used by scientists. In order to obtain reliable information, questions that are close to the everyday experience of researchers need to be used. Table 2 provides first suggestions. The suggested questions are not yet suitable for standardized surveys. However, they provide examples of questions that are linked to the everyday experience of researchers and thus in all likelihood can be meaningfully answered.

Developing standardized questions from these first considerations requires an experimental approach. Standardized questions in 'test surveys' need to be combined with interviews and possibly bibliometric analyses in order to establish

- how respondents understand the questions,
- which perceptions of respondents' research are included in answers, and
- how accurate these perceptions reflect the epistemic properties of interest.

Table 2. Questions about epistemic conditions or intervening variables

Variables	Possible questions
Resource intensity	Which resources do you need if you begin a typical new research project? - Funding for personnel - Funding for dedicated equipment - Funding for research materials or consumables - Funding for buying data - Funding for buying research services
Dependence on project funding	Who does usually supply this funding?
Dynamics of methodological knowledge	How frequently are new methods developed in your field that are relevant for your research? - new relevant methods are developed each year or even more frequently, - it takes several years before new methods are proposed, - methods are improved but new methods are rarely developed.
Degree of codification of knowledge, Role of personal perspectives in decisions on problems and approaches	To what extent do researchers in your field agree on the meaning of the concepts used to describe - empirical phenomena, - approaches to theoretical or empirical research, and - theories? When you formulate a research problem How likely is it that somebody else formulates the same problem, and produces a result that anticipates yours?
Decomposability of research	Can a typical research project of yours be broken down into separate steps that could be conducted by different researchers?
number of parallel projects	To how many projects do you currently contribute a) ideas b) empirical work (producing empirical objects, collecting data, analysing data) c) conceptual work (including designing empirical investigations or experiments, calculations, modelling and simulation, developing arguments, interpreting data)
Specialisation, division of labour	To what extent do researchers in your field specialise in specific contributions to research projects (e.g. producing empirical objects, measurement, data analysis)? Is it feasible for one researcher to have all these skills, or do researchers specialise and combine their expertise?
Typical duration	How long does it usually take from the beginning of a research project to the publication of its major results?

Conclusions

Researchers who employ surveys to study science ignore the field-specificity of causal relationships, limit their surveys to one (large) field, or use field names (self-descriptions of fields). Neither approach enables the inclusion of field-specific research practices in theoretical accounts of causal relationships in science.

With this paper, I suggest to build a theoretical account of relevant properties of fields and research processes that can be operationalized for standardized surveys. Quite obviously, this is just a first attempt that might be completely overthrown by later developments. However, in order to utilize the potential of survey research for theory development in science studies, we need to begin somewhere.

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