
1. Rigorous sociology*

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1. INTRODUCTION

Sociology today manifests itself in textbooks, journals, departments, conferences, and professional associations in two different ways. First, like other social science disciplines, sociology covers a broad and diverse range of research problems, research topics, and research fields. This indicates that sociology is thriving. Second, sociology is fragmented. It comprises a multitude of ‘approaches’ that do not share a common core of basic methodological standards for theoretical and empirical work. This is a worrisome feature and is less common in several other social science disciplines. Without a common core across approaches, theoretical and empirical work is hard to evaluate and to compare, and cumulative growth of knowledge is impeded. Yet, this fragmentation is sometimes euphemistically welcomed within the discipline, using labels such as ‘multi-paradigmatic’ (see Goldthorpe 2007, Chapter 1 and Hedström 2005, Chapter 1 for critical discussion of multi-paradigmatic fragmentation).

Multi-paradigmatic fragmentation must be distinguished from pluralism. Growth of knowledge and scientific progress benefit from pluralism in the sense of alternative and competing theories – ‘theoretical pluralism’ (Popper 1972, Chapters 6 and 8; Lakatos 1970). Growth of knowledge and scientific progress also benefit from ‘empirical pluralism’, that is, from alternative and complementary research designs and methods of data collection, from complementary data, and from alternative and complementary methods of data analysis (on ‘empirical pluralism’ in this sense, see Buskens & Raub 2013; Jackson & Cox 2013; see also related work on ‘causal explanation’ in the social sciences by Cox 1992 and Goldthorpe 2007, Chapter 9). Benefits from theoretical and empirical pluralism, however, do require a shared core of basic methodological standards, such that progress as well as dead ends can be identified and cumulative growth of knowledge becomes viable. After all, shared standards help identifying similar or, rather, competing theoretical claims. Shared standards are likewise needed to assess empirical claims. These include claims with respect to empirical regularities that in turn become *explananda* and claims concerning the results of hypotheses testing. Thus, shared standards ensure that critical discussion of competing claims and comparative assessments of such claims are feasible. Moreover, shared standards are a precondition for creativity. ‘Creativity’ does not mean ‘anything goes’. Rather, creativity in science flourishes in a cognitive and social context that encourages innovations and allows us to

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assess whether and how such innovations complement, improve on, or replace existing knowledge.

There are numerous research programs and ongoing developments in sociology – in theory, methods, and statistical modeling – that do share methodological standards. The *Handbook* focuses on these research programs and developments as well as on their common core. The *Handbook* reflects ‘unity in diversity’: while addressing different research problems and topics, and thus covering different research fields, these research programs and developments share guidelines, including basic methodological standards, for theory construction and empirical research in sociology.¹ The *Handbook* explicitly employs an *integrative perspective*, emphasizing the common core for variants of rigorous sociology that contribute to sociological science. A common core does not imply that critical discussion and controversy is or should be avoided. On the contrary, there is continuous critical discussion and controversy in rigorous sociology, as will become clear in this introduction and in the chapters of the *Handbook*. It is precisely a common core of shared criteria that makes it possible to evaluate controversial claims. In the end, a common core is what allows for communication and furthering cumulation of knowledge.

Importantly, we do not use ‘rigorous sociology’ as a label for yet another new approach. In line with our integrative perspective, we use it as an umbrella label for a family of research programs and ongoing developments in sociological science.² As Goldthorpe put it, our

main concern is not to propose to sociologists how they should conceive of and practice their subject. It is rather to suggest a way in which a fuller and more explicit rationale than has hitherto been available might be provided *for what a large and steadily growing number of sociologists in fact already do* – although, perhaps, without a great deal of reflection on the matter. (Goldthorpe 2016, p. 2, emphasis in original)

Rigorous sociology often focuses on interactions, and the macro-consequences of interactions, of actors who do not act ‘mindlessly’. Actions may depend in various ways on actors’ ‘definition of the situation’ and on what they expect other actors will do. This is similar to Weber’s (1947, p. 88) definition of social action: ‘Action is social in so far as, by virtue of the subjective meaning attached to it by the acting individual (or individuals), it takes account of the behaviour of others and is thereby oriented in its course’. Actors can also react to results of sociological research when these results become public knowledge. Such processes might lead to either self-destroying or self-fulfilling predictions. While this is different from typical situations in other sciences (somewhat related to

¹ We use ‘research programs and developments’ deliberately in a loose sense. For the purposes of this introduction, it does not seem necessary to distinguish systematically between, say, ‘research programs’, ‘paradigms’, ‘approaches’, ‘schools’, ‘traditions’, or ‘intellectual movements’. Likewise, it does not seem necessary for our purposes to decide which of these notions is best suited to characterize, say, ‘sociology as a population science’, ‘analytical sociology’, or ‘rational choice sociology’ from a philosophy of science perspective.

² We hope that ‘rigorous sociology’ turns out to be useful, if somewhat provocative, as an integrative label. We would be happy to employ a different one, should we become aware of a more useful alternative. In any case, what is needed is a label that is *different* from those commonly used for referring to various research programs and ongoing developments such as those covered in this *Handbook*, precisely because of our integrative perspective and the need for an umbrella label. It should be clear, however, that ‘rigorous’ is meant as *rigor without mortis*.

Weber's examples in this context: tomorrow's weather does not react upon today's weather forecast), it does not imply that common standards of scientific rigor or criteria for evaluating theoretical and empirical claims become inapplicable (see Voss' chapter on roots of sociology as a science in this *Handbook*).

Why this *Handbook*? Our reasons are two-fold. First, rigorous sociology comprises different strands and is pursued in very diverse research fields of sociological science. What these strands and fields have in common seems not always evident. Making the common core explicit may therefore be informative and may facilitate more critical exchange and collaboration. Second, while highlighting established variants of rigorous sociology, the *Handbook* additionally aims at drawing attention to burgeoning new and more recent developments such as computational approaches (the chapter by Flache, Mäs & Keijzer), work on the intersection of sociology and the life sciences (the chapters by Hopcroft, Dippong, Liu & Kail on evolution, biology, and society and by Mills on sociogenomics), stochastic network modeling (the chapter by Steglich & Snijders), contributions to the analysis of societal problems such as the climate crisis (the chapter by Wiertz & De Graaf), and on furthering open science practices in sociology (see the chapter by Auspurg & Brüderl on reproducibility and credibility). In these regards, the overall goal of the *Handbook* is to contribute to progress in the discipline in a cognitive sense. Moreover, it aims to contribute to the discipline's institutional context, for instance, as a resource for teaching and training of graduate students. This is in line with Merton's (1973) argument that social conditions affect how science develops and makes progress.

For whom is the *Handbook* intended? Its chapters are conceived for readers, including graduate students, with a background in rigorous sociology and interested in the state of the art in some strand or field that is not their 'home turf'. In addition, the *Handbook* includes chapters on topics that some might not associate with rigorous sociology, while the association is in fact a close one. The chapters on cultural capital, on historical sociology, and on ethnography, exemplify such topics. These chapters could be interesting for readers with less affinity with rigorous sociology but willing to explore what it offers.

Chapters in this *Handbook* document progress and cumulative growth of knowledge in rigorous sociology. Often, depending on the specific focus of chapters, they are either more on progress with respect to theory formation (see chapters in Part I as well as the chapters on networks in Parts II and III) or on progress with respect to research designs and statistical modeling (see chapters in Part III) or on progress with respect to empirical knowledge in a specific research field (see chapters on specific research fields in Part II). In addition, Part IV of the *Handbook* presents paradigmatic examples of outstanding earlier pieces of research in rigorous sociology, together with contributions on how these paradigmatic examples affected research agendas and subsequent research in their respective fields. The chapters in Part IV are particularly suited to showing how cumulative growth of knowledge can be and has been realized in rigorous sociology, including progress concerning theory formation *as well as* research designs, statistical modeling, *and* empirical knowledge.³

³ Goldthorpe (2005) is an instructive 'case study' of progress in research on social mobility. He considers advances in data coverage and data quality, research designs, statistical modeling, and the 'stock' of established empirical regularities as well as advances in the development of explanations. Importantly, a limited and thus focused set of research problems is studied and refined in a stepwise fashion, allowing for new research to

In what follows, we discuss some features of rigorous sociology in more detail. Our sketch does not aim at providing a set of features that are jointly necessary and sufficient for characterizing rigorous sociology. We are also reluctant to argue that some subset of these features should be conceived as ‘minimal requirements’, while other features should be seen as ‘add-ons’. Our claim is more modest. Again consistent with our integrative perspective, it seems more useful to assume ‘family resemblance’ (see Stegmüller 1973, pp. 195–198 for a careful discussion of Wittgenstein’s concept) with respect to various strands of rigorous sociology. Rather than sharing a unique set of core features, different strands share some, but not all of these features, and they may differ in their emphasis on specific features.

2. SOME FEATURES OF RIGOROUS SOCIOLOGY

Without suggesting ‘watertight’ distinctions, we roughly distinguish three categories of features. First, there are those more related to theory construction. Others are more related to empirical work and to the intersection of theoretical and empirical work, including methods of research in a broadly conceived sense. Still other features concern applications of sociological knowledge in contributions to policy making related to societal problems.

2.1 Theory Construction

Conceiving of sociology as a problem- and theory-guided discipline is a basic feature of rigorous sociology. Sociology in this sense is a discipline in the spirit of philosophy of science à la Popper (1934, 1963) and Lakatos (1970) as well as of analytical philosophy of science, broadly conceived (for example, Hedström 2009). Consequently, theory construction aims to explain social phenomena, specifically macro-level phenomena and macro-level regularities. Regarding theory construction, competing explanations and theoretical pluralism contribute to the growth of knowledge. With respect to basic methodological principles, sociology does not differ from other sciences (see the chapters by Jackson on sociology as a population science and by Voss). Of course, this does not imply *per se* that sociology could or should be conceived as a science much like physics. It could well be that, from a philosophy of science perspective, natural sciences such as biology, chemistry, or meteorology bear more resemblance to theory construction in sociology (Lieberson & Lynn 2002 discuss these issues).

2.1.1 Explanations

Explanations involve deductive arguments or variants of such arguments. Therefore, theory construction involves more than specifying sets of hypotheses. Rather, theory construction involves specifying assumptions, including but not limited to hypotheses, as well as specifying implications of these assumptions. Assumptions need to be logically

improve on previous research. Goldthorpe (2005, pp. 70–73), following Merton (1973), likewise underlines the role of social organization in facilitating scientific progress, such as collaboration between researchers and collaboration within and between institutions, including the specific norms governing collaboration.

consistent and they must have empirical implications to preserve testability. For such theory construction, conceptual clarity and analytical rigor are important ingredients. This point has been made in different strands of rigorous sociology. Prominent examples include Coleman's (1964, Chapters 1.4 and 18) 'synthetic theories', work in 'structural individualism' by Hummell (1973) and Ziegler (1972) on the need for and advantages of formalization in sociology (see Raub 2021 for an overview of this work and Lindenberg 1992 on the 'method of decreasing abstraction'), work in analytical sociology (for example, various chapters in Hedström & Bearman 2009a; Manzo 2014b) as well as other work in mathematical sociology (for an overview: Edling 2002).

Chapters in this *Handbook* provide examples of the use of a variety of formal models in theory construction. These include agent-based models (chapters by Flache, Mäs & Keijzer and by Manzo on analytical sociology), more formal versions of rational choice theory, including game-theoretic models (chapters by Diekmann, by Buskens, Corten & Raub on social networks, and the showcase chapter by Breen & Goldthorpe), as well as stochastic network models (chapter by Steglich & Snijders). Specifying an explanation in terms of a formal theoretical model, or at least formalizing some assumptions employed in an explanation, often supports theory construction. For example, it can help or even be a prerequisite for identifying the implications of an *explanans*, including implications that can be tested empirically. Therefore, formal modeling can help checking whether an *explanandum* does indeed follow from an *explanans*. It can facilitate checking how robust implications are to modifying certain assumptions and can thus help finding those assumptions that are key for specific implications. However, formal model building is not an end in itself. When the logical consistency and empirical implications, including empirically testable implications, of verbally formulated assumptions are clear, formal model building is not needed. Parts I and II of this *Handbook* offer examples of informal, yet clearly specified theory (such as chapters by Jaspers, Van der Lippe & Evertsson on division of household labor, by Ermakoff on historical sociology, and by Varese on ethnography).

2.1.2 Micro-macro links

Rigorous sociology is often, though not always, about micro-macro links and thus follows principles of methodological individualism (see the chapter by Voss): it attempts to explain phenomena at the level of social systems as well as at the level of individual behavior (see the chapters by Jackson, by Manzo, by Flache, Mäs & Keijzer, and by Diekmann). Here, 'macro' refers not only to large-scale systems at the level of whole societies but likewise to smaller scale systems such as a family, a group, an organization, or a market. 'Macro' also relates to 'populations' in the sense of Goldthorpe's (2016) 'sociology as a population science'. 'Micro' refers to the actors making up the systems. These are typically individuals, but depending on the application and on simplifying assumptions deemed acceptable, the micro-level may also include 'corporate actors', such as firms as actors on markets (Coleman 1990a). In some studies, these corporate actors are considered part of a 'meso-level' (for an example, see the chapter by Wiertz & De Graaf).

A widely known and meanwhile popular diagram depicting the 'logic' of micro-macro sociological explanations is Coleman's 'boat' (for example, Coleman 1986, 1990a, Chapter 1). The chapters by Steglich & Snijders and by Buskens, Corten & Raub offer

detailed examples of how to ‘reconstruct’ work on social networks in terms of Coleman’s diagram. His diagram is a useful heuristic device that draws attention to key features of theoretical models involving micro-macro links, but it is not in itself a fully-fledged theoretical model. Therefore, the diagram as such and methodological individualism more generally should not be confounded with Coleman’s theoretical work and his program of employing rational choice assumptions as a theoretical core for sociology.⁴

In terms of theory construction, the basic idea is that macro-outcomes and established empirical macro-level regularities are the core *explananda* of sociology. A core idea is that macro-level relationships *as such* tell little about *why* we observe macro-level outcomes or about micro-level processes that bring about macro-level outcomes and macro-level relationships (for example, Hedström & Bearman 2009b). Explanations of macro-outcomes and macro-level regularities comprise different kinds of assumptions. First, there are assumptions on macro-conditions as well as assumptions on macro-to-micro links. These assumptions specify how macro-conditions affect micro-conditions for individual behavior. Adding assumptions on micro-conditions together with assumptions on micro-level regularities that specify how micro-level outcomes depend on micro-conditions, implications for micro-outcomes can be derived. Concerning micro-level behavioral regularities, Coleman advocated using assumptions on rational choice. However, micro-macro explanations and methodological individualism do not presuppose employing assumptions on rational choice. In fact, methodological individualism comes in rather different flavors (Udehn 2001) and quite some other assumptions on micro-level behavioral regularities are often used in micro-macro models in sociology (Raub 2021). Finally, assumptions on micro-to-macro links are needed on how actors’ behavior generates macro-outcomes.⁵ Then, *explananda* at the macro-level follow from an *explanans* that includes assumptions on macro- and micro-conditions, on micro-level regularities, and on macro-to-micro as well as on micro-to-macro links. Micro-macro explanations along these lines resemble Merton’s (1968) middle range theories. Also, such explanations are quite consistent with Durkheim’s (1895, p. 109) rule of including assumptions on macro-conditions in explanations of macro-outcomes (in his terminology: ‘*faits sociaux*’).

Analytical sociology, one of the strands of rigorous sociology (see Manzo’s chapter), advocates ‘mechanism-based’ explanations (Hedström 2005). What is meant by ‘social mechanisms’ can be clarified by explicitly linking assumptions on mechanisms to different kinds of assumptions in explanations comprising micro-macro links in line with Coleman’s diagram (Hedström & Swedberg 1998, pp. 21–23). One can then distinguish assumptions on mechanisms concerning macro-to-micro links from assumptions on mechanisms concerning micro-level behavioral regularities and from assumptions on mechanisms concerning micro-to-macro links.

Work in rigorous sociology that uses micro-macro models often focuses on how macro-level outcomes and macro-level regularities result from interaction and interdependence between actors (see the chapters by Manzo, by Flache, Mäs & Keijzer, by

⁴ Note that Coleman’s boat is a variant of earlier diagrams (see Raub & Voss 2017 for details). More recently, further modifications of the diagram have been suggested (for example, Hedström & Bearman 2009b; Ylikoski 2021).

⁵ We distinguish between ‘macro-to-micro links’ and ‘micro-to-macro links’. We use ‘micro-macro links’ when we refer generically to both ‘macro-to-micro’ and ‘micro-to-macro links’, thus avoiding even more cumbersome terminology such as ‘macro-micro-macro links’.

Buskens, Corten & Raub, by Steglich & Snijders, the showcase chapters by Salganik et al. and by Van de Rijt, and the chapter by Wiertz & De Graaf). This is also often work that highlights macro-consequences of micro-level behavior that are unintended and unanticipated by the actors and sometimes at first sight are also counter-intuitive from an external observer's standpoint (see Merton 1936 for early work as well as Merton 1968, Chapters III, XIII; Boudon 1977).

2.1.3 Insights from other disciplines and from classical sociology

Theory construction in rigorous sociology has an interdisciplinary flavor by employing and adapting insights from other disciplines. Research fields, topics, and specific research problems studied in rigorous sociology often overlap with those in other social science disciplines. In addition, there are more specific features of theory construction in rigorous sociology that make exchange with other disciplines attractive. One such feature concerns explanations that relate macro- and micro-levels of analysis. In this respect, theoretical work in rigorous sociology (see various chapters of Part I of this *Handbook*) confronts research problems and employs tools for addressing those problems that are similar to theoretical work in, say, economics and political science. Since explanations involve assumptions on micro-level regularities of behavior, insights from (social) psychology are useful for theory construction in rigorous sociology. Formal models employed in theory construction in rigorous sociology have often been adapted from disciplines such as applied mathematics or economics where they have originally been developed. In addition, rigorous sociology has an interdisciplinary character when it concerns ethnographic research (see Varese's chapter) and when it considers historical events and developments (see Ermakoff's chapter). More recently, rigorous sociology also includes research that integrates insights from sociology and biology as well as genetics (see the chapters by Hopcroft, Dippong, Liu & Kail and by Mills).

It should be added that theory construction in rigorous sociology must be distinguished from history of ideas. Quite in line with Merton's arguments (1968, Chapter I), rigorous sociology adopts a focus on the 'systematics' rather than on the 'history' of sociological theory. Still, rigorous sociology aims at systematic reconstruction of explanations provided in classical sociology and at showing how new theory construction develops from and can build on classical work. For example, Boudon (1979a) and Esser (1993a, 1993b, 1999–2001) have provided a variety of such reconstructions.

2.1.4 Theory construction: issues and controversies

As chapters of this *Handbook* show, variants of rigorous sociology often differ by focusing on distinct 'elements' of micro-macro explanations, while taking other elements more or less for granted. For example, 'sociology as a population science' (Goldthorpe 2016; Jackson's chapter) emphasizes firmly the establishment of replicable and reliable empirical regularities at the macro-level, but invests less in further developing assumptions on micro-level regularities of behavior. Programmatically, 'analytical sociology' (Hedström 2005, Hedström & Bearman 2009a, and the chapters by Manzo as well as by Flache, Mäs & Keijzer) focuses on agent-based models that 'generate' *specific* macro-level regularities, rather than on using the *same* micro-level assumptions for deriving implications for *different* macro-level regularities. Conversely, 'rational choice sociology' (Coleman 1990a; see Diekmann's chapter) emphasizes the use of basically the *same*

micro-level assumptions on behavioral regularities for deriving implications on a broad range of different macro-phenomena. These micro-level assumptions are the standard axioms for rational behavior under certainty, risk, and uncertainty and the implications on utility maximization that follow from such axioms, as well as assumptions on game-theoretic equilibrium behavior (for a classic exposition, see Harsanyi 1977). Using the same micro-level assumptions is seen as allowing for a common theoretical core of explanations that facilitates cumulative growth of knowledge (for example, Diekmann & Voss 2004, p. 20). Conversely, a common core of assumptions employed in competing explanations for the same macro-outcomes or -regularities will facilitate comparison of these explanations. Such a core facilitates the design of empirical tests that can help discriminating between competing explanations.

These differences between variants of rigorous sociology can go well with common methodological standards and with the features of theory construction outlined above. However, they also induce discussion and at times controversy on the pros and cons of the variants. To illustrate, we briefly refer to three examples of ongoing discussions.

The first example concerns the assumptions on micro-to-macro links in explanations. Coleman (1987) argued that adequately accounting for macro-effects in micro-macro models often hinges on careful specification of assumptions on micro-to-macro links. This is especially important when macro-effects are the result of interaction and interdependence between actors. Coleman maintained that sociological explanations are often deficient when it comes to specifying these, often non-trivial, assumptions. This is also claimed in programmatic work of analytical sociology (Hedström 2005; see Manzo's chapter) and much programmatic work on agent-based models (see the chapter by Flache, Mäs & Keijzer). Conversely, in his work on sociology as a population science, Goldthorpe (for example, 2021, Chapters 9 and 10) has expressed doubts on whether a strong focus on assumptions on micro-to-macro links can contribute to improve explanations of well-established macro-level empirical regularities. Seemingly, Goldthorpe assumes that in at least certain fields of rigorous sociology such as research on social mobility and in the sociology of education, the assumptions on micro-to-macro links are typically less complex and problematic than Coleman supposed.

Second, there is controversy in rigorous sociology on micro-level assumptions on behavioral regularities. Diekmann's chapter shows that quite different versions of rational choice assumptions are employed in rigorous sociology, with discussion concerning these versions. Goldthorpe, for example, argues for employing assumptions on bounded rationality as well as on 'subjectively rational' and, hence, 'intelligible' action. He maintains that such assumptions differ from assumptions on 'objectively maximizing behavior' that he sees as micro-level assumptions typically employed in economic theory (Goldthorpe 2007, Chapters 6–8; 2021, Chapters 9 and 10). Opp (for example, 2013a, b) has suggested a 'wide version' of rational choice theory. This version combines assumptions on maximizing behavior with assumptions on preferences that might not be purely self-regarding and also allows for subjectively perceived, rather than objectively given, opportunities and constraints. In addition, various alternatives for rational choice assumptions are used as assumptions on micro-level regularities of behavior in rigorous sociology. Quite some work in analytical sociology as well as work employing agent-based modeling relies on assumptions from learning models and assumptions on myopic or otherwise adaptive behavior (see the chapters by Manzo and by Flache,

Mäs & Keijzer as well as the chapter by Steglich & Snijders). In this way, rational choice assumptions on ‘forward-looking’ behavior are avoided, although the question arises if and when learning and adaptive processes, over time, lead to behavior that resembles behavior according to rational choice assumptions. Still other alternatives include prospect theory (Kahneman & Tversky 1979), dual process- and two selves-models (for example, Kahneman 2011), and variants of such models that have been developed by sociologists, such as Esser’s model of frame-selection (Esser & Kroneberg 2015) and Lindenberg’s (2001) theory of social rationality.⁶

Third, there is a discussion on an issue related to employing rational choice assumptions (for example, Goldthorpe 2007, Chapter 6), while the issue is in principle also relevant for alternative assumptions on behavioral regularities (see Jackson’s chapter). Namely, such assumptions might represent ‘central tendencies’. Individual behavior might often deviate from that tendency. However, when it comes to macro-implications of the behavior of multiple actors, these deviations may cancel each other out and the macro-implications may resemble those that would have resulted, had there been no deviations at all. Of course, such arguments have to be used with care and will not always apply. Certainly for contexts with interdependencies between actors, idiosyncratic deviations from a central tendency often do not cancel out (see Raub et al. 2011, pp. 15–16 and Mäs 2021 for further discussion and references).

2.2 Empirical Research, Methods, and the Intersection of Empirical with Theoretical Research

A basic feature of rigorous sociology is implications from theory that are *testable*: empirical content in the sense of testability, at least ‘in principle’, is a criterion for appraising sociological theories (see McIntyre 2019 on the ‘scientific attitude’ in addition to accounts such as Popper 1934, 1963 and Lakatos 1970). In addition to testability as such, at least some testable implications should be tested, as the outcomes of actual tests do affect the appraisal of theories. Empirical corroboration presupposes that theory stands up to severe tests. This requires tests of implications that are new in the sense that they did not belong to those *explananda* the theory was designed to explain in the first place. Empirical corroboration therefore requires, among other things, that explanations for well-established macro-level empirical regularities should likewise imply *new* implications for regularities not yet established. It is a well-known topic, also from philosophy of science, that generating testable predictions from theory and drawing conclusions from empirical work on whether or not predictions are supported requires additional and often non-trivial assumptions on data and their measurement. This already suggests that a key aim of rigorous sociology is linking theory construction with empirical research and statistical modeling. Work in this direction includes the development of statistical models that integrate core assumptions on behavioral regularities into the statistical model itself. Random utility theory (McFadden 1973) is an example, along with stochastic network models like those outlined in the chapter by Steglich & Snijders. Another approach is related to Boudon’s (1979b) notion of ‘generating models’. Here, one aims at specifying

⁶ Bruch & Feinberg (2017) review work in the field of judgment and decision-making on assumptions on behavioral regularities that can be employed in micro-macro explanations.

assumptions of a formal model, possibly in the form of an agent-based model, that imply statistical regularities. Empirical data are then used to estimate relevant unknown parameters of the model (for example, Hedström 2005, Chapters 5 and 6; Manzo 2022 for extensive coverage and related earlier work such as Coleman 1981 and Cox 1992; see also the chapters by Manzo and by Steglich & Snijders).

Rigorous sociology comprises a broad variety of empirical research strategies and methods, varying from observational to experimental designs, as well as qualitative designs (see the chapters by Breen on causal inference and by Gangl on longitudinal designs, by Gërxhani & Miller on experimental sociology, and by Varese and by Ermakoff on qualitative designs). Here again, different strands of rigorous sociology differ with respect to emphasis on employing certain designs. For example, sociology as a population science seems to focus in particular on surveys and observational designs, including features such as standardized data storage. Research employing rational choice assumptions and to some degree also analytical sociology tend to more systematically employ experiments, both in the laboratory and in the field, in addition to observational designs. Still less common, but perhaps promising as a variant of ‘conceptual replications’, is the use of alternative and complementary designs for testing the same hypotheses (see Buskens & Raub 2013; Jackson & Cox 2013; see also the chapter by Gërxhani & Miller).

Research can include both ‘quantitative’ and ‘qualitative’ variants of theoretical and empirical work (on ‘qualitative’ work, see, for example, Brady & Collier 2010; King et al. 1994; Lieberman & Horwich 2008 and the chapters by Varese and by Ermakoff). The point is often made that qualitative work can be useful in the ‘context of discovery’ for suggesting new findings and regularities and also for suggesting new theoretical insights. However, it stands to reason that qualitative work can also contribute to linking theory and empirical evidence in the ‘context of justification’. Consider a study like Gambetta’s (1993) on the Sicilian mafia, as well as related work in the wake of Gambetta’s on mafia-like organizations in other countries. One could argue, somewhat in line with Lieberman & Horwich’s (2008) ‘implication analysis’ (see Stinchcombe 1968, Chapter 2.I for similar arguments), that Gambetta’s empirics are indeed relevant for the context of justification. This is not so because of a futile effort to infer support for theory from a single or very few observations. Rather, his empirics are relevant for the context of justification because he generates from the same set of theoretical assumptions a series of implications for rather different phenomena in various contexts related to activities of the mafia. He then shows that these implications broadly correspond to what empirical work in those contexts reveals.

Empirical research is valuable not only with an eye on testing theory, it also contributes to the growth of descriptive knowledge about the social world. Goldthorpe has frequently argued that it is crucial for the discipline to offer accurate and reliable answers to descriptive questions to begin with. In fact, this was a key feature of his programmatic 1996 paper in the *European Sociological Review* (reprinted in Goldthorpe 2007, Chapter 6) on a sociological alliance between the quantitative analysis of large-scale data sets and rational action theory. Typically, empirical regularities are relevant *explananda* for theory development. With regard to such *explananda*, it is useful to distinguish two aspects (see Goldthorpe 2016, pp. 12–16). First, sociology is typically concerned with regularities on the macro-level rather than (exclusively) on the micro-level, even though macro-level regularities are brought about through micro-level behavior. Second, establishing macro-level regularities through careful empirical research is specifically

important when these regularities are not obvious but become evident only when appropriate and often complex data become available and proper statistical modeling is employed (see Jackson's chapter). The focus on large-scale surveys rather than, for example, experimental designs in sociology as a population science seems to be related to the aim of descriptively establishing population-level regularities, certainly against the background of research on social mobility, educational opportunities and inequalities as core domains of this approach. Providing explanations for such regularities can then be seen as good examples of solving 'puzzles' (in the sense of Kuhn 1962, Chapter IV).

Rigorous sociology is reluctant with respect to *purely* data driven research as well as research that is *exclusively* driven by new technological opportunities (see, for example, the discussion of the use of 'big data' and 'computational sociology' in Goldthorpe 2021, Chapter 10). However, new technological opportunities, such as rapidly increasing computing power combined with the availability of social digital trace data, can offer possibilities to use 'not-designed' data to test hypotheses. For example, one can think of geographical data from mobile phones to test claims based on routine activity theory (criminology) or to test hypotheses on the spreading of pandemic diseases. Another example are data from dating sites to understand the relation between homogamy tendencies and preference formation. Likewise, using artificial intelligence and machine learning methods, data-driven research based on big data sources can reveal unexpected findings and new empirical regularities that require sociological explanation (see the chapter by Flache, Mäs & Keijzer). Also, not-designed data can be combined with more conventional social science data such as survey data, thus providing new opportunities for testing hypotheses (see Salganik 2018, Chapter 3 for general discussion; Hofstra et al. 2017 is an example).

Importantly, fostering scientific integrity and transparency is an ingredient of rigorous sociology. This includes, first, transparency with respect to the research process in terms of reporting. Second, it includes open materials, code, and data. Third, it requires transparent choices with respect to model specification. Concerning empirical research that aims at testing theory, it is also important to make theoretical assumptions explicit from which testable implications follow as well as to ensure minimal criteria such as the consistency of the set of theoretical assumptions. In the end, transparency and open science facilitate replication research in its various forms, thus contributing to cumulative knowledge (see the chapter by Auspurg & Brüderl).

2.2.1 Empirical research, methods, and the intersection of empirical with theoretical research: issues and controversies

There is not only discussion in rigorous sociology with respect to specifics of theory construction but also on issues related to empirical research, methods, and the link between empirical and theoretical research. Some pointers to such issues will suffice here.

One such discussion, also visible in chapters in this *Handbook* (see the chapter by Gërkhani & Miller as well as the chapters by Breen and by Gangl), is on employing experimental designs in rigorous sociology. In rigorous sociology, the use of experiments for testing theories seems less contested, including, for example, testing assumptions on micro-level regularities of behavior that are hard to observe or control in settings outside a lab. On the other hand, the potential of establishing empirical regularities through experimental research is more controversial due to the issue of external validity.

The notion of ‘causation’ is a topic of ongoing discussion in rigorous sociology. In a well-known contribution, Goldthorpe (2007, Chapter 9), distinguished between understanding causation as ‘robust dependence’, as ‘consequential manipulation’, and as ‘generative process’. He defended the generative process understanding as more appropriate for rigorous sociology. In more recent work (Goldthorpe 2016, Chapters 8 and 9), he compared in more detail the influential ‘counterfactual’ and ‘potential outcome’ approaches to causation to the generative process notion. The chapters by Breen and by Gangl provide more detailed overviews of developments in this field.

The implications of scientific integrity and transparency are a further topic of ongoing discussion and also controversy. The chapter by Auspurg & Brüderl is on issues related to scientific integrity, transparency and open science in quantitative empirical research. However, such issues also arise in qualitative research. It is sometimes suggested that anonymity requirements compromise the possibilities for transparency in qualitative research. The chapter by Varese shows that attempts at anonymization practices such as disguising field sites, altering dates, and changing informant characteristics such as age or gender are often unnecessary or futile, while hampering critical discussion of validity issues and conclusions. Varese indicates how transparency and, consequently, opportunities for replications can be secured in rigorous ethnographic research.

2.3 Contributions to Policy Making Related to Societal Problems

There is a large literature reflecting contributions of rigorous sociology to policy making, including policy making that aims to mitigate societal problems. Coleman’s reports on educational opportunity and inequality in the United States (Coleman et al. 1966; Coleman et al. 1975; Coleman et al. 1982) are meanwhile classic examples of contributions to educational policy. Another example is his work on ‘corporate actors’ and on how to control corporate actors and to mitigate the power asymmetry between corporate actors and natural persons (Coleman 1974, 1982).

Turner (2019) offers a recent discussion of how sociology should (or, respectively, should not) address and contribute to solving societal problems. He argues that sociology as a ‘science of society’, very much in line with core features of rigorous sociology as outlined here, can contribute in important ways to addressing and mitigating societal problems. Turner likewise argues that what he sees as a trend for American sociology, namely, conceiving of sociology as an ‘activist discipline’ and ‘increasingly mimicking a social movement organization’ (2019) would reduce sociology’s potential to scientifically contribute to mitigating societal problems. By way of example, the chapter by Wiertz & De Graaf shows how rigorous sociology can contribute to a better understanding of the climate crisis.

De Graaf & Wiertz (2019) is a recent textbook on societal problems, illustrating how rigorous sociology can contribute to illuminate a wide range of societal problems. The book argues that many societal problems can be conceptualized as ‘public bads’, i.e., collective action problems (in the sense of Olson 1971), related to the provision and management of public goods, common-pool resources, and club goods (De Graaf & Wiertz 2019, Chapter 1). The book further proposes an analytical framework for studying societal problems with micro-macro models as discussed above (De Graaf & Wiertz 2019, Chapter 2). This framework is subsequently employed to examine a selection of pressing

societal problems, mostly pertaining to modern industrialized countries. These problems include population aging, problems related to migration and multicultural societies, inequalities in terms of income and gender, weaknesses of the financial system, and corruption (De Graaf & Wiertz 2019, Chapters 4–13). Along the way, many examples of government intervention to tackle societal problems are discussed. Some interventions are successful, while others create unforeseen incentive- and opportunity-structures that induce interdependent individual actions with unintended behavioral consequences that in the end exacerbate existing problems or create new ones. For example, Massey et al. (2016) show how increasingly enforcing the Mexico-US border in the period 1986–2008 actually increased unauthorized and undocumented migration and population growth, with a settled population of immigrant families replacing a circular flow of male workers.

It is also instructive to consider how studying societal problems can stimulate theory development in rigorous sociology. It has sometimes been observed (for example, Heckman & Neal 1996) that Coleman has contributed in important ways to both theory and empirical research in sociology but that much of his theoretical and empirical work developed, by and large, without much mutual influence. However, Coleman's policy-oriented empirical work on schools and education did in fact have consequences for how his ideas on sociological theory evolved (Braun & Voss 2014, Chapters 3 and 8; Goldthorpe 2021, Chapter 9). His empirical work on schools and education as such was not driven by methodological individualism. Still, Coleman (for example, 1990b, Chapter 15) recognized the way in which, for example, parents reacted with 'white flight' to policy measures such as 'busing' that were based on Coleman's initial empirical work. These reactions undermined the intended policy aim of school desegregation, while increasing residential segregation. Coleman studied these reactions and processes empirically (Coleman et al. 1975) and came to realize that parents reacted to incentives as well to opportunities and restrictions, and that such reactions led to important macro-consequences.

3. DESIGN OF THE HANDBOOK AND RELATED LITERATURE

This *Handbook* was induced by our impression that bringing together and reviewing perspectives on rigorous sociology is a useful contribution to mitigating fragmentation of the discipline. The *Handbook* does so by elaborating on common ground for analytical and empirical work that facilitates cumulative growth of knowledge in different strands of rigorous sociology. In line with our integrative perspective, and to show its potential, we have deliberately chosen for some 'heterogeneity' with respect to the chapters included and topics addressed: this illustrates that rigorous sociology comes in different 'flavors' and the *Handbook* aims to make that clear rather than keeping it out of sight. On the other hand, if only for reasons of limited space, the *Handbook* must be selective. We do not aim at providing complete and exhaustive coverage of rigorous sociology. Much research and outstanding scholars are not included in this volume. We do not, of course, intend to suggest that work left undiscussed in this volume does not fall in the rigorous sociology family: rigorous sociology is about standards of inquiry, not about fields of inquiry, let alone about exclusion of certain fields.

At the same time, the *Handbook* fills a gap: there are only few previous efforts in a similar direction, although ideas underlying our conceptualization of rigorous sociology have been floating before in various forms. An early effort along the lines that form the basis for this *Handbook* is found in Marshall (1990). Focusing on sociology in the United Kingdom, he reviewed a set of studies from the period, roughly, 1950–1980, in the rigorous sociology tradition that were theoretically sophisticated, methodologically innovative, and had practical applications in fields such as social mobility and inequality, ethnic relations, and families and social networks. An early edited volume by Blossfeld & Prein (1998) has focused on building a common ground between rational choice theory and quantitative analysis of large-scale datasets. While the contributions covered quite diverse research fields in sociology, it stands to reason that the volume contributed specifically to more exchange and collaboration between researchers in the field of social mobility, broadly conceived, and various strands of methodological individualism, including rational choice theory. Wittek et al. (2013) is a further effort seeking common ground between rational choice theory and a broader variety of theoretically informed empirical research in very diverse fields of sociology. Hedström & Bearman (2009a) focus on one specific research program, namely, analytical sociology, that contributes to rigorous sociology. The Hedström & Bearman volume highlights work along the lines of analytical sociology on a broad array of topics but also includes chapters on what the editors labeled ‘perspectives from other fields and approaches’. Manzo (2014a) and Manzo (2021) similarly focus on analytical sociology, while also including work from other quarters of rigorous sociology. Our *Handbook* builds on these earlier volumes. Importantly, it aims explicitly at a much broader scope in terms of research programs involved, research fields, and methods applied. Moreover, it aims at showing that there is valuable common ground even with such a broader scope.

A noteworthy and commendable development is new textbooks with a perspective on rigorous sociology that is closely related to the perspective set forth in our *Handbook*. Van Tubergen (2020) is a much-needed introductory textbook on sociological theory and empirical research. De Graaf & Wiertz (2019) is a textbook on how sociology contributes to understanding societal problems and to mitigating such problems. One might hope that the availability of such textbooks will strengthen the impact of rigorous sociology on the development of the discipline, not least through improved teaching. Much work on the history of ideas in sociology is from a perspective quite different from that of rigorous sociology, sometimes misleadingly suggesting that sociological theory is a variant of such a history of ideas. Goldthorpe (2021), however, is a challenging selection of contributions of some of the pioneers of rigorous sociology, albeit with an explicit and sometimes provocative focus on work leading to his sociology as a population science (in various ways, Voss’ chapter complements Goldthorpe’s study). As resources for teaching and training of students, these monographs, together with this *Handbook*, can also play a role in the social organization of rigorous sociology. The US-based journal *Sociological Science*, launched in 2014, and the *European Sociological Review*, as the flagship journal of the European Consortium for Sociological Research, very much aim at publishing work in line with rigorous sociology in the sense of this *Handbook* and, likewise, contribute to strengthening the institutional context for this work.

4. BRIEF OVERVIEW OF CHAPTERS

The *Handbook* comprises five parts. The first part presents overviews of *research programs* contributing to rigorous sociology, focusing on sociology as a population science (Jackson), analytical sociology (Manzo), agent-based computational sociology and computational social science (Flache, Mäs & Keijzer), stochastic network modeling as generative social science (Steglich & Snijders), and rational choice sociology (Diekmann).

The second part surveys *new and ongoing developments* in rigorous sociology in *selected fields* of the discipline. This includes core research areas of the discipline and developments at the intersection of sociology with other social science disciplines as well as the intersection of sociology with the life sciences. Chapters are on sociology of education (Meier Jæger), migration and the incorporation of migrants (Kalter), social networks (Buskens, Corten & Raub), households, employment and gender (Jaspers, Van der Lippe & Evertsson), historical sociology (Ermakoff), rigorous ethnography (Varese), evolution, biology and society (Hopcroft, Dippong, Liu & Kail), and sociogenomics (Mills).

The third part features developments related to *methods of research and statistical modeling*, with an eye on applications in empirical research as well as on methods that can support the systematic link between theory formation and empirical research. Two chapters focus on observational designs and data, namely, a chapter on causal inference and estimation with observational data (Breen) and the other chapter on longitudinal designs and models (Gangl). The chapter on experimental sociology (Gërkhani & Miller) addresses experimental designs as a tool of rigorous sociology. Together, the first three parts of the *Handbook* include discussions on how research covered in the respective chapters contributes to the common ground of rigorous sociology and relates to relevant other research programs and developments. In addition, the chapters combine reviews and assessments of the state of the art with suggestions for new research avenues.

The fourth part of the *Handbook* shows that rigorous sociology is not only for the future but has produced outstanding work in the past. This is done by presenting ‘*showcases*’ of work in rigorous sociology, including critical discussion of those showcases as well as their impact on past and ongoing research. Our sample of showcases, for sure ‘biased’ in various respects, includes work over a 30 year period from the 1990s until, almost, 2020. The first showcase is the 1997 Breen & Goldthorpe paper on explaining educational differentials, accompanied by a review chapter by Becker. Our second showcase is Burt’s 2004 paper on structural holes and good ideas, together with a review paper by Vedres. The third and fourth showcases can be seen as a couple. One is the 2006 Salganik, Dodds & Watts paper on inequality and unpredictability in an artificial cultural market. The other one is Van de Rijt’s more recent 2019 paper on self-correcting dynamics in social influence processes that likewise reflects the impact of the earlier Salganik, Dodds & Watts study.

In the final part, some *further perspectives* on rigorous sociology are discussed. This includes how rigorous sociology can help make sense of the climate crisis as one of the most pressing societal problems (Wiertz & De Graaf), a chapter that outlines roots of present-day rigorous sociology from a ‘history of ideas’ perspective (Voss), and a chapter on research integrity and transparency in rigorous sociology (Auspurg & Brüderl).

The contributions to this *Handbook* show that sociological science can build on a common core that includes theory formation, empirical research, as well as the link between theory and empirics. Building on such a common core avoids fragmentation of the discipline, with ‘unity in diversity’ allowing for critical discussion within and across diverse strands of rigorous sociological research. This is how progress through cumulative growth of knowledge has been and can be made and why sociological science can continue to thrive.

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