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Group Formation in Science between Homogenization and Differentiation: Modeling the Development of U.S. and German Sociology

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ABSTRACT

We assess the empirical development of scientific homogenization and differentiation processes in terms of group development comparing U.S. and German sociology from 2004 to 2019. We introduce hierarchical multi-layered Bayesian stochastic block models to the issue of scientific group development. Based on publication data from *Scopus*, we analyze group formation simultaneously as collaboration networks, reference networks, and topical networks. Employing this method allows us to trace back the temporal dynamics of multidimensional group development and formation for each national scientific field. Overall, the findings indicate clear path dependencies in both fields that have been shaping processes of differentiation and homogenization in U.S. and German sociology and that continue to impact on the formation, stabilization, and dissolution of scientific groups.

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1. Introduction

The academic field is undergoing significant transformations, including economization, standardization, bureaucratization, increasing accountability of researchers to actors external to science, and internationalization (Münch 2019). These changes, summarized under the term ‘academic capitalism’ (Slaughter and Rhoades 2004; Slaughter and Cantwell 2012; Münch 2014), have led to intensified institutional competition, both among strategically motivated, entrepreneurial universities for competitive advantage, monopoly rents, and attention, as well as among scientists for resources and prestige (Münch 2014). The implementation of competitive logic – for example in the form of rankings and ratings – requires easy-to-use quality criteria to establish comparability; for example, an institutional focus on articles being published in journals according to their impact factor (Espeland and Sauder, 2016). The increased relevance of impact factors has resulted in scientists increasingly adapting their publishing activities to the criteria of journals, which allows for increased control through peer review processes.

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As a consequence of such processes, a normalizing effect, with a corresponding *homogenization* of the knowledge canon and standardization of practices, theories, and methods can be expected (Li and Parker 2013). However, increased resources and ongoing specialization can lead to a *differentiation* of scientific fields, including crucial issues such as thematic orientations and cooperation patterns (Leahey and Reikowsky 2008).

In this article, we assess the empirical development of scientific homogenization and differentiation processes in terms of group formation and development. It has been argued in theoretical terms (Kuhn 1962, Bourdieu 2004) and shown empirically that scientists develop and employ their theories and methods, and unfold their practices, largely in the form of more or less integrated groups. Group formation occurs, for example, through common research interests, methods, and theories, and also for strategic reasons, such as to share work and resources, or maximize social capital or prestige through cooperation (Leahey 2016). We contribute to recent research by addressing two complementary deficits. On the one hand, aspects of group formation in science such as the practices of collaboration, citation, and discourse have classically been used in isolation (Lievrouw 1989). This tendency has continued in more recent computational research (Evans et al. 2016; Shwed and Bearman 2010). From a more conceptual point of view, however, group formation and perpetuation – such as in the ideal-typical case of a paradigm – must be understood as the interaction of all these aspects (Basov et al. 2020; Lietz 2016; Roth and Cointet 2010). On the other hand, the sociology of science has a rich tradition of theorizing scientists' organization in groups (Bourdieu 1993, 2004; Fleck 1935; Kuhn 1962). Yet, when applying theoretical concepts in superficial ways, the focus can be rather narrow and rigid, such as when assuming that paradigms or thought collectives adequately describe the empirical reality of scientific fields. An overly strict transfer of these concepts runs the risk of neglecting other forms of group formation in science, for example, group formation that is not primarily based on shared paradigmatic convictions, and collectives that are not merely based on common modes of thought. As a result, the current sociology of science is burdened by a dichotomous approach to the core issue of how science and scientists organize themselves.

In order to address this dichotomy, we employ a relational conceptualization of group formation in science that treats the notion of paradigm as a *relative rather than absolute concept*. This conceptual proposal motivates an innovative methodological approach to data clustering: Using multi-relational network analyses, we simultaneously analyze three crucial aspects of group formation in science: social networks of collaborating with other scientists, the citation of scholarly references, and word use. We use the case of sociology's development in the U.S. and Germany over the last 15 years; the discipline has been traditionally described as being particularly fractured into disunited subunits in the German case (Schmitz et al. 2020; Schwemmer and Wieczorek 2020) and 'loosely overlapping' (Moody 2004) and 'semantically fragmented' (Varga 2011) in the U.S. case. Based on articles from U.S. and German sociology journals, we construct multi-relational networks and compare the temporal developments of scientific group formation, stabilization, reconfiguration, and dissolution for both national fields.

2. Group formation and development in science

Group formation in science is crucial for the exchange of expertise, ideas, and resources (Lewis et al. 2012), for reducing uncertainties (White 2008), and for yielding synergistic effects through collaboration, which can foster increased innovative capabilities, visibility, career success, and chances of future funding (Leahey 2016). In recent years, a growing number of empirical contributions from the field of computational social science have quantified paradigmaticness by analyzing scholarly publications (Evans et al. 2016) or the citations made therein (Shwed and Bearman 2010); other approaches sort social networks into clusters (Newman 2012) or aim to reduce the dimensionality of topical spaces (Blei and Lafferty 2007), in order to better study scholarly fields. In more fundamental terms, different sociologists have proposed theoretical approaches to the issue of the emergence of classed forms of scientific practices. We can, for instance, categorize a collection of concepts that address the fact that scientists and ideas appear in groups: Fleck (1935) proposed the concepts of ‘thought collectives’ and ‘thought styles’ to address the crucial role of the collective organization of scientists’ perception and construction. Similarly, Kuhn (1962) describes paradigms as fundamental theories, methods, standards, and conventions shared by a particular scientific community of scientists at a specific time. In a similar way, Bourdieu (2004) sociology of science investigates classes of actors and practices that structure a scientific field at a certain point in time and physical space. Likewise, the network perspective on group formation investigates how structures of connectivity and culture co-constitute each other (Fuchs 2005); this idea has, amongst other things, motivated the concept of the ‘invisible college’ (Crane 1972). Despite considerable differences in these theoretical and methodological approaches, they show important commonalities in that they employ theoretical reasoning to shed light on group formation but, in doing so, do not assume the existence of rigid paradigms. Rather, these works hint at the *relational and dynamic* nature of how various practices in scientific fields co-constitute each other (Basov et al. 2020; Roth and Cointet 2010), how scientists form groups, how ideas emerge, or how respected intellectuals are created (Lietz 2016; Zuccala 2006).

In the following, we articulate eight crucial implications resulting from this relational conceptualization of group formation; together, they motivate our relational methodological approach. *First*, the dimensions that can make up a respective group, class, or group should cover a range of scientific practices that underlie and constitute group formation, rather than single constituents, since group formation is based not on one indicator, but several. Constituents such as orientations in terms of preferred theories, methods, and topics (Kuhn 1962), as well as connections to established work of the past and different forms of cooperation (Fleck 1935), should ideally be taken into consideration here. Accordingly, *second*, the ways in which these elements relate to and interact with each other must be established and understood if we want to assess the different forms of scientific group formation. *Third*, the *a priori* assumption of paradigms (Kuhn 1962) or thought collectives (Fleck 1935) in a narrow and ideal-typical way neglects to a consequential extent the social reality of science. Coalition building, grouping, connecting new ideas, etc. – such aspects do not necessarily have to be based on shared assumptions, methods, or even epistemologies. For example, institutional proximity, state-defined funding lines, and similar factors can lead to scientists and ideas being

bound together or detached from each other, but this does not necessarily imply paradigmatic congruency (Münch 2014). Thus, *fourth*, in an applicable empirical case, one should take into account groups whose definability as a paradigm can range from very high to very low, so that we shall speak of *degrees of paradigmaticness* (Evans et al. 2016). *Fifth*, to speak of a specifically high or low level of paradigmaticness in a particular case depends on the observational distance, that is, the question of how closely one approaches a group with regard to the aggregation of group memberships. For example, what may appear to be a distinct paradigm from a distance may turn out to be a differentiated subfield upon closer observation. *Sixth*, an important condition of groups development is their embeddedness in a common field, such as in disciplinary fields and thus their relations vis-a-vis the fields' structures and the other groups toward which they may react such as by distancing (Schmitz et al., 2017), adapting (cp. Fuchs 2005), competing (Popper 1959; Feyerabend 1965) etc. *Seventh*, what has been prominently discussed for paradigms in a narrower sense, namely their interrelatedness, should also be assessed for groups with low paradigmaticness. In fact, we may assume that the paradigmaticness of a group can increase over time partially depending on its relation to other groups in the field (such as by way of distancing oneself). *Eighth*, groups of scientists, just like groups of ideas, for example, are not independent from time and space but should be understood as highly fluid and context specific. Group development can entail path dependence, such as when past research practices and events impact future developments, including the formation of thought collectives, which may develop a high degree of paradigmaticness (cp. Peacock 2009) as seen in economics, which has historically exhibited a certain degree of homogeneity (Beckenbach 2018). This will require us to reconstruct the dynamics of group formation as well as to take cultural and national context into account, in our interpretations. We shall use this conceptual approach to understand the development of two national fields, namely U.S. and German sociology, as a group-based phenomena. These two national fields have experienced considerable change in recent decades, both in terms of externally induced and internal transformations.

On the one hand, the developments often referred to as academic capitalism' (New Public Management, metrification, standardization, loss of autonomy) would lead us to expect an increasing *homogenization* over time (Auspurg et al. 2015; Münch 2014; Slaughter and Cantwell 2012; Slaughter and Rhoades 2004). Homogenization, here, refers to the increasing similarity of one or more indicators of group composition. The homogenization processes affecting groups can differ with regard to specific indicators, such as when stable social collaboration is present but paradigmatic closure is absent, or the other way around (White 2008). Scientists' group building should become more relevant to those scientists who increasingly strive to attract third-party funding by way of the strategic formation of groups (Münch 2014). Since third-party funding is more and more tied to goals defined from outside the scientific field (Münch 2019) and scientists orient themselves to these predefined aspects, scientific groups should also increasingly engage with these topics, irrespective of their underlying paradigmatic backgrounds. Thus, we could expect groups to engage with, or constitute themselves according to, similar topics, as well as those theories and methods that are seen as currently legitimate. As a consequence, we might expect the number of traditional,

established groups to decline over time, since they will become increasingly similar, or even merge, and because groups will dissolve that cannot fulfill the requirements of the field. Yet, for the same reason, the number of new, temporarily existing groups that organize themselves pragmatically rather than paradigmatically around certain opportunities might increase as well. Thus, to the extent that external standards structure academic practice, we would expect paradigmatic aspects in a narrower sense to become less relevant for group formation and maintenance. Conversely, those groups that have an established paradigmatic tradition and at the same time meet the necessities of modern scientific fields (e.g., competition for third-party funding, familiarity with peer review, publication in high-impact journals) should become more integrated and coherent, eventually showing increased levels of paradigmaticness. Finally, given that the aforementioned transformations of science impacted U.S. science earlier and that German sociology is structured by persistent national traditions (Schmidt-Wellenburg and Schmitz 2023), the extent of homogenization of groups in the U.S. should be considerably higher than in Germany.

On the other hand, we may also expect processes of *differentiation* of the scientific field, fostering the diversification of scientific groups. Differentiation, here, refers to the decreasing similarity of one or more indicators of group composition. The expansion of science, in the form of a growing number of professorships and researchers and the proliferation of journals and research fields, is potentially accompanied by opening and decentralizing effects that oppose the closing and centralizing effect of academic capitalism. The scientific field has experienced progressive professionalization and specialization (of research sections/communities and journals; cp. Leahey and Reikowsky 2008; Daenekindt and Huisman 2020). This structural inflation of the field might thus be reflected in an increasing diversity of groups specialized in different forms of scientific practice and the establishment of new groups over time. Moreover, the technical and cultural circumstances by which science is organized in the form of groups have changed dramatically (digitalization, strategic pressure to cooperate) which, overall, should foster the formation and stabilization of group-based science. Moreover, the aforementioned increased external influence on the scientific field may well fuel antagonisms and distinctions such as struggles over resources and legitimate forms of science (Schmitz et al. 2020). Numerous sociologists have recently, and self-reflexively, criticized the described developments; this may lead to the formation of counter movements (Schmitz et al. 2020). This structural trend should be more noticeable in Germany than in the U.S. given Germany's deeply embedded cultural differences (Moebius 2021), with a strong theoretical tradition and fierce oppositions of methodological groups.

3. Data and methods

3.1. Publication data

For reconstructing the dynamics of group formation, stabilization, and reconfiguration we use data comprising publications from German and U.S. sociology journals. A total of 3,070 publications from six German-language sociology journals and 13,014 publications from 23 U.S. sociology journals, both representing the core of the respective national disciplinary field, were extracted from the *Scopus* database for analysis. A

complete list of the journals in our sample is provided in the online [Appendix](#). The selection of journals is based on the category ‘sociology’ in the *Social Science Citation Index* (SSCI) and a qualitative process to select journals published in Germany or the U.S., excluding journals that are too peripheral in the American case and adding journals that are indexed in *Scopus* but not in the SSCI in the German case. The different scope of the journals analyzed reflects the different publication opportunities in the two fields, but it must also be noted that peripheral German-language journals are less frequently indexed in *Scopus* or SSCI than comparable journals from the U.S. (Vera-Baceta et al. 2019). This has to be taken into account when interpreting the results. The observation window is 2004 to 2019. This time period was chosen because the abstracts for the selected journals prior to 2004 are not fully available in *Scopus*. Data were divided into four time windows, each representing a four-year period (2004–2007, 2008–2011, 2012–2015, 2016–2019)¹. The data underwent an extensive quality check, which involved identifying outliers such as publications with exceptionally high or low numbers of references or words, or an unusually high number of authors. Measures were taken to address missing and duplicate entries, and errors were manually corrected. Whenever required, missing data, including abstracts, were manually collected and included in the analyses. A table with the relevant journal and author statistics is given in the online [Appendix](#).

3.2. Data organisation

To analyze group formation, we measure three types of scholarly practice and their outcomes as networks. For this purpose, we utilize publication metadata on authorships, cited references, and publication abstracts. From these, three types of network relations are constructed among authors as nodes. To measure social collaboration and the thought-collective aspect of paradigms, we have constructed *author coauthor networks*, leveraging the well-established disambiguation quality of the *Scopus* Author ID (Aman 2018). Authors in this network are connected if they have published jointly. The edges are weighted using cosine similarity of authors, indicating the similarity of coauthorships among the corresponding authors within each time window.

Citation maps the paradigmatic structures of fields (Shwed and Bearman 2010; Small 1980). To measure citation practices, we accessed complete reference lists in *Scopus* which enables us to go beyond the references already indexed in this database. This approach is necessary due to *Scopus*’ primary focus on English-language journal articles which neglects non-English monographs and chapters, particularly in the social sciences (Vera-Baceta et al. 2019). A disambiguation algorithm was used to assign unique matching keys to references based on author name, year of publication, (source) title, volume, and page number (Lietz 2020). Subsequently, $tf*idf$ values for each reference in each time window are calculated to emphasize relevant references while reducing the weight given to references appearing in a large proportion of publications. Next, the references are linked to the authors who cited them in their publications. *Author co-reference networks* are constructed based on this author-reference mapping, where authors are connected if they use the same references. The edges are weighted using the cosine

similarity of reference citations among the connected authors based on the tf^*idf values of the shared references.

The discursive practice of how scholars express themselves in writing quantifies another aspect of group formation and thought styles. While cited references often mark individual methods and concepts used in a field, text analysis provides a window into the broader topics and problem spaces of scientific inquiry (Evans et al. 2016; Callon et al. 1983). To tap into this, we apply a preprocessing pipeline to the abstracts of publications. First, words are lemmatized, and stop words are removed. n -gram detection is performed to identify bi- and trigrams in addition to the existing unigrams. The former are sequences of two and three words, respectively, that occur with high probability, and they resemble topical concepts used in an abstract. Then, tf^*idf values are computed for each n -gram within the corresponding time window and associated with the Author IDs. This process leads to the construction of an *author co-word network*, where authors employ similar topical foci are connected. The edges in this network are weighted based on the cosine similarity of tf^*idf -transformed n -gram usages.

3.3. Modeling groups and their developments with SBM

In order to grasp the multiple related dimensions of scientific group formation and their interactions, we combined all three networks, namely the author coauthor, co-reference, and co-word networks, in one multi-relational network for each time window. In each multi-relational network, we cluster nodes into groups using a multi-layered Bayesian stochastic blockmodel (SBM) (Peixoto 2019). The SBM integrates the three dimensions of group formation as layers in one model and depicts their interactions in one clustering solution. The resulting groups can be more or less manifest (strongly connected) or latent (weakly connected) and differently so in each layer. This allows us to detect groups with varying degrees of coherence in different dimensions (e.g., conceptually unified but collaboratively dispersed groups) (White et al. 1976). In particular, we used the degree-corrected, hierarchical (nested) SBM with independent layers (Peixoto 2015) in Python's graph-tool (Peixoto 2014).² Degree correction is well-suited to account for the large heterogeneity of node degrees that naturally occurs in networks like ours. The nested SBM allows us to study group structure on different levels of resolution without having to set the number of clusters or the resolution level (Peixoto 2019).

On the first level with highest resolution, the authors are clustered into the largest number of groups. These building blocks are then hierarchically grouped into parent blocks until only one group remains at the last level. We started by looking at the finest resolution of group composition and then zoomed out further. We decided to use the clustering solution from the resolution level with the second-largest number of blocks because it provides the best tradeoff between macro-level structure and differentiation.

In the ensuing modeling step, block similarities across time windows were calculated. For this purpose, the mean cosine similarity, weighted by tf^*idf values of the coauthor, co-reference, and co-word similarities of the authors in the corresponding groups were computed. Blocks and edge weights were then mapped onto a block evolution graph, connecting groups from consecutive time windows, with edge weights representing their

respective similarities. The edge weights were subsequently filtered to reveal paths of similar blocks over time within the block evolution graph. This kind of modeling does justice to the relational conceptualization of groups: these are not essentialist formations that we track over time, but they emerge in a dynamically evolving field.

The degree of paradigmaticness can then be assessed, first, by the similarity of the authors within a group on the three constitutive dimensions, second, by the degree of similarity of the groups over time (i.e., a high or low degree of path reproduction), and, third, by the extent to which strands of groups are separated from each other.

4. Results

4.1. U.S. Sociology³

The evolution of blocks is shown in Figure 1, where the size of the node depicts the number of authors. There are two distinct evolutionary strands that exhibit strong average similarities over time. At the top of the graph, we see a path predominantly concerned with qualitative research. Scientists here study gender, masculinity, and family. Widely used references include Goffmann, Glaser, and Connell – authors who contribute to the conceptualization of social interaction and their qualitative assessment,

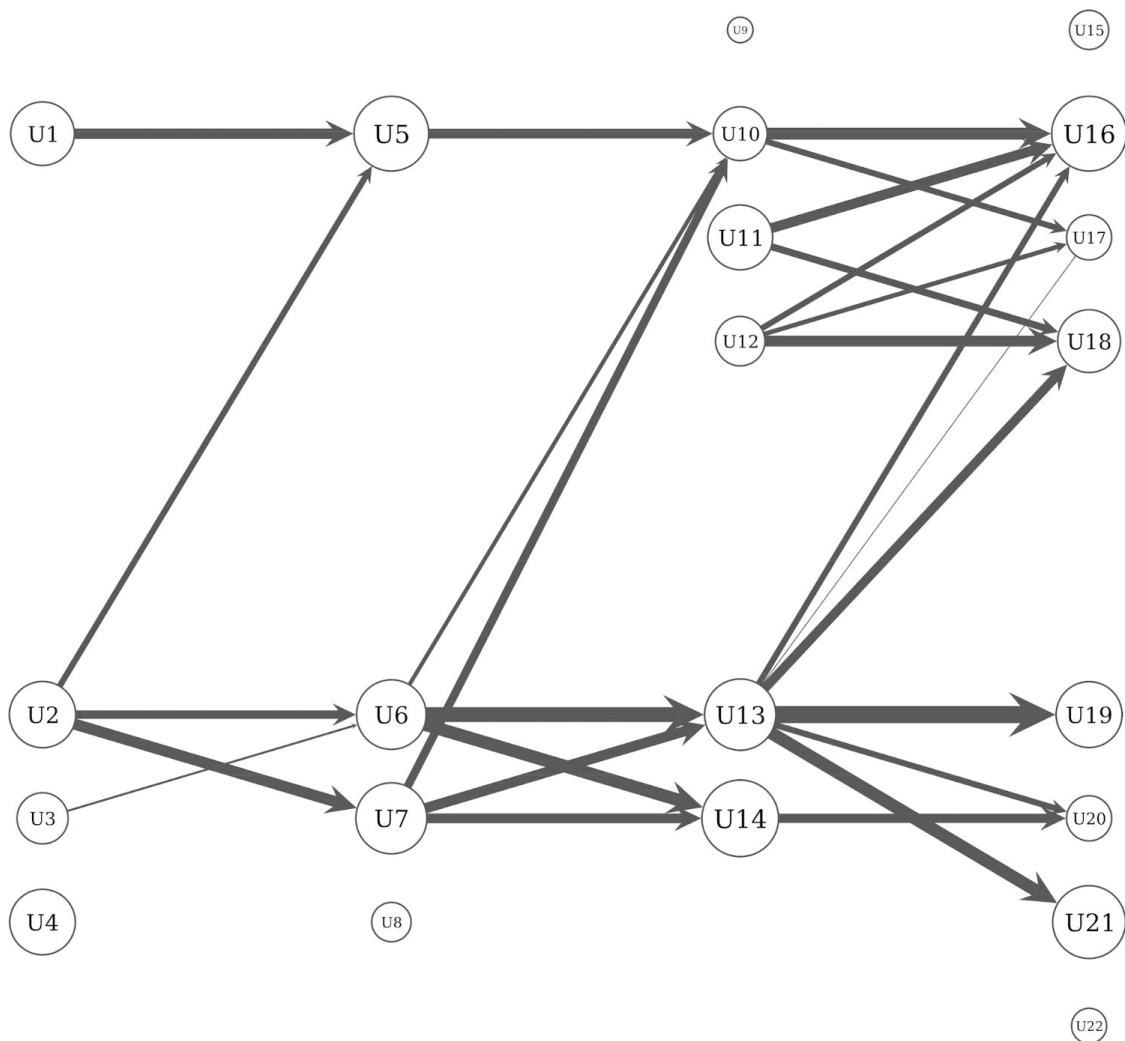


Figure 1. Development of groups in U.S. sociology (block evolution 2004 to 2019).

especially in the context of gender and social inequality. A typical group for this research strand is group U1, in which the authors are predominantly concerned with theorizing gender relations using the relevant terms and sources. Frequently used terms with a high tf*idf score in these groups are ‘feminist’, ‘masculine’, and ‘hegemonic_masculinity’, and frequently used references include Connell, Butler, and Glaser.

Over time, we see a linear development between the U1, U5, U10, and U16 groups. A growing aspect in this line is the focus on research concerned with societal betterment. Examples are the U10 and U16 groups. The authors in group U10 frequently use the terms ‘political’ and ‘action’. As a conceptual foundation, they mobilize interactionist and culturalist frames (Goffman, Glaser, Benford, and Swidler). These authors publish their work mainly in *Sociological Forum*, *Symbolic Interaction*, and *Journal of Contemporary Ethnography*, all journals with a lower impact factor.

Beginning in 2012–2015, three additional groups in the main strand as well as two peripheral groups⁴ emerge that also focus on qualitative social research but share little similarity with the qualitative groups from the time windows before. Among the emerging groups, U12 revolves around gender-related research with a pronounced feminist orientation, using terms like ‘masculine’, ‘inequality’, ‘feminist’, ‘gender’, and ‘woman’. Authors in this group with a high number of publications between 2012 and 2015 include Wilkins, Musto, and the co-founder of the field of critical men’s studies, Hearn. The other emerging group, U11, is primarily concerned with the reflexivity of knowledge, both in terms of teaching and societal application. The final time frame exhibits a further differentiation. Group U18 focuses on socio-political issues and theory oriented toward gender issues with, to some extent, recourse to grounded theory. In contrast, the authors in group U17 predominantly conduct practice-oriented qualitative research with practical procedures on topics such as gender, health, sex work, and family.

Overall, this strand has stabilized and intensified its strong orientation toward the topic of gender showing a slight degree of paradigmaticness. Since 2012–2015, there has been several differentiations and a noticeable increase of work actively promoting social change and empowerment. At the same time, references to texts from classical social theory decrease while references to object-oriented theories, such as gender theory, grow in relevance. When examining the abstracts and reference lists, we see that the same classical texts of qualitative social research, for example on grounded theory, are cited again and again, albeit with decreasing intensity. One might assume that these references are increasingly used to legitimize and situate the respective authors’ research, rather than to actually provide a theoretical framework for the works in question.

In contrast, the bottom of the graph shows a strand of groups of quantitative, individualist social research. There is a particularly strong path involving groups U6, U13, and U19, indicating a strong degree of paradigmaticness⁵. In researching inequality, stratification, race, and gender, authors in these groups focus on the individual and life-courses. They mainly use survey data and standard quantitative social research methods such as linear regression techniques. These studies often refer to authors such as Raudenbush, Putnam, Sampson, and Wilson, authors who deal with the effect of social structures, communities, neighborhoods, and social capital on the individual. Accordingly, the terms used most frequently by authors in group U13 are ‘survey’,

‘model’, ‘explain’, and ‘individual’. The corresponding articles appear predominantly in high-impact journals such as *Social Science Research*, *Social Forces*, *American Sociological Review*, and *American Journal of Sociology*.

Throughout all time periods, we also identify differentiation. For example, the U2 group differentiates into U6 and U7. In contrast to U6, the authors in group U7 deal with political and economic sociology; their approaches are not exclusively individualistic, but also apply quantitative network research or neo-institutional motivated statistical approaches in addition to conventional regression models. The last transformation between 2012–2015 and 2016–2019 reveals a differentiation mainly in methodological terms. Toward the end, authors in groups U19 and U21 work with classical methods of quantitative social research on topics like inequality, race, family, and the state. Here we observe the differentiation of U13 into groups of authors that prioritize the empirical application of basal quantitative methods (U19 and U21) and another group who engage in elaborate reflection on quantitative methods (U22). To some extent, group U20 also emerges from this differentiation. Authors there use a certain type of qualitative methods, namely Qualitative Comparative Analysis (QCA) and case studies, but not in the context of the qualitative methodology mentioned above.

Overall, the quantitative strand shows a high degree of paradigmaticness, with a strong individualistic focus on topics such as inequality and the labor market that increasingly incorporate aspects of race and, above all, gender. The development of this strand can be described as increasing technical specialization and, at the same time, as increasing detachment from theoretical perspectives. Authors in the U2 and U6 groups cite references from DiMaggio, Granovetter, Putnam, Coleman, and Bourdieu, all more theoretical works. In contrast, the authors in the subsequent groups – U13 and U19 – cite more technical papers by Raudenbush, McPherson, and Sampson.

From the relational viewpoint of our concept, we are also interested in the interrelations between these groups and the paths they take over time. When inspecting the relationships of these two strands, it is noticeable that – with very few exceptions – the connecting edges between them run from the quantitative path to the qualitative path. This means that the upper qualitative strand incorporates authors, references, and linguistic concepts from the lower quantitative strand, but not *vice versa*. Take the qualitative group U10 as an example: It is devoted to applied action research from a less technical, qualitative perspective. However, these authors include references from the quantitative group U7 to Benford (*Framing processes and social movements*) or Putnam (*Bowling Alone*). These works provide valuable insights that are utilized for quantification (by employing the notion of social capital in individualistic analyses) and critical examination of contemporary political circumstances.

Finally, we see that authors of both strands increasingly deal with similar topics. In recent years, these have predominantly come to be the topics of gender and race. However, both strands process these issues by implementing different methods and references, and referencing different circles of authors. If there is overlap, it is only in the form of references from the quantitative, individualistic strand being taken up in the work of authors from the upper qualitative path.

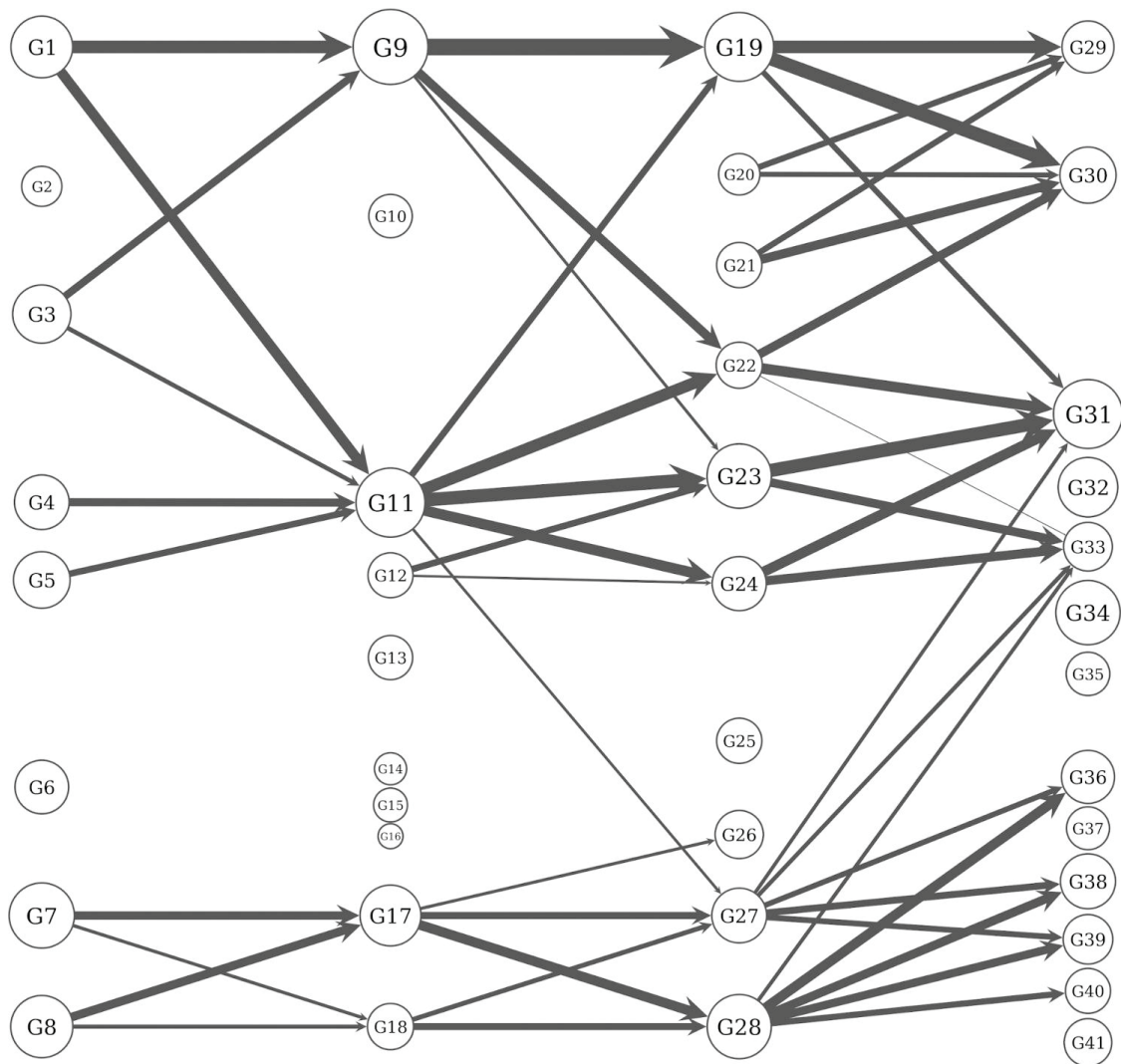


Figure 2. Development of groups in German sociology (block evolution 2004 to 2019).

4.2. German sociology⁶

In contrast to the U.S. case, the block evolution (see Figure 2) for Germany shows three clear strands: one strand of authors who predominantly work qualitatively, one group who work predominantly quantitatively, and another engaged in social theories.

The strand of author groups at the top of the graph comprises those who predominantly employ quantitative social research. Main research topics here are inequality, migration, gender, the labor market, and education. These topics are studied using data from large population surveys and analyzed using standard quantitative social research techniques such as linear regression. Much of the work appears in the *Cologne Journal for Sociology and Social Psychology* (KZfSS), the core journal of quantitative survey research, with a high relevance in German sociology. The path with the highest average path similarity and a strong degree of paradigmaticness encompasses groups G9, G19, and G30. The authors in group G9 predominantly study migration, inequality, gender, income, family, and the labor market; they make reference to authors such as Boudon and Esser. In their work, they use less basic theory, instead citing theory that allows for empirical subject-related research frames. The G19 group in the following time window

also deals with inequality, education, families/households, occupation, and employment; this group predominantly uses survey data from the Socio-Economic Panel (SOEP). Authors appearing in both groups include Hinz, Auspurg, and Diekmann: prominent authors within German individualistic quantitative sociology with a focus on social inequality, experimental sociology, or game theory.

In this strand, however, differentiations also occur. For instance, two smaller groups (G20 and G21) emerge in the 2012–2015 time window. Research in G20 is about migration, education, and ethnic group relations. Research in group G21 concerns inequality based on the micro-macro distinction and the use of temporal models. In the last time window, they blend into the main quantitative strand which has itself differentiated into groups G29 (on education, migration, and family) and G30 (on labor markets).

The authors in the groups of the middle strand are similar in terms of a stronger theoretical orientation compared to the other strands: The groups G11, G23, and G31 exhibit the strongest block continuity. The authors in group G11 are predominantly concerned with social theory and work on (global) society, economics, and markets. Frequently cited references are by authors of comparatively contemporary social theory, for instance, Luhmann, but also Boltanski, Callon, Granovetter, and Fligstein. Nationally recognized authors in this group include Rössel, Schwinn, and Münch, who deal with cultural sociology, social differentiation, or general theory building. The G23 group also includes a range of authors focusing on social theories, with references to Habermas, Luhmann, Joas, Bröckling, Boltanski, White, and Dux – influential authors who engage in social theory, the sociology of culture, or social change and modernity.

In the following time window, the focus shifts toward social analysis or societal diagnosis in the G31 group, which including empirical work. Diagnoses of the present (*Gegenwartsdiagnosen*) by Rosa and Reckwitz, for example, are becoming more important, as are theories such as by Meyer, Bourdieu, and Boltanski, who contribute to field theory and approaches that are oriented less to other theories than to empirical research.

A third strand of author groups predominantly conducts qualitative social research and frequently publishes papers in the open-access journal *Forum: Qualitative Social Research*. Above all, the blocks in this strand are united by a high degree of dissimilarity to the other strands. Group G7, for example, consists of authors who use qualitative methods (ethnomethodology, ethnography, discourse analysis, grounded theory), often framed by the sociology of knowledge.

The authors in group G27 also employ ethnography and ethnomethodology in the realms of the sociology of knowledge but, in doing so, focus on gender and migration. In addition to the more content-focused groups, other groups are dedicated to more technical questions of qualitative social research, such as the G18, G28, and G40 groups. These groups illustrate the intensive engagement with diverse methodological procedures and their application as a core aspect of the development of qualitative social research in Germany.

In the last time window, 2016–2019, we see the formation of a mixed-methods group (G36) that combines quantitative and qualitative methods. Influential authors in this group are Kuckartz, Baur, and Kelle. This group shows particularly high similarities with two qualitative groups (G27 and G28) and G24 from the theoretical middle strand,

but practically no overlap with groups in the quantitative strand. This shows that recent German mixed-methods research has arisen from research groups that are not part of highly standardized quantitative research.

When comparing the three strands of the German field, it is visible that the qualitative strand is relatively decoupled from the other strands and only similar to a lesser extent, indicating a lower degree of paradigmaticness. Yet, when inspecting the last two time windows, it becomes clear that many edges run from the qualitative strand toward the middle strand. This indicates an increased incorporation of qualitative studies in the theory-oriented strand, especially by the *Gegenwartsdiagnosen* of prominent contemporary intellectuals like Reckwitz and Rosa. In contrast, the quantitative and theoretical strands incorporate more pronounced paths of reproduction due to their higher degree of paradigmaticness. These two strands also show connections that indicate exchange. One main group connecting the quantitative and qualitative strand is group G22, which consists of authors who conduct research on religion, secularization, culture, and markets. The similarity to the quantitative strand arises from a high word similarity between group G22 on the sociology of religion and the G9 and G30 groups of the quantitative strand, which points to the empirical research questions of this group, for example, on topics like religious markets and competition or comparative studies between countries. In turn, the similarity to the theoretical strand arises from a high author and reference similarity to groups G11 and G31.

5. Comparing U.S. and German sociology

First, we observe, for both national fields, a strand of highly standardized quantitative, individualistic research that is characterized by a high and increasing similarity of authors, references, and words both within a time window and over time, indicating a large degree of paradigmaticness. In the U.S. and Germany, these strands are similar in their topics (such as inequality or labor market). The paradigmaticness is so strong, in fact, that it can span the distance between both national fields. In epistemological and methodological terms, German and U.S. sociologists are very close to each other, while referring partly to different authors. In Germany, for example, typical legitimate sources are nationally renowned authors such as Esser, Opp, or Auspurg, who maintain a certain level of abstract framing on, for instance, theoretical and methodological issues. In contrast, Wilson and Sampson are typically cited in the U.S., in references that are less abstract and more oriented toward empirical issues (cities or geographical contexts, continuing the traditions of the Chicago school).

Second, we likewise see loose strands of qualitative research consolidating over time in both U.S. and German sociology. However, while authors in both national strands clearly differentiate themselves from quantitative authors in their use of references and words, the two national strands do not share a highly standardized vocabulary or set of references. Yet, overall, German qualitative research has developed, since 2008, a more technical discourse on qualitative databases and methods, not least as a reaction to the dominance of the quantitative-individualist paradigm. We also see an emerging exchange between authors working qualitatively and theory-oriented authors, in the form of the inclusion of qualitative studies in theoretical works of contemporary

diagnosis (Rosa and Reckwitz). However, the more technically oriented groups cannot be categorically separated from the other qualitative groups; rather, the authors switch between theory and method depending on the publication context. In U.S. sociology, qualitative research has become less technically oriented, but more oriented toward topics like social change and empowerment. We still see connections between the qualitative strand and the quantitative strand, albeit this is not a hierarchy-free relationship: The superiority of quantitative social research can be seen in the fact that qualitative is oriented to quantitative social research, rather than the other way around, and in the existence of specific forms of qualitative research that are closer to individualistic quantitative epistemology, such as QCA. In contemporary Germany, in contrast, we observe a clear continuation of the historically emergent methodological antagonism between explanatory and understanding-oriented forms of empirical research.

Third, in contrast to the U.S. field, in German sociology, we identify a strand of authors predominantly devoted to social theory, since theoretical research has a long tradition there. However, *Gegenwartsdiagnosen* become more prevalent, as well as theories that are closely linked to empirical social research, indicating a decline in abstract theory (Osrecki 2018). In contrast, several decades ago, theoretical research paradigms were imported into U.S. sociology from outside, such as through Parsons' theories (Calhoun 2007). However, by the 1960s at the latest, systems theory in the U.S. had become less and less demanding and had lost its paradigmatic status. Accordingly, in continuation of U.S. sociology's development, we cannot identify a strand of sociological theory from 2004 onward. Instead, theoretical works are increasingly cited when they underpin and legitimize quantitative and qualitative research. But even these references to classical texts of social theory can be seen to decrease over time.

Fourth, we see a high and growing prevalence of race and gender related topics in U.S. sociology in general, both in quantitative and qualitative research. This can be interpreted to a considerable extent as the *issue-based integration* of contemporary U.S. sociology. Such a strong dominance of gender issues cannot yet be observed for contemporary Germany, but, given German sociology's orientation toward the U.S. hegemony, it is not unlikely that comparable tendencies will become more visible in time.

Fifth, overall, we can see relatively stable, path-dependent strands for both national fields. Remarkably, the development of German sociology is characterized by three strands, whereas U.S. sociology only exhibits two strands. The fields' paths prevail today in both countries. This is worthy of attention since, structurally, the larger market of the U.S. with its considerably more core journals could be expected to harbor more strands than the smaller German market.

Sixth, we also see a homogenization process in terms of word use across research strands: For U.S. sociology, we observe an increasing use of terms concerning the topic gender ('gender', 'woman') by authors throughout the entire field. We also see a more homogenous use of the terms 'change' and 'context', which from 2012 are increasingly included by authors from qualitative groups, and of the term 'experience', which is increasingly used by authors from quantitative social research. For Germany, we can show a homogenization of word usage between quantitative and theoretical authors, especially for the term 'time' and between theoretical research and quantitative research, especially for the term 'change'. In contrast, other word usages are stable, such as

methodological terms for quantitative ('survey', 'individual', 'model', 'explain') and qualitative research ('understand', 'explore', 'interview'). In the context of interaction and references, we see no tendencies of homogenization across research strands. Consequently, the discourses of gender and race do, to a certain extent, contribute to a thematic integration of U.S. sociology.

Seventh, despite clear paths, we see patterns of differentiation in the development of both fields. Overall, we see differentiation in the increasing number of groups over time, from four (U.S.) and eight (Germany) groups in 2004–2007 to eight (U.S.) and thirteen (Germany) groups in 2016–2019, respectively. We see a differentiation in thematic terms for the U.S. in qualitative research, as part of the engagement with political action research, as well as other research that addresses gender from a practical or theoretical perspective. For quantitative research, we see a methodological differentiation into research that deals with advanced empirical methods, research that applies basal methods, and research that conducts mixed-methods research under a quantitativeegis. Compared to the U.S., we see a more differentiated structure of the field in Germany from the beginning of the study period: While we see two strands in the U.S., we can observe three strands for Germany, although we are looking at significantly fewer journals in Germany and a more quickly growing field in the U.S. compared to Germany. For each strand, we can identify specific trends of differentiation. We see a differentiation in the German field, especially in the quantitative strand, in the emergence of groups that combine quantitative and theory-based research. In German qualitative research, we see a methodological differentiation into more content-based research, work that reflects qualitative methods technically, and research that uses mixed methods. In contrast, we do not see any thematic differentiation regarding the core topics of quantitative social research: education, inequality, and the labor market.

Eighth, when taken together, the specific cases of the homogenization of word usage – around the topics 'gender', 'change' and 'context' in the U.S., and in Germany for the terms 'change' and 'time' – and the differentiation in methodological and topical terms reveal that differentiation and homogenization can also operate simultaneously. This means that the topic of gender in the U.S. and the terms 'time' and 'change' in Germany are particularly suitable for being treated in different methodological ways and for being integrated into already existing research programs.

In sum, we see an overall pattern of stability for both national fields, with a slight differentiation in methodological and topical terms; a homogenization of the usage of words around the topics 'gender', 'time', and 'change'; and a joint differentiation and homogenization of research in the context of gender, time, and change.

6. Conclusion

In the reflexive self-analysis of science, contemporary research often resorts either to the possibilities of modern data analysis or to elaborate theoretical concepts. As a result, research is conducted either by theory-averse statistical groups or much less empirical, theoretical groups – referred to variously as paradigms or thought collectives. To face this conceptual gap, we have proposed a relational understanding of group formation, stabilization, and reconfiguration in the context of scientific fields. The conceptual

development of group formation motivated the use of hierarchical multi-layered Bayesian stochastic blockmodels. This allowed us to establish connections between multiple indicators of group formation, enabling the analysis of the development of social relationships, cited references, and linguistic concepts over time. Using the cases of U.S. and German sociology, we reconstructed how the group structures of both fields have developed between 2004 and 2019.

Quantitative, individualist research, in both countries, shows particularly stable strands over time and, thus, a strong path dependency (Peacock 2009). In fact, in the U.S. case one can even diagnose an increasing coherence in the rationalist paradigm. For both national fields, qualitative social research cannot be said to show considerable levels of paradigmaticness. Although we observe stability in terms of a broader qualitative epistemology, such as an emphasis on understanding social phenomena, a closer examination reveals the persistence of groups with different topics, methodologies, and references. Qualitative approaches are less rigid in terms of different data sources, topics, methods, and circles of authors. Thus, our results show that, in both countries, the concept of paradigms (Kuhn 1962) or thought collectives (Fleck 1935) can indeed be applied, albeit only to very specific groups and to varying extents.

Regarding social research, we see that both in the U.S. and in Germany, quantitative research and qualitative research become *less theoretical* over time – being free from theory may indeed be interpreted as a constitutive factor of group formation. Hence, our findings for both countries align with the observations of Moody and Light (2006), who identified a transition in research focus from theoretical inquiries to practical, applied research. We can corroborate and further differentiate these findings by showing differences between the German and the U.S. field: Theory has been more relevant in the German field and this relevance is still extant today. The presence of a stable theory group here indicates that dealing with theory is a constitutive group factor. Thus, *despite* fundamental epistemological and theoretical differences and, hence, paradigmatic incommensurabilities, the very act of engaging in theory *at all* in contemporary sociology can foster the formation and stabilization of a group. Overall, the latent order-creating function of theory coexists with an increased relevance of empirical research, even in the subfield of German theory, which has moved closer to empirical applications over time.

A core factor of group stabilization and reconfiguration is to be found in societal and political demands, such as the mechanisms described as academic capitalism. Precisely because external influences such as predetermined research funding topics are becoming more important (Gläser and Laudel 2016; Laudel 2006), paradigms should be less relevant – or only a few paradigms should be suitable for the current situation. In the U.S., almost all groups have been increasingly engaging with issues of race and gender. This overall trend of homogenization is, however, realized based on the respective scientific traditions of quantitative and qualitative research. Thus, we observe, in the specific omnipresent context of race and gender, a continuation of different research traditions where groups are constituted by continually decreasing similarities in collaboration and citation behavior. Just like theory, political demands in the form of topics can be a source of order that scientists then flexibly deal with by adapting their social groups and citation behaviors. Thus, this pattern could be labeled *multiple homogenization*: as

the (re)constitution of groups around a topic that affects the whole field. The relational and multi-layered nature of group formation can manifest in form of power effects: In the U.S., the methodological-individualist paradigm's large degree of paradigmaticness and its fitness vis-a-vis contemporary societal demands can be an explanation for the one-sided orientation of qualitative researchers toward topics, persons, and, ultimately, the epistemology of the dominant group.

Based on the proposed analysis strategy, we see several opportunities and necessities for further research. Our approach offers a distinct advantage by allowing us to examine the dynamic interactions among the practices of collaboration, citation, and topics that constitute groups. This enables us to identify patterns of both homogenization and differentiation in group compositions over time while accounting for an understanding of varying degrees of social and cultural indicators. By considering only one indicator of group composition like topical profiles, we would have established a homogenization of the entire field of U.S. sociology (centered on gender), but we would have overlooked the emerging trends of methodological differentiation. Consequently, further research should aim to refine and expand upon this approach. While we were able to identify clear strands of research, it could be interesting to use a dynamic SBM. This would eliminate the need to create network snapshots, which may differ depending on the research context, and could corroborate the robustness of our results. Additionally, future research should explore the role of language, beyond mere terms, in the development of scientific groups.

A crucial aspect for understanding group formation in science is the meaning actors assign to their activities. The formalization of blockmodels does not allow us to understand the authors' individual motivations, meanings, and strategies. Therefore, further research should complement the quantifying approach using expert interviews of typical scientists from the respective groups, or group interviews, to better understand the practical levels of group formation, stabilization, and reconfiguration. Issues such as the influence of the peer-review process on collaboration, citation, or topics, as well as aspects of social and cultural uncertainty regarding the group formation process (White 2008), should be addressed in these endeavors.

Even without taking into account other publications and their formats, it is a striking finding to identify a comparatively highly differentiated structure in contemporary German sociology. While we focused, in the current paper, on the core of both nations' disciplinary fields, future research should systematically extend the perspective. This comprises broadening the scope of journals to include interdisciplinary journals, thus revealing the extent of the field and its ramifications in other disciplines. Not least, it requires an analysis of other publication formats, such as books on the one hand (in order to take into account the structures of the field that have evolved historically) and gray literature on the other (to include current communication that might not be directed at the professional public). We expect an extension of the data in these ways to shed light on further variations of the national disciplinary fields' different structures and developments; this will both require and enable comparative approaches between different national and regional and, eventually, transnational fields.

Overall, these methodological applications and expansion should also investigate how the embedding of both disciplinary fields in their national traditions impacts group formation in ways that foster homogenization or differentiation. Finally, the interplay of

both of these processes – which we encountered in the case of U.S. sociology and labeled ‘multiple homogenization’ – should be taken into account in future studies.

Notes

1. This paper does not attempt to find the optimal temporal or spatial cluster solution, but rather to propose a methodological strategy that considers group formations from different perspectives (different indicators of constitution as well as different perspectives of observation on both the temporal and spatial dimensions, see Chapter 2). The division into four-year periods resulted from an iterative process aimed at finding a balance between differentiation and stability of the cluster solutions. The goal was to maximize the similarity of individuals within clusters and between clusters of successive years, while ensuring maximum differentiation (as many time windows and as many groups within a time window as possible) and interpretability of the clusters.
2. In order to avoid clustering solutions becoming trapped in local minima, we inferred three blockmodels per time window and chose the one with the smallest description length.
3. The number of publications in the USA increased between the time windows 2004–2007 to 2016–2019 from 2,795 to 3,668 publications. During the same period, there was a rise in the average number of authors per publication (from 1.4 to 1.8), along with an increase in the count of distinct authors (from 3,285 to 5,260).
4. Group U9 is a loose cluster of authors working on issues such as violence against women as well as men and masculinity. Group U15 focuses on the application of ethnography and grounded theory in the field of sport and health. Both groups are relatively weakly integrated and show a low degree of paradigmaticness.
5. Despite the highly integrated groups within the quantitative individualist strand, there are smaller, less integrated groups that also employ quantitative research. For example, Group U4 includes authors who focus on longitudinal educational research and segregation, with a particular focus on race. Similarly, Group U8 works on educational issues with an emphasis on advanced statistical modeling.
6. In Germany, the volume of publications remains relatively constant, averaging between 689 and 834 publications per four-year span, except for instances such as when numerous Special Issues are released within a single time window. Throughout the observation period, there was an increase in the mean number of authors per publication (rising from 1.3 to 1.7), accompanied by a growth in the number of unique authors (increasing from 966 to 1,306).

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