SNSF Starting Grant 2014
Research proposal [Part B1]

Social norms, cooperation and conflict in scientific collaborations

CONCISE

Principal investigator: PD Dr. Heiko Rauhut
Host institution: University of Zurich
Proposal duration: 60 months

Proposal summary: The production of scientific knowledge has dramatically changed from solitary scientists to teams. The increasing social character of science raises the question how scientific discoveries can be achieved cooperatively.
This proposal outlines a unified framework of how social norms contribute to cooperation in scientific collaborations. It builds on the applicant's theory of normative conflicts and derives positive and negative consequences of collaborations in science. On the one hand, norms of prosociality can promote collective good provisions such as sharing data, joint writing and division of labor. Yet, normative conflicts can result from asymmetries between invested time and effort and its outcomes in reputation and prestige. Further, teams may be more prone to norm violations and scientific misconduct.
The research design specifies a triangulation of three different quantitative research methods to overcome their individual limitations and provide a comprehensive understanding. Project A analyzes scientists' "objective" behavior by bibliometric data, allowing the estimation of different disciplinary name ordering norms, normative change and normative conflicts. While sparse, this data yields high-stake behavior without social desirability. Project B analyzes scientists' "subjective" attitudes, beliefs and reported behaviors in surveys. While fine-grained, this is limited by misreporting. Project C uses meta-analyses for estimating the extent, trend and disciplinary differences in publishing biased and fake data. This design requires big data, but overcomes social desirability.
This research program contributes to understanding the consequences of increasingly larger and more interdisciplinary teams in science. It develops a novel theoretical understanding of cooperation norms, allows fundamental insights how distributive justice affects productivity in work groups and organizations and contributes to improving cooperation in scientific collaborations.

Cross-panel and cross domain nature of the proposal: This proposal develops a sociological research framework for studying scientific collaborations. This goes far beyond sociology because of three reasons. First, scientific collaborations are investigated over a large variety of disciplines, including sciences, engineering, social sciences, arts and humanities. Second, the hypotheses are developed from general game theoretical models. These models are state of the art in the newly evolving fields behavioural economics and experimental game theory and are not (yet) common ground in sociology. Third, the empirical methods in part A consider "big data" analysis of the Web of Science data base, containing over 46 million articles over 241 disciplines. This requires statistical programming and advanced data processing, which is more common in computer science than in sociology. The applicant has expertise in all three fields. Since this is rare among sociological experts, a cross-panel evaluation is indicated.

Research question, innovative scope and interdisciplinary nature of the proposal

There is a strong trend towards more co-authorship in all disciplines. Wuchty et al. (2007) show with 19.9 million papers and 2.1 million patents across more than 200 disciplines that "research is increasingly done in teams across nearly all fields" (p. 1036). This trend from solitary scholars to teamwork raises the question how scientific discoveries can be achieved cooperatively.

This proposal outlines a unified framework of how social norms contribute to cooperation in scientific collaborations. It builds on the applicant's theory of normative conflicts and derives positive and negative consequences of collaborations in science. On the one hand, norms of prosociality can promote collective good provisions such as sharing data, joint writing and division of labor. Yet, normative conflicts can emerge from asymmetries between invested time and effort and its outcomes in reputation and prestige. Further, teams may be more prone to norm violations and scientific misconduct.

The research design considers a triangulation of three different quantitative research methods to overcome their individual limitations and provide a comprehensive understanding: bibliometric data, meta-analyses and surveys. This methodology goes far beyond what is typically done in sociology. The hypotheses are developed from general game theoretical models, which become increasingly accepted in the interdisciplinary field of behavioral game theory, but not yet much applied in standard sociology. Further, the "big data" and meta-analyses requires statistical programming and advanced data processing, bridging computer science and sociology. The applicant is one of the few having expertise in all these three fields. The combination of all three methods reflects a research strategy with high risk, but also high potential to gain a more comprehensive understanding of scientific collaborations, teamwork and conditions for cooperation more in general.

Advantages and disadvantages of teamwork

Teams have the advantage that scientists with different skills and strengths can work together. This can lead to a wisdom of crowd effect (Surowiecki, 2004; Rauhut and Lorenz, 2011; Lorenz et al., 2011), where the aggregation of diverse opinions and viewpoints leads to better collective results compared to individual performances. The fact that multi-authored scientific articles receive more citations compared to single-authored ones (Wuchty et al., 2007) may be due to this mechanism.

However, free-riding in teams can also create disadvantages. A multi-authored scientific publication can be regarded as a collective good (Olson, 1965), since authors are rarely excluded from a publications and all authors can freely consume scientific credits from joint publication in terms citations, reputation and improved promotion prospects. Larger groups may be more prone to cooperation failures, because the relation of individual contribution efforts to collective benefits becomes smaller with group size. Each co-author may contribute less for each added member to a research team and large team may even be more prone to misconduct. Another problem, especially in interdisciplinary collaborations, is differences in co-authors' expectations about how much effort and time are appropriate for which author constellation (Maciejovsky et al., 2008).

A theory of normative conflicts and its application to co-authorships

Social norms can promote cooperation in research teams by proscribing collective good provisions such as joint planning, contributions to funding, designing and conducting research, analysis of data and writing. An often taken-for-granted view on social norms is that they have positive effects for society and promote cooperation (Coleman, 1990). Social norms have a double-edge, however. On the one hand, they may promote cooperation, on the other, they can generate conflicts. The perspective of normative conflict is central to this proposal, whose building blocks I have jointly developed with Fabian Winter in a series of publications (Rauhut and Winter, 2010; Winter et al., 2012). The main problem here is not to overcome self-interest but to agree on the norm which should be followed. Normative conflict is defined "as the transaction failure resulting from actors holding partially (at least) exclusive normative expectations" (Winter et al., 2012, p.921).

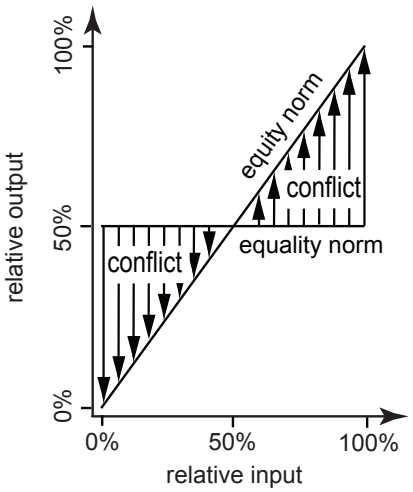

Fig 1. Normative conflicts between team members holding different distributive justice norms (Based on Winter, Rauhut and Helbing (2012)).

Normative conflicts can emerge when team members balance their effort and their output in terms of wage or reputation. One distribution principle is the *equity norm*, where benefits are proportional to investments. An alternative is the *equality norm*, proscribing equal divisions of merits. Both norms can solve cooperation problems in work teams. The larger the differences in inputs, the

larger the conflict potential (Fig. 1).

On a more theoretical level, two factors can trigger normative conflicts Winter et al. (2012). People can disagree on the "level of normative commitment", meaning how strong a norm should restrict self-interest (related concepts are "social value orientation" in social psychology and social preferences in economics). People can also disagree about the content of the norm (e.g. equity vs. equality). One application of normative conflicts to scientific collaborations is the problem how to order names on articles. This can have serious consequences. Einav and Yariv (2006) have shown for economists that "faculty with earlier surname initials are significantly more likely to receive tenure at top ten economics departments . . . , and, to a lesser extent, are more likely to receive the Clark Medal and the Nobel Prize" (p. 175). These norms differ strongy in disciplines (Waltman, 2012), for example non-alphabetical ordering is dominant in psychology and there is co-existence in medicine: with first authorship and last authorship.

Combination of three research methods to overcome their individual limitations

The proposed methods combine three quantitative data sources, subsequently called projects A, B and C. This composition can complement their limitations and combine their potency (Fig. 2). Project A analyzes "objective" scientists' behaviors by using the bibliometric data source Web of Science. This data allows the estimation of different disciplinary name ordering norms, normative change, normative conflicts, inequalities in scientists' careers and their network formation. The strength is that this captures actual behavior, unbiased from misreporting or biased memories. The limitation is the sparseness of the data. Project B analyzes scientists' "subjective" attitudes, beliefs and reported behaviors in surveys. The advantage is more fine-grained information about the causes and consequences of cooperation, norms and punishment of uncooperative collaborators. A limitation is misreporting and social desirability bias. This will be reduced by elicitation of scientists' social value orientation using monetary payoff divisions among the participants, yielding incentive-compatible behavioral data. Project C analyzes actual behavior regarding scientific norm violations in an indirect way to overcome the problem of social desirability in surveys. The extent, trend and disciplinary differences of publishing biased or fake data will be analyzed by collecting a large number of reported test statistics from journals articles in different fields. The strength of this approach is that it is not biased by scientists' whitewashing and denials. The limitation is that a large number of articles is needed to detect publication bias and fake data.

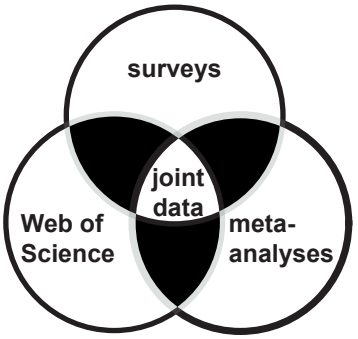

Fig 2. Methodological combination of surveys ("subjective" attitudes, beliefs, reported behaviors) with "objective" behaviors in bibliometric data and meta-analyses of published statistical results.

Project A: Distributional justice norms in team publishing

There is little research on investigating name ordering norms over all fields of science (Frandsen and Nicolaisen, 2010). One major problem has been to cope with the large amounts of bibliometric data available. This is now possible with the Thomson Reuters Web of Science data base, consisting of over 46 million articles, subdivided into 241 disciplines.

One major issue in determining authorship norms is the distinction between intentionally and incidentally alphabetically ordered papers. In the case of two authors, there is a 50 % chance that a paper is alphabetically ordered, although the order has been intentionally based on merit or other principles. For the case of three authors, this probability is 17 %, and more generally, for n authors, the probability of an incidentally alphabetically ordered paper is $\frac{1}{n!}$. Taking this probability, one can estimate the rate of intentionally alphabetically ordered papers, i.e. the prevalence of an alphabetical norm in a field, by adjusting the rate of observed alphabetically ordered papers by the following correction formula (Rauhut and Winter, 2012; Waltman, 2012):

$$\text{p(alphabetical norm)} = \frac{\text{alphabetical rate} - \frac{1}{\text{n!}}}{1 - \frac{1}{\text{n!}}} \tag{1}$$

The first step is corroborating that name ordering norms are largely heterogeneous in different fields. This assumption is crucial for many of the more specific hypotheses of the project. The principal investigator and his collaborator Dr. Fabian Winter has conducted preliminary analyses of the Web of Science data base. This confirms substantial heterogeneity over a selection of three disciplines (Fig. 3), giving weight to the basic assumption that different name ordering norms exist in different disciplines and yields ground for normative

conflicts about contribution credits in interdisciplinary working groups (Fig. 3).

Hypothesis A.1 (Equity trend): *Authors on publications are increasingly ordered non-alphabetically.*

It is expected that the more authors, the more difficult to split up contributions equally. Further, the larger the teams, the larger the diffusion of responsibility (Darley and Latane, 1968). If teams reach a certain size, it takes a "leader" to bring a project forward. Due to these factors, it is expected that there is a trend towards equity-based contribution norms regarding non-alphabetical name ordering.

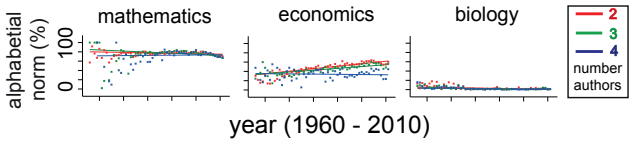

Fig 3. Trend of intentionally alphabetically ordered papers in three fields over 50 years subdivided by author group sizes. Preliminary data analysis of the Web of Science data base by Rauhut and Winter (2012).

Hypothesis A.2 (Interdisciplinary normative conflicts): *The larger the differences in name ordering norms in the co-authors' disciplines, the less citations.*

Conflicts can arise from different disciplinary cultures, in which authors have been scientifically socialized. Often, social norms are taken for granted and are not explicitly stated up front. Scholars from different disciplines may have increasingly different expectations and conflicts, the larger the differences in the empirically measured name ordering norms of their disciplines. More citations are used here as proxy for valuable work and – inversely – less citations as proxy for conflicts. These comparisons should also take control variables into account, for example journal impact factors and the number of co-authors.

Hypothesis A.3 (Z-effect on working alone): *The later the position of the surname initial of scientists, the higher the probability to work alone. This effect becomes stronger, the stronger the alphabetical norm in the field (interaction effect).*

Authors with late surname initials have decreased visibility in fields with an alphabetical norm. In the case of three authors, a paper is typically abbreviated by "first-author et al." with the effect that the first author receives higher visibility. In addition, bibliographies are often alphabetically ordered with the implication that even for two authored papers, the first author receives higher visibility.

The state of the art primarily investigated disadvantaged surname initials in economics over a short period of time. However, this project allows a full-fledged analysis of the implications of inequality in surnames in all academic fields over a longer period of time. This allows to test the following novel idea. Authors with later positions of surname initials in the alphabet have a higher probability to work alone. In addition, this effect becomes stronger, the stronger the alphabetical norm in the field. This interaction effect will be called the "Z-Hypothesis" (see Fig. **??**). The following logistic regression model will be estimated separately for each of the 241 academic fields:

$$\log \frac{\pi(\text{single author})}{1-\pi(\text{single author})} = \alpha + \beta \cdot \text{letter}. \qquad (2)$$

Here, π is the probability of being a single author of one publication of one specific author in the database. "Letter" is the standardized position of the surname initial in the alphabet with $A = 1/26, B = 2/26, \ldots, Z = 26/26$. By ordering the estimated 241 logit coefficients by the alphabetical norm in each field, it is possible to test the Z-hypothesis as sketched in Fig. **??**. The increasing effect of logit coefficients for increasing alphabetical norms can be estimated using a linear (or non-linear) fit through all coefficients, weighted by the inverse of the standard error.

Project B: Norm perception and social value orientation

An online survey will be conducted, starting with scholars at Swiss universities and and extension of EU and US universities. Researchers from social sciences, natural sciences, engineering and medicine at different points in their careers are targeted. In case some universities do not provide their address list, student assistant will collect respective Email addresses from the scientists' homepages. Step 1 is the Swiss pilot of 100 participants. Step 2 is the full Swiss survey with 1000 participants. Step 3 considers the extension extended to European and US universities, when design and questionnaire is improved based on the analysis of the Swiss data. The target sample size of the extended study is 3000, allowing comparisons of countries, elite and non-elite universities and fields, all of which with different Ph.D. programs, academic job markets and tenure procedures.

Distributive justice norms in research are elicited by vignettes, using the survey design of Maciejovsky et al. (2008). Vignettes show name ordering examples of hypothetical publications. Respondents have to evaluate

whether authors contributed equally or unequally to the work (Fig. **??**.) Vignettes vary in alphabetical order and number of authors. This measures the extent to which co-authors from different fields have different opinions about how much a first, second, third or forth author should have contributed to a paper.

Hypothesis B.1 (Prosocial scientists in team disciplines): *The larger the research teams, the stronger the scientists' prosocial value orientation. These disciplinary differences become larger, the higher the scientists' career status (interaction effect).*

The questionnaire also contains a novel, sensitive and high-resolution measure of social value orientation, called the SVO slider measure (Murphy et al., 2011). The measure has six main items, asking for divisions of joint money between the respondent and another participant in the survey. This allows the computation of types (Fig. 4), reflecting respondents who maximize other's payoffs (altruistic), joint payoffs (prosocial), own payoffs (individualistic), or differences between own and others' payoffs (competitive). It is expected that the larger the researchers' teams and the larger the average team size in the respondents' discipline, the stronger the prosocial value orientation. In contrast, researchers in small teams have stronger individualistic orientations.

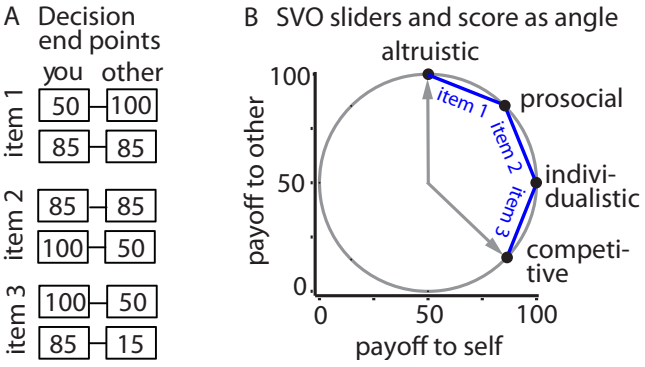

Fig 4. Simplified social value orientation slider measure (Murphy et al., 2011).(A) Monetary payoff allocation between two scholars. (B) Self-other allocations plane, where divisions "slide" between pure types (blue lines).

Project C: Team effects on publishing biased and faked results

This project will analyze violations of scientific norms in research groups, ranging from biased publication strategies to faking data. The conjectured relation between misconduct and team size can go in either way.

Hypothesis C.1 (Social control): *The larger the team, the less norm violations.*

There is more social control in larger co-author groups (Auspurg and Hinz, 2011). Compared to working alone, other researchers receive insider knowledge in the data collection and production process of an article. The more co-authors, the higher the probability that one of them has a skeptical attitude and demands receiving in-depth information on the production process of critical results. Hence, the more co-authors, the less scientific misconduct (*control hypothesis*).

Hypothesis C.2 (Volunteering): *The larger the team, the more norm violations.*

There is more diffusion of responsibility in larger co-author groups. The more authors, the higher the probability that all involved authors think that the others closely checked data collection or processed results, while in fact, nobody did it. The fact that the probability of volunteering decreases with increasing group size is well known by "diffusion of responsibility" (Darley and Latane, 1968) and the "volunteer's dilemma" (Diekmann, 1985). Applied to scientific collaboration, we would expect that with more co-authors there is more scientific misconduct (*volunteer hypothesis*).

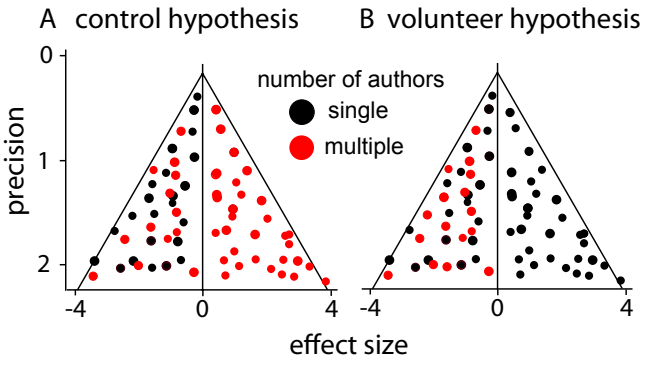

Fig 5. Funnel plots of standardized effects against precision (hypothetical data). Panel A shows the control hypothesis with biased publishing of solo authors (skewed black funnel), panel B the volunteer's hypothesis with biased publishing in teams (skewed red funnel).

The research design of this project utilizes meta-analytic methods from statistics and computer science to detect scientific misconduct. The first kind of misconduct is the so-called "publication bias". The publication bias is defined as a biased selection of published results in favor of the research hypothesis. This can be explored by so-called funnel plots (Light and Pillemer, 1984; Weiss and Wagner, 2011). The method requires to collect a large sample of reported test statistics from journal articles in order to plot effect estimates at the horizontal axis against precision of tests at the vertical axis. If there is no publication bias, the plot resembles an inverted funnel. If there is bias, the funnel is asymmetric and skewed, because confirming studies have a higher likelihood to be published.

In addition, more serious misconduct of publishing fake data will also be investigated. It will be tested whether published regression coefficients follow the Benford distribution (Tödter, 2009) and whether distributions of t-values have suspicious peaks (Caliper test). In addition, questions about scientific misconduct will be included in the survey of scientists (project B), using methods for reducing social desirability bias, i.e. the randomized response and item count method.

Importance and impact

Due to the dramatic change from solitary researchers to teamwork in virtually all disciplines, we need solid evidence about causes and consequences of research in teams. From a practical point of view, the project will suggest optimal team compositions, flexible ways of conflict resolution and recommendations for productive, fair and accepted name ordering norms for different fields and team sizes. More fundamentally, the project yields a novel theoretical understanding of how social norms and cooperation are interlinked. While the current state of the art emphasizes the positive aspects of social norms on cooperation, this project sheds novel light on the negative facets, including normative conflicts despite all good intentions. The project also contributes to organizational sociology, labor economics and management by showing under which conditions effort-based reward schemes generate higher outputs and when equality-based principles.

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