OPEN INNOVATION IN SCIENCE (OIS)

Research Conference

2021
April 07–09

LUDWIG BOLTZMANN GESELLSCHAFT

CBS COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN

IFEE Institute for Endowment Management and Entrepreneurial Finance | ESMT BERLIN

FTE NATIONALSTIFTUNG
FORSCHUNG | TECHNOLOGIE | ENTWICKLUNG

Welcome to the Open Innovation in Science (OIS) Research Conference 2021!

The year 2020 has been challenging in many ways. But it also allowed us to see the power of openness and collaboration in science and innovation: Never before has humanity developed, tested, and manufactured multiple effective vaccines in less than a year.

Developments like these highlight the importance of understanding the antecedents, contingencies, and consequences of applying open and collaborative practices along the entire process of generating and disseminating scientific research.

The aims of the OIS Research Conference, thus, remain to
- Inspire discussions around an integrated and contingent view on the role and value of openness and collaboration in the context of science,
- Connect researchers across various disciplines, and
- Link different streams of research on open and collaborative science as well as science-based innovation

To achieve these goals, this year's (virtual) OIS Research Conference features a variety of interactive sessions, including high-quality research paper sessions, an OIS Debate, an inspiring keynote speech, a selection of OIS cases, and, as it has become a tradition, an OIS experimentation session.

Starting at the last conference, 47 co-authors from the natural and social sciences as well as the humanities collaborated successfully to conceptualize, write, and publish an article on the "Open Innovation in Science (OIS) Research Field" (see Beck et al., 2020). We continue to experiment with novel approaches to our own research also this year: We focus on scientific agenda-setting and test a novel approach to co-produce research proposals inspired by the "users" of our research: Scientists.

It is wonderful to see that the scientific community around Open Innovation in Science is prospering and thriving. Thank you for your commitment to the OIS research community, and for joining us on our journey to better understand and shape the future of science and innovation!

Best regards,

The Organizing Committee

The Organizing Committee

MARION POETZ

Scientific Director &
Associate Professor

Copenhagen Business School &
LBG OIS Center

SUSANNE BECK

Senior Post-doc &
Conference Coordinator

LBG OIS Center &
Copenhagen Business School

HENRY SAUERMANN

Professor

European School of Management
and Technology Berlin

CHRISTOPH GRIMPE

Professor

Copenhagen Business School

Contents

OIS

KEYNOTE

Keynote
by Hila Lifshitz-Assaf
April 07 I 12:30 – 13:45

Hila Lifshitz-Assaf

Associate Professor of Information, Operations and Management Sciences at NYU Stern School of Business

- Faculty associate at Harvard University, at the Lab for innovation Science
- Her award-winning research focuses on developing an in-depth empirical and theoretical understanding of the micro-foundations of scientific and technological innovation and knowledge creation processes in the digital age
- Among other projects, she conducted an in-depth 3-year longitudinal field study of NASA's experimentation with open innovation online platforms and communities, resulting in a scientific breakthrough.

Keynote:
"Openness and collaboration in scientific research: From NASA, to crowds and AI"

OIS DEBATE

OIS Debate:
The potentials of Citizen Science beyond its usual scope of application
April 07 I 17:00 – 17:50
Moderator: Henry Sauermann

Panelists

Kevin Crowston
- Distinguished Professor of Information Science and Associate Dean for Research at the Syracuse University, School of Information Studies
- Editor-in-chief of ACM Transactions on Social Computing and co-editor-in-chief of the journal Information, Technology and People
- His research focuses on examining new ways of organizing made possible by the use of information technology

Marisa Ponti
- Senior lecturer at the Department of Applied IT at the University of Gothenburg
- Her fields of expertise include Data, Data Infrastructure and Citizen-Generated Data; Human Computation in Citizen Science; and Citizen Science and Sustainability
- Her research focuses on the design of machine-human cooperation to advance collective knowledge for scientific activities and solve social problems

Jacob Sherson
- Jacob Sherson holds a joint professorship at the departments of Physics, Management and Cognitive Science at Aarhus University
- Founder and Director of the Center for Hybrid Intelligence and the game-based citizen science platform ScienceAt-Home with more than 300,000 contributors
- In his interdisciplinary Center, both human and algorithmic problem solving is investigated through the lens of machine optimization, psychology, cognitive science, and behavioral economics. Apart from natural and social science games, he is also investigating large-scale game-based assessment of both basic cognitive skills and 21st century skills like creativity

OIS EXPERIMENTATION SESSION

OIS Experimentation Session:

Experimenting with a novel open and collaborative approach to setting scientific research agendas

April 08 I 15:45 – 18:00

At each year's OIS Research Conference, we experiment with a novel way of incorporating open and collaborative approaches into our own research in the fields of science and innovation studies. This year, we will experiment with a novel format to set research agendas: Scientists from different fields share challenges they have faced when practicing OIS, i.e., when they apply open and collaborative approaches in one or more stages of their own research.

A big thank you to the following scientists who kindly agreed to share their OIS challenges and by doing so, inspire the development of new OIS research projects:

Michael Doser

Research physicist (Antimatter, Antihydrogen, Gravity)
CERN

Melinda Goodyear

Senior Research Fellow
Child Mental Health & Behavioral Neuroscientist
Monash University

Nora Katona

Researcher focusing on the prevention of torture, ill-treatment and human trafficking
Ludwig Boltzmann Institute of Fundamental and Human Rights

OIS EXPERIMENTATION SESSION

OIS Experimentation Session:
Experimenting with a novel open and collaborative approach to setting scientific research agendas
April 08 I 15:45 – 18:00

Markus Mitterhauser

Director Ludwig Boltzmann Institute Applied Diagnostics
(Radiopharmacy, Experimental Nuclear Medicine, Applied Diagnostics, Molecular Pathology)
Medical University of Vienna

Francesco Moscato

Associate Professor in Biomedical Engineering
Center for Medical Physics and Biomedical Engineering
Medical University of Vienna

Muhammed Sameed

Quantum physicist and antimatter expert with a focus on accelerator technology and applications
ALPHA Experiment
University of Manchester and CERN

Inspired by these "problem pitches", conference participants co-develop OIS research proposals by discussing:

- what we already know about this OIS challenge from the existing literature and what don't we know
- what we, consequently, might be interested in further investigating (research question and/or hypotheses)
- how we could answer this question or test these hypotheses methodologically (develop first ideas)

The results of this rapid prototyping process for generating new OIS research proposals are summarized in a collaboratively written article (developed as part of an online process after the conference) that will be published (open access) in the CERN IdeaSquare Journal of Experimental Innovation (CIJ).

By involving the "users" of our scientific research and engaging an interdisciplinary group of scientists, we aim to contribute to agenda setting in the fields of science and innovation studies and prototype an OIS approach for doing so.

A special thank you also goes to the group of facilitators who actively guide the proposal development process during the OIS experimentation session (alphabetical order):
Carolin Häussler, Hila Lifshitz-Assaf, Maria-Theresa Norn, Alexander Ruser, Christopher Tucci, and Philipp Tuertscher.

SESSION 1

Paper Session 1: Academia-Industry Knowledge Transfer

April 07 | 14:00 – 15:15

Chair: Susanne Beck

Discussants: Markus Nordberg & Valentina Tartari

Paper 1:
Get away from or near to competitors: Competitor ties and academic collaborations

Yajing Li

Previous studies on indirect ties with competitors have largely shown a potential negative effect for firms based on the knowledge leakage argument through the shared third party, and studies find that firms are more likely to avoid indirect ties with competitors. However, prior studies on indirect competitor ties have investigated the for-profit third party rather than nonprofit third party. I contrast the effect of indirect competitor ties in these two contexts and propose that in the nonprofit third party context such as academic collaborations, knowledge leakage is less a concern because academic institutions embedded in the academic logic have low motivation to leak and tacit scientific knowledge is more difficult to leak. Instead, firms seek to reduce uncertainties by imitation and are more likely to form indirect ties with competitors. Analyses of research collaborations of publication co-authorship between US biotech and pharmaceutical firms and US academic institutions support my model.

Paper 2:

Open science in the dark: Examining inside-out innovation in drug discovery

Alex Graddy-Reed, Maryann Feldman, Janet Bercovitz

Open innovation, the managed flow of information across organizations, has the potential to increase scientific output, notably within drug discovery. We examine a dramatic example of inside-out open innovation case of Published Kinase Inhibitor Set (PKIS). In 2011, the pharmaceutical firm GlaxoSmithKline (GSK) decided to distribute materials and full documentation of scientific discoveries related to what is known as the Dark Kinase – called dark due to the previous lack of scientific attention. While protein kinases had emerged as one of the most successful sources of cancer drugs, the broader scientific community was focusing on only 20 percent of the several hundred kinases found in the genome. Prior to 2011, GSK scientists had published their protein kinases work in literature, sending a signal that the company was interested in this topic, however, further follow-on research was not forthcoming. In order to encourage further exploration and advancement of the science from the research bench to marketable drug compounds, GSK provided a set of 367 kinase inhibitor compounds along with documentation (the PKIS) to scientists. GSK did so at no charge, with no restrictions, and no expectation of direct value capture. In this paper, we examine the open science experiment of GSK's PKIS. Our case highlights that even when knowledge was initially placed in the public domain and seemingly open, there were still significant transaction costs that limited the ability of external players to use the knowledge. We then consider the strategic implications of "extreme" open science that extends beyond publications to providing compounds for the development of pharmaceutical products.

Paper 3:

The real effects of financial markets on scientific disclosure: Evidence from a quasi-natural experiment

Stefano Baruffaldi, Markus Simeth, David Wareham

While innovation disclosure is essential for cumulative knowledge production and economic growth, evidence on firm incentives to disclose scientific research outcomes is still lacking. Firms are active contributors to the stock of scientific knowledge, but appropriability concerns are strongly pronounced in the context of corporate research. This poses the question under which conditions firms pursue strategies of scientific openness. We examine the role of financial markets, and especially the public financial information environment, in firms' decisions to disseminate scientific research results. We posit that firms use scientific publications as a signal to reduce information asymmetries with regard to investors. We analyze our research question using a representative sample of US publicly listed firms for the years 1997 – 2014. We employ a quasi-natural experiment that exploits plausibly exogenous variation in analyst coverage, resulting in higher information asymmetries. By applying a difference-in-differences methodology, we find that firms respond by a quick and enduring increase in scientific publications outcomes, whereas other innovation-related metrics such as patents and R&D expenditures remain unchanged. In particular, a reduction of one analyst leads to an increase of scientific publications by about 13%. This effect also extends to the quality of the scientific output in terms of citation-weighted publications and collaborative publications with academic institutions. We also show that disclosure decisions are shaped by financial constraints and managerial incentives. Firms increase scientific publication outputs especially when they are financially constrained and when CEO's have personal motives to reduce information asymmetries. We discuss important implications, such as potential crowding out effects between corporate governance initiatives and socially desirable scientific disclosure. Overall, our study provides new insights into the micro-foundations of scientific openness strategies in the corporate context.

SESSION 2

Paper Session 2: Crowd Engagement and Collaboration in Science

April 07 | 15:30 – 16:45

Chair: Julia Suess-Reyes
Discussants: Lars Frederiksen & Jacqueline Lane

Paper 4:
When crowds judge science: Citizens' evaluations of scientific research proposals

Chiara Franzoni, Henry Sauermann, Diletta Di Marco

Decisions about the direction of scientific research have for a long time been made primarily by professional scientists or administrators. However, non-professional citizens have started to influence research agendas by providing input to policymakers and funding agencies or allocating their own resources to specific projects through crowdfunding. While advocates hope that such processes can help "democratize" science and steer research towards greater societal relevance, skeptics are concerned that crowds are unable to assess the scientific merit of projects or may favor projects based on personal agendas and interests. In this study, we examine how members of the general public ("the crowd") evaluate scientific research proposals.

In the conceptual part of the paper, we start from the criteria traditionally used by professional funding agencies: (1) scientific merit of the project, (2) social impact of the work, and (3) capabilities of the researchers. We then discuss how crowd members might evaluate these three dimensions and which dimensions they prioritize when deciding whether to support a research project. We also consider potential heterogeneity among citizens, hypothesizing how project evaluations may differ depending on citizens' personal relationship with the proposal topic, the level of education, as well as the level of income.

To investigate these questions empirically, we study how the crowd evaluates research proposals posted on the crowdfunding platform experiment.com in the fields of social sciences, biology, and medicine. We asked more than 2,000 workers recruited on Mturk to evaluate these projects along with the three criteria (scientific merit, social impact, researcher capabilities). We also elicited respondents' stated preferences (i.e., recommendations) and their revealed preferences (i.e., real money donations) for seeing the project funded.

Our empirical results provide insights into the weights crowd members assign to scientific merit, social impact, and researcher capabilities when deciding whether to support a project. Simultaneously, qualitative analysis of open-ended responses suggests that crowd members do not always interpret these three attributes in the same way professional scientists would. Given that crowd evaluations of social impact are a key focus in policy discussions, we benchmark crowd assessments of social impact against objective measures of importance such as the burden of disease. Finally, we examine the relationships between project evaluations and citizens' individual characteristics, finding significant effects of the personal relevance of the topic, the level of education, and income.

We discuss contributions of our findings to the literature on crowd and citizen science as well as the literature on the economics of science. We also consider potential implications for scientists, policymakers, and funding agencies.

Paper 5:

Quality is in the eye of the beholder: Campaign strategies for crowdfunding of science

Christian Hopp, Jermain Kaminski, Montserrat Prats-Lopez, Ward Ooms, Fenia Aivaloglou

Ever since philosopher Auguste Comte used public funds to finance his work as a philosopher, academics have experimented with different types of private and collective capital to escape the institutionalized grant application processes in lieu of more informal ways and means to garner external financial support.

In this research, we analyze 1,848 scientific crowdfunding campaigns on Experiment.com, ranging from the years 2013 to 2019. Building upon theories and hypothesis of legitimacy, identity mechanisms, associative mechanisms and audience heterogeneity, we analyze effects of gender, institutional affiliation, reputation, as well as narrative structures in text and speech content. Preliminary results point towards higher success likelihoods of female-lead and dominantly female-composed crowdfunding teams, higher chances of reaching the campaign goal with more analytic and authentic language in video presentations of projects, as well as the financial support by backers with academic affiliation. Further, campaigns that are supported by super-backers, i.e. backers supporting more than 5 campaigns at the point of a project's inception, are more successful in reaching the funding goal, and reaching a higher total funding amount. We currently do not find conclusive evidence that campaigns from THE 500 ranked universities (top 500, top30) perform better than non-THE ranked universities, hence pointing towards other signals than institutional affiliation in scientific crowdfunding. Furthermore, we currently do not find evidence that emotionality in language, or signals of expertise in speech and text content help campaigns being more successful.

Paper 6:

Assembling the collaboration puzzle: Integrating dispersed knowledge on individual-level antecedents of scientific collaborations with non-professional scientists

Susanne Beck, Agnes Effert, Olga Kokshagina,
Karin Hoisl, Marion Poetz

The production of scientific knowledge increasingly involves collaborations at eye-level with individuals not primarily employed in the academic science system such as citizens, patients, managers, or specific groups such as indigenous people. Proponents of this research approach claim that such collaborations yield promising benefits for science (e.g., diversity gains that can lead to more novel research ideas, approaches, and solutions) and for society (e.g., learning effects, democratization of science). However, although research in various disciplines such as biology, ethics, engineering, innovation, or health care increasingly implements and investigates this type of collaborations, the discussion has so far remained within the boundaries of the respective disciplines. This research would benefit, however, from a cross-disciplinary discussion, as this is the only way to get a comprehensive picture of the conditions under which they occur, how the processes are organized, and under which conditions they can be successful or are likely to fail. We focus on the role of individuals within this form of scientific collaboration and want to understand the individual-level drivers that foster and barriers that inhibit such collaboration (i.e., attitudes, beliefs, personality traits, demographics, abilities and skills). A major challenge is to achieve a unified understanding of the role of individual-level drivers of and barriers to such collaborations, given the diversity of the stakeholders involved and the collaborative approaches used. This integrative review addresses this challenge by synthesizing the important but fragmented existing knowledge on individual-level antecedents. We do so by classifying collaborations along three dimensions, building on the OIS conceptualization:1) field proximity, 2) number of different stakeholders involved, 3) participation because of professional vs. personal expertise. This approach allows us to collectively consider stakeholder groups that have previously been discussed separately, for instance, because they are characterized by different forms of collaboration (e.g., citizen science or university-industry collaborations). We systematically review a set of 78 articles published between 2000 and 2020 across all disciplines that test, propose, or reflect upon individual-level antecedents for scientific collaborations. This dataset is the result of a multi-step screening and coding procedure applied to 33,216 papers retrieved through a keyword search in two major publication databases (Scopus and EBSCOhost). Our analysis reveals micro-level factors influencing three outcome dimensions: 1) the general willingness to engage in a collaboration, 2) the collaboration process, and 3) the (perceived) collaboration outcome. The resulting integrative framework further distinguishes between individual-level drivers of and barriers for scientists and non-scientific stakeholders, as well as those resulting from their interaction (e.g., developing common goals). Based on this framework, we outline propositions for future research on micro-foundations of scientific collaborations, contributing to the literature on the organization of science and distributed knowledge production. The adoption of this framework will allow the accumulation of empirical research into a cohesive body of knowledge about the micro-foundations of collaboration.

SESSION 3

Paper Session 3: Infrastructures and Organizational Design for OIS

April 08 | 12:45 – 14:00

Chair: Rosalia Bitterl

Discussants: Philipp Tuertscher & Jonathan Wareham

Paper 7:
Open sharing of scientific equipment: Performance lifecycles and diverse user groups

Cornelia Lawson, Ki-Seok Kwon

Access to equipment and facilities is particularly crucial for science. These often represent a strategic resource in the race for priority and the past decades have seen an explosion in the need for scientific instruments and equipment (Stephan, 2012; Hubert 2017). As part of a policy push towards open science, the open sharing of research facilities have emerged as one area of policy action, to foster new research and innovation. Yet, while sharing of equipment comes with opportunities for both sharers and users, it may also create problems, for instance if use time is diverted from core science activities towards routine service provision. The crowding out of basic research in particular could hamper the research progress promised by open science (Flanagan et al. 2003). This paper empirically investigate the shared use and performance of 187 items of equipment held by a national science infrastructure in South Korea between 2014 and 2018. We find that the equipment is used by a diverse set of users, with universities and small companies being most prominent. On average each item analyses more than 600 samples a year and earns about €30k per year. Performance in terms of service income follows an inverse u-shape that appears to be in line with the general depreciation value of the equipment. Each item of equipment also produces about 5 publications per year on average. Science performance in terms of publications increases along the equipment lifecycle, but this growth becomes weaker and publications by internal users are gradually replaced with external publications. We also find that different user models could impact this balance. A dominance of industry users has potential negative effects on publications and crowds out impactful internal research. Our results further show that only user models that prioritize public users, such as universities, can produce new science. These results present the first quantitative evidence of equipment performance and how it relates to user models and lifecycle. This research is preliminary but has the potential to inform institutions that seek to share their equipment. It also has potential to develop theory around equipment lifecycles and user models.

Paper 8:

Exploring organizational design for openness and collaboration in scientific organizations

Susanne Beck, Marcel LaFlamme, Robin Brehm, Marion Poetz

Academic scientists are increasingly expected to conduct their research in an open and collaborative manner, crossing disciplinary and organizational boundaries as well as those of the science system to increase productivity and impact. These expectations are being shaped by ecosystem-level actors such as funding agencies, but also by communities of researchers seeking to advance priorities ranging from reproducibility to social equity. Scientific research organizations such as universities or research institutes have been slower to examine their role in purposefully fostering openness and collaboration, even as a trend towards managerialism has progressively enmeshed organizational priorities with individual researchers' agendas and workflows. This raises the question of how and to what extent scientific organizations as such can facilitate or block researchers from engaging in open and collaborative research practices. To answer this question, we take an Open Innovation in Science (OIS) perspective, which seeks to unify diverse practices of scientific openness and collaboration as applied along the entire process of generating and disseminating new scientific insights (e.g., collaborations with citizens, companies, and other external stakeholders, as well as open approaches to sharing data, material, or publications). We operationalize this perspective by focusing on scientific activities that involve researchers engaging in open or collaborative practices that a) go beyond their own research organizations, and b) cross either the boundary of their discipline or of the science system. We investigate our research question from an organizational design perspective and explore two in-depth case studies of scientific organizations, drawing on data that includes 63 interviews, 4,129 pages of secondary material, and field observations. Our analysis resulted in a list of 30 factors, grouped into seven clusters (strategy, leadership, processes, structure, infrastructure, people, and culture), which were found to facilitate or block researchers from engaging in open and collaborative practices. Subsequently, we reflect on these results against the backdrop of three contingencies linked to the particularities of the science system: namely, the scientific field, the OIS practice applied, and the intensity of organizational influence on researchers within the organization. For example, implementing a strategy to provide direction for OIS activities was found to be a powerful driver of openness and collaboration in organizations with a high intensity of organizational influence, while an organization with a low intensity of influence on researchers may find the implementation of such a strategy impractical. Also, interestingly, the OIS practice applied did not substantially influence the effect of most of the identified drivers and barriers, providing support for the OIS perspective's integration of different open and collaborative practices. Our findings contribute to the literature on the organization of science and hold meaningful implications for research policy as well as for managers of scientific organizations.

SESSION 4

Paper Session 4: Data Sharing
April 08 | 14:15 – 15:30

Chair: Marcel LaFlamme
Discussants: Kevin Crowston & Gernot Pruschak

Paper 9:
The stickiness of scientific data

Laia Pujol Priego, Jonathan Wareham

Researchers are generating unprecedented volumes of data (Hey 2009). The huge expectations on big and open scientific data have situated data as a relevant scholarly object and have eclipsed the research policy debates. There is a large consensus about the goodness of scientific data sharing, the reasons being: reproducibility; to increase scientific quality, to improve problem-solving and fraud prevention, and to increase scientific efficiency by reducing redundancy and innovation gains (Borgman 2015; Edwards et al. 2011; European Commission 2019; OECD 2015; Tenopir et al. 2015). At the policy level, greater emphasis has been placed since the last decade on transparency and public scrutiny in research processes: Starting with open access publishing, it soon expands towards open scientific data, open standards, open bibliography, open lab-notebooks, open-source software and hardware, and the list continues endlessly including the qualifier 'open' to all activities of the scientific endeavor (Kupferschmidt 2018). Yet, scientific data sharing poses new questions for the incentives and rewards scholarly system, but also to the challenges of "misuse, misinterpretation, liability, lack of expertise, lack of tools and resources, lack of credit, loss of control..' that researchers claim (Pasquetto et al. 2017) p. 32; Tenopir et al. 2015; Wallis et al. 2013). While sharing scientific data has been discussed for some time now, only in recent years, the range of challenges is becoming apparent. The phenomenon remains poorly understood to make effective progress towards an increase of data flows in the scientific community. Hence, the research questions that this study asks are: Do researchers share their data? How do they share their data? Which mechanisms emerge to enable researchers to share their data?

To answer our research question, we engaged in a mixed-methods design by combining: a) survey data collected in 2018 to explore data sharing behaviors of scientists across disciplines and countries, implemented with the support of Elsevier in the framework of Open Science Monitor developed for the European Commission from 2018 – 2020; which we compare to the results of a consistently designed survey in 2016 implemented by Elsevier; with b) qualitative data from a case study sequentially sampled within one of the disciplines displaying the highest rates of data sharing and reuse across scientists to explore plausible explanations about the factors enabling scientists' data-sharing behaviors and elaborate in the quantitative results from the survey (Creswell 2018).

As a lens to understand scientific data-sharing practices, our study confronts two theoretical perspectives: We bring a cultural perspective from sociology of science around the notion of 'epistemic cultures' which help us explain the heterogeneity of practices of scientists towards data sharing that the survey data uncovers; and b) a rational perspective from the classic collective action theory, which provides a useful framework to explain why researchers would contribute with their data to collective resources and governance mechanisms that set the conditions for scientists to share. We contend that their insights and the dialogue of both perspectives could fruitfully inform what we know about scientists' data-sharing practices.

Paper 10:

Big data and open data in scientific research: A new paradigm?

Agustí Canals, Alexandre López-Borrull

The recent big data hype has emphasized data analysis as one of the main sources of knowledge generation. Of course, the idea of data as a fundamental element for the existence of knowledge is not new. But the possibility of acquiring and analyzing large amounts of data from varied sources at high speed (the so-called 3 V's of big data) has become possible only lately in many areas. Therefore, many companies are starting to rely on machine learning algorithms applied to huge databases to know more about their customers, their competitors, or their environment.In other fields, though, this trend is not new at all. In many fields of science like high energy physics, genomics or astrophysics big data have been there for a long time. For instance, the famous High Energy Physics experiments that have taken place at CERN in the last decades would have been impossible without the capacity to gather, combine and analyze the large streams of data churned out by their huge particle detectors. Similar cases are those of the Human Genome Project or the large telescopes.

However, some authors go beyond the acknowledgment of this trend, advocating for a change of paradigm in scientific research. Is it possible to do science just by analyzing large amounts of empirical data, with no need for theoretical models? How will open data and, more generally, the open science movement affect the way in which science is done?

To shed some light on these issues, in this paper we will examine how the process of extracting knowledge from data as it is performed in one of the most complex experiments ever: the ATLAS experiment. ATLAS is one of the main experiments of the Large Hadron Collider at CERN, where the Higgs' boson was detected.

Relying on a knowledge management approach, our research combines archival research on the ATLAS experiment documentation with in-depth interviews with several physicists and engineers conducted at CERN in the last years. We look at different aspects of the generation of scientific knowledge from data like the research data management, data infrastructures, collaboration in data analysis, the role of simulations or the validity of scientific knowledge derived from data. We also examine the ATLAS policy on research data management and their bet for open science through CERN's Open Data Portal.

Some of the insights we extract from this research may be useful not only to those interested in the nature of the scientific endeavor, but also to scientists in other fields now getting into big data like some areas of social science (i.e., computational social science), and also to companies and institutions testing the waters of the big data business.

Paper 11:

Feeding a virtuous cycle of co-creation by sharing knowledge through Biological Resource Centers

Fabian Hans, Riold Furtuna, Samantha Zyontz, Carolin Haeussler

Open Science holds the potential to generate more and highly impactful research (e.g., Furman & Stern, 2011; Murray et al., 2016). In doing so, Open Science builds on the importance of openly sharing and accessing knowledge, data, or scientific tools (e.g., Mukherjee & Stern, 2009; Nielsen, 2011; Murray et al., 2016). There are many reasons for sharing knowledge (or not) (e.g., Andreoli-Versbach & Mueller-Langer, 2014; Thursby et al., 2009), but few empirical studies investigate the consequences of sharing, especially of publicly sharing (intermediate) research results via, for example, repositories (Haeussler et al., 2014; Boudreau & Lakhani, 2015). Initial research shows a positive effect of Biological Resource Centers (BRCs), i.e., repositories, on cumulative knowledge production (Furman & Stern, 2011).

In addition, there has been a rise in collaborative research (Wuchty et al., 2008; Jones, 2009). Concurrently, a substantial literature stream emerged focusing on inter-institutional collaborations (e.g., Katz & Martin, 1995; Adams et al., 2005; Cummings & Kiesler, 2007; Jones et al., 2008) or collaboration networks (e.g., Newman, 2001; 2004). Recently, studies have been interested in how such collaborations form (e.g., Heinze & Kuhlmann, 2008; Stephan, 2012; Boudreau et al., 2017; Chai & Freeman, 2019). However, whether and how data and knowledge sharing via repositories is related to the formation of inter-institutional scientific collaboration is still missing in current research.

To fill this void, we build from a unique data set on the rapidly evolving DNA-editing technology, CRISPR. The data set combines data of more than 10,000 publications from Microsoft Academic Graph (complemented with Web of Science) as well as depositing and ordering information on more than 12,000 scientific tools from Addgene, a key repository for plasmid sharing (LaManna & Barrangou, 2018). We use network analysis (Newman, 2001; 2004) to investigate how new collaborations between (inter)national research institutions emerge. Then, we apply a diff-in-diff model (e.g., Furman & Stern, 2011) to compare the variance in scientific co-creation between institutions before and after CRISPR tools became available on Addgene.

Our study contributes to science in science (e.g., Wuchty et al., 2007; Jones et al., 2008) and Open Science literatures (e.g., Mukherjee & Stern, 2009; Vicente-Saez & Martinez-Fuentes, 2018) in two ways. First, we illustrate the diminishing impact of proximity on the formation of new types of (inter)national research collaborations within an influential and exploding technology. Second, we demonstrate how research collaboration formation is influenced by sharing via repositories. Thus, we empirically show how knowledge sharing and collaboration as conceptual components of Open (Innovation in) Science interrelate.

We also contribute to research on data and knowledge sharing (e.g., Furman & Stern, 2011; Haeussler et al., 2014). In doing so, we provide further insights into the role that repositories have in democratizing scientific tools and in functioning as catalysts of inter-institutional research collaboration. Thus, we build on Isaac Newton's statement "If I have seen further than others, it is by standing on the shoulders of giants" (Furman & Stern, 2011) and add the opportunity of co-creation with the giant.

Paper Session 5: Crowd and Citizen Scientists' Engagement
April 09 | 10:00 – 11:15

Chair: Henry Sauermann
Discussants: Marisa Ponti & Christopher Tucci

Paper 12:
An explorative study of the influence of emotions on online participation in crowd science

Alex Cayrol, Thomas Gillier, Olga Kokshagina

Online platforms are fast becoming powerful instruments for conducting scientific research projects in an open collaborative style. Crowd science involves a larger number of contributors with unique and diverse skills at a lower cost than traditional scientific research. Unfortunately, maintaining crowd science communities are challenging due to sparse and uneven participation (Franzoni & Sauermann, 2014; Sauermann & Franzoni, 2015). Volunteer participations often tend to be quite low and unequal (Cooper et al., 2010; Ortega et al., 2008). An important amount of works shows that participation depends on individual characteristics such as intrinsic motivation (Arguello et al., 2006), personality traits (Cullen & Morse, 2011; Nov et al., 2013) and values (Grace-Farfaglia et al., 2006). Another research stream shows that participation in online communities also depends on how individuals communicate, behave and interact among each other (Rodgers & Chen, 2005; Bisgin et al., 2010; Casaló et al., 2013; Dennen, 2014).

However, much less research has been done to understand how the emotional content of messages influence participation in online communities. Prior research has shown that online messages could become viral due to their emotional tone ((Berger & Milkman, 2012) and influence others' behavior (Cheshin et al., 2011; Van Kleef, 2016). Unfortunately, prior findings are still limited about which emotions encourage online participation (Lee & van Dolen, 2015; Garcia et al., 2016). As a consequence, this article aims at exploring the influence of emotional tone of the messages on participation in crowd science.

This study is an exploratory analysis of Polymath, a crowd science project in mathematics (Gowers & Nielsen, 2009). Using the Linguistic Inquiry and Word Count (LIWC), this research measures the emotional content of the posts of four successful Polymath projects. Based on count panel data analysis (fixed effects), our results show that online participation does not depend on the valence of the emotion (ie. negative or positive emotion) but online participation rather depends on the emotional intensity of the posts. Our finding show that an inverted U-shape relationship between emotional intensity and online participation. Participation tends to increase with the rise of emotions, however, too much emotions decrease participation. Furthermore, our results show that ambivalence (i.e., expressing high positive and negative emotion at the same time) also follows an inverted curvilinear relationship with participation. Participation tends to increase with the rise of ambivalence, but too much ambivalence decreases participation.

These findings suggest that participants should avoid posting extremely positive or negative messages in crowd science. Instead, a moderate level of both positive and negative messages must be encouraged. This research provides first empirical evidence about the influence of affective factors in crowd science communities.

Paper 13:
Cognitive abilities in the wild: Population-scale game-based cognitive assessment

Mads Kock Pedersen, Carsten Bergenholtz, Janet Rafner, Steven Langsford, Jacob Sherson

Psychology and the social sciences are undergoing a revolution: It has become increasingly clear that traditional lab-based experiments fail to capture the full range of differences in cognitive abilities and behaviours across the general population. Some progress has been made toward devising measures that can be applied at scale across individuals and populations. What has been missing is a broad battery of validated tasks that can be easily deployed, used across different age ranges and social backgrounds, and employed in practical, clinical, and research contexts. Here, we present Skill Lab (https://www.scienceathome.org/games/skill-lab-science-detective/), a game-based approach allowing the efficient assessment of a suite of cognitive abilities. Skill Lab consists of six games that measure fourteen different cognitive abilities. All games are validated against traditional, computerized cognitive ability tasks. We have engaged players beyond a traditional lab in a crowdsourced population-size sample recruited in collaboration with the Danish Broadcast Company (Danmarks Radio, DR) leading to 13.289 having played at least one game. The participants are broadly representative of the main demographics of the Danish population. A main feature of the setup is that our game-based measures are five times faster to complete than the equivalent traditional cognitive abilities tasks. Importantly, we are able to replicate well established findings on the decline of cognitive abilities with age in this large population sample, providing confidence in the overall validity of the gamified approach. Furthermore, in collaboration with psychologists, political scientists, management and entrepreneurship researchers we have added a survey portfolio to the Skill Lab environment, and 720 participants have played the games as well as answered the survey. This allows us to associate answers to questions about risk and entrepreneurial intentions (among other variables) with players' cognitive abilities. Preliminary analysis indicates that there seems to be no relation between risk and executive functioning. Yet, in contrast to Jack-of-all-Trades theory we find that people with greater variation in cognitive abilities had higher entrepreneurial intentions. Overall, we consider this work a first step towards crowdsourcing population wide collection of individual behavioral data, as well as facilitating broad collaboration across sciences to facilitate answers to a range of questions that in the past were logistically difficult to address. The pre-print can be accessed here: https://psyarxiv.com/m6awp/.

Paper 14:

Co-creation in (citizen) science: Unbundling the concept and identifying key challenges

Julia Suess-Reyes, Susanne Beck, Robin Brehm, Marion Poetz, Henry Sauermann

Co-creating together with citizens is increasingly gaining importance in science. As a force for democratization of science it promises to generate meaning for all involved parties, rather than being just an alternative research approach. Some of the expected benefits of co-creation in science include addressing grand societal challenges, developing novel and effective solutions and bridging the ivory divide between science and society. However, the foundations of the concept remain fuzzy in the science context, hindering the development of a solid knowledge foundation. While much has been written about co-creation in other areas, for example, customer involvement, design co-creation and co-created learning, insights regarding co-creation in a science context are limited. This paper addresses this gap first by conceptualizing a refined definition of co-creation in science and second, by providing empirical insights about key challenges of co-creating citizen science. First, extending previous suggestions, we specify four underlying dimensions and define co-creation in science as (1) the joint creation of knowledge by citizens and scientists, (2) where citizens contribute effort and knowledge, (3) in at least one of the stages of the research process and (4) have non-trivial decision rights in at least one of these stages. Second, looking into the field of citizen science, we can observe a recent trend moving from contributory projects with rather low-complex labor inputs by citizens towards more co-creative approaches that grant citizens enhanced decision rights and include them along different stages of the research process. In doing so, we collect data from ten heterogeneous co-created citizen science projects varying along the dimensions of co-creation (i.e., regarding the type of citizens' contributions, the steps in the research process with citizen involvement, and their level of shared decision rights) and with regard to exogenous criteria such as the research field. In total, we conducted 23 interviews, while considering both the project coordinators' and citizen scientists' perspectives in each of the cases. The data from the interviews was triangulated with secondary data such as scientific publications, podcasts, press releases and project websites. Through an inductive-deductive iterative coding process, we identify key challenges which are summarized in a conceptual model. In doing so, this paper extends contemporary knowledge about the concept of co-creation in a science context and offers insights on related core challenges in citizen science. This knowledge can, for instance, be used by professional scientists and citizens to inform how they can collaborate and by policymakers and funders as part of designing grant requirements. Thus, our findings contribute to the scholarly knowledge in the areas of the organization of science and distributed knowledge production.

SESSION 6

Paper Session 6: Micro-foundations of Networks and Collaborations

April 09 | 11:30 – 12:45

Chair: Christoph Grimpe

Discussants: Janet Bercovitz & Michael Rose

Paper 15:
Bridging the gap: Boundary spanners' selective network mobilization across the industry-academia divide

Valentina Tartari, Anne ter Wal, Maureen McKelvey

Network boundary spanners have been shown to be in a privileged position to generate innovation outcomes, yet it is unclear how they decide which contacts to rely on when. This paper posits that many boundary spanners will forgo the opportunities their structural position affords, as stronger identification with one of the two domains they span may lead them to predominantly mobilize network contacts in that domain, irrespective of the type of input specific situations may require. We argue that those with a high self-monitoring orientation, however, will overcome tendencies to have identity inform network choices, and will thus selectively mobilize contacts from both sides of the boundary. We test these predictions in the context of scientists with dedicated boundary-spanning roles between industry and academia who are expected to routinely draw on network resources on both sides of the "divide" to perform their jobs. Using a multi-study setup which includes two framed field experiments, we find support for our predictions. Our findings imply that it may not be sufficient for organizations seeking to promote the cross-fertilization of ideas to allocate individuals to boundary-spanning roles; they need to train and encourage their staff to identify with the domains at both sides of the boundary to enable selective network mobilization to help them leverage the potential from boundary spanning.

Paper 16:

Mobilising informal networks for open science practices in biomedicine

Adrian A. Diaz-Faes, Pablo D'Este, Óscar Llopis

Interdisciplinarity and co-creation are becoming powerful catchwords in current debates about creativity and innovation in scientific knowledge production. Science policy initiatives and research funding agencies increasingly exhort scientists to undertake research approaches that are interdisciplinary and integrate scientist and non-academic communities. However, despite its discursive prominence, we know little about the micro-mechanisms underlying knowledge production in academic practice that involves interdisciplinarity and co-creation, and to what extent these research practices contribute to creativity and innovation in science.

Social network research has shown that social interaction is a powerful vehicle for knowledge creation and innovation (Granovetter, 1983; Hansen, 1999). This paper takes a relational approach to personal networks and focuses on how resources are mobilized through research networks (Borgatti and Cross, 2003; Levin and Walter, 2019; Walter et al., 2015). We investigate the specific benefits of research networks involving collaboration between actors belonging to different professional domains and institutional settings, and examine the specific type of resources mobilized by diverse research network configurations. This perspective contrasts with more standard network approaches that examine the structural aspects rather than the network mobilization decisions (Balkundi et al., 2007; Burt, 2004; Tan et al., 2015).

Social network research shows that new knowledge accessed through network ties is crucial for the initial (idea generation) phase (Baer, 2012; Perry-Smith and Mannucci, 2017), but this is not the only benefit flowing through a tie. We draw on Levin et al. (2011) and examine several types of resources that can be mobilized through networks, including intangible (knowledge related and legitimacy) and tangible resources (materials and equipment, funding). Additionally, we take into consideration network diversity by examining two types of actor heterogeneity: cognitive (i.e., diverse professional practices) and institutional (i.e. diverse organization affiliation).

By delving into the resources that flow through networks, we shed light on questions related to whether interactions with particular type of actors are conducive to idea generation and/or idea implementation processes; and about the specific type of benefits researchers gain when mobilize networks formed of highly heterogeneous actors. Answering these questions will provide valuable insights to understand the underlying collaborative dynamics in open innovation environments.

Our theoretical claims are tested in the biomedical setting. This context provides a unique opportunity to examine the importance of personal research ties formed by academics, and how such ties provide diverse sets of benefits. Our study draws on a large-scale survey conducted in 2018 on Spanish biomedical scientists. Among other questions, respondents were asked to report their main professional contacts, along with the specific type of benefits(s) received from each contact. This allows us to depict our respondents' social structure of collaboration and to dig deeper onto the specific type of benefit received from each tie. The questionnaire was administered to 5,325 biomedical scientists. We received 1,146 valid responses, an overall response rate of 21.5 percent.

Paper 17:

Opening up science for a sustainable world: A new expansive normative structure of open science and innovation in the digital era

Rubén Vicente-Saez, Robin Gustafsson, Clara Martinez Fuentes

New digital technologies and tools, together with evolving open digital and physical infrastructures, are re-modelling science and innovation practices at universities and challenging their existing cultures, norms, missions, and policies. The purpose of this empirical study was to understand how existing and recently adopted open science practices and the underlying principles and norms of research teams support the advancement of knowledge and the development of actions, solutions and technologies for sustainable development. We studied 23 research teams at Aalto University in Finland from the disciplines of science, engineering, art, design, architecture, electrical engineering, and chemical engineering that perform research and innovative work that addresses the grand challenge of combating climate change and its impacts. The specific objectives of our study were to first expose how the four dimensions of openness in science – transparency, accessibility, authorization, and participation (Vicente-Saez, Gustafsson and Van den Brande, 2020) - were present in research teams working on sustainability, specifically in the area of climate change. Second, we aimed to identify commonalities as well as distinctive features in open science practices adopted by research teams working on climate change issues. Third, we analyzed both the efficiencies gained and the key challenges prevalent in opening up science encountered by research teams. Finally, we aimed to identify the impact of open science practices on the role of scientists and their teams when researching and developing actions, solutions and technologies for sustainable development. The results of this study provide novel insights and important suggestions for directions on how to advance open science and innovation policies at universities for a sustainable economy, society, and environment and therefore for a sustainable world. First, we infer an expansive normative structure of open science among researchers working on sustainability, including institutional goal, norms, and practices, which are key for designing and fostering efficient science public policies in the digital era. Second, we reveal a major update in open science practices that has occurred in sustainability research among forerunner research teams. We identify how open data practice has radically transformed university research teams' processes of collecting, evaluating and circulating data and designing and performing scientific studies. We also identify how transdisciplinary research practice by research teams has enlarged their research process in terms of academic and societal engagement and collaboration by recognizing and including new participants in every stage of the research process. Finally, we reveal how a new academic entrepreneurial ethos that embraces open science norms, observed among many of the research teams we studied, is contributing to the evolution of the role of researchers and, with it, the traditional process of knowledge value creation and transfer – the innovation process - in the digital era. Based on our findings, we propose an expansive normative structure of open science and innovation to guide the renewal of the governance of research and innovation at universities in the digital era.

Virtual Poster Session: Learning about OIS cases
April 08 | 11:00 – 12:30

VIRTUAL POSTER SESSION

Project 1:
Enabling seamless international collaboration in science: ScienceMesh for the European open science cloud

Angelo Romasanta, Jonathan Wareham

Project 2:
Contemplative scientific collaboration: A CERN-inspired vision for a mindful research culture

Wolfgang Lukas

Project 3:
SciNote: A digital tool to facilitate social learning, complex problem solving and scientific argumentation

Janet Rafner

Project 4:
Connecting.Ideas4Research: Crowdsourcing for innovative research ideas – reflections on exemplary use cases with communities of practice

Harald Kleinberger-Pierer, Matthias Werner

Project 5:
Design tools to embed science-driven inputs into human-centered design processes

Bernardo Balboni, Clio Dosi, Silvia Marchini, Giuseppe Mincolelli, Matteo Vignoli

Virtual Poster Session:
Project 1–5:
April 08 | 11:00 – 12:30

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