Atlanta Conference

On Science and Innovation Policy

OCTOBER 9-11, 2017 ATLANTA, GEORGIA USA

GEORGIA TECH GLOBAL LEARNING CENTER

Abstract Book

atlantaconference.org

Carlos Aguirre-Bastos, Andrew Cummings, Mariabel Dutari, Diana Candanedo and Anthea Villanueva

A new generation of research and innovation policy in Panama: Overcoming the linear model and facing the challenge of inclusive development

Session 3A

Considerable advances in the fight against poverty have been made in developing countries in the past two decades. These were facilitated by favorable international economic conditions and adequate macroeconomic policies. In spite of these advances the rate of progress towards social inclusion remain slow. Particularly hit by exclusion and poverty conditions are indigenous communities.

In the case of Panama, studies show insufficient spillover from economic growth to improved well-being and further, due to the phasing out of large infrastructure projects, the lack of an industrial policy and other weaknesses in the business sector, growth is expected to decline in the coming years, thus endangering social advances. In such a context, the definition of public policies with sufficient strategic depth and long-term vision is of high priority.

In 2015, Panama adopted for the first time an explicit, long term, research and innovation policy. The policy and the five-year strategy that implements it, adopts, also for the first time, an effective system's approach and calls for the national system of innovation to strengthen its governance and scientific capacities to face the grand challenges of competitiveness, sustainability and inclusiveness.

Such approach to policy formulation is an important first step to overcome the linear model of innovation, still entrenched in many developing countries today. It is considered that the new policy provides a great opportunity to deal successfully with re-focusing the national innovation system to face the challenge of inclusion. Thus, in this way, research and innovation policy has an advantage point articulated with many other policy domains.

Against this backdrop, this presentation argues that there is a need to develop new policy tools as a distinct set of policy-making instruments, in order to effectively set the national innovation system to face the challenge of inclusive development in its two key interrelated dimensions, inclusive innovation and innovation for social inclusion.

The interest in defining new policy tools arises also and most importantly because of the prominence of the complex problems that have to be addressed by developing countries that defy standard policy approaches.

This latter requirement highlights the need to move towards a culture of "dialogue between knowledges". The approach is a new tool, in line with the vision that the crux of the matter to overcome exclusion is to revise the relationship between institutions and structures, as well as with an ample array of agents. The creation of a 'dialogue-pact' is a political instrument to implement in a democratic context, policies and institutional reforms with a medium and long-term strategic perspective, with smaller risk of being reverted.

The development of policy tools that would allow to bridge innovation at large with social inclusion can be conceived as starting from a set of basic principles. In first place, the importance of poor and often marginalized groups of actors needs to be highlighted, as these should be seen as potential consumers, producers and business partners as well as innovators in their own right, rather than passively remaining dependent on the developed world's social and economic structures and cultures.

Through their own independent social and economic innovation systems, the communities at the periphery can start from where they are, use their own resources and ingenuity, in combination with relevant external resources, to address their own particular social needs and support transformative social change in their own way. Such approach provides the communities with a sense of belonging and empowerment that they lack when policy takes a traditional top-down approach.

The "dialogue between knowledges" is not addressed to identify problems being faced by the communities, but rather to facilitate the latter to explain their understanding of their situation in their own terms. This approach overcomes the traditional "diagnosis" and tries to avoid terms such as problems or needs, so much embedded in development

literature and practice. It is also an additional step to those methods applied to promote or to reach the periphery with social innovations.

Of key importance in the definition of new policy tool is the identification of the community's cosmo vision, as a long-term vision, strongly linked to concepts such as territory, mother earth and so on. The understanding of the cosmo vision cannot be considered simply as an anthropological task; rather it is a way to rediscover more efficient techniques of production and management. This is where a development vision based on a dialogue between local traditional knowledges and new scientific knowledge becomes possible.

Once the cosmo vision is well understood, scientists can offer their knowhow. This is equivalent of asking how the scientific community can help the periphery to construct their future and take it out of exclusion. Such approach would also facilitate to construct a new type of foresight technique, as the approach is in effect part of a prospective dialogue, tuned to integrate the local community into the innovation system under its own visions.

The mutual understanding that comes out of the dialogue between knowledges would then permit to define "innovative initiatives for inclusive development" conducted by both the traditional innovation system actors and the local communities, integrated into the system. Such initiatives can identify successful experiences and existing limitations in the implementation of social policies and redefining them under a vision of research and innovation and determine what type of approach for technology transfer and innovation can be applied to specific poor settings

Finally, the outcome of the dialogue will lead to set a research and innovation led mission that will help to "convert the local indigenous community into an entrepreneurial and prosperous setting under their own definitions".

Jeffrey Alexander, Kirsten Rieth and Rainer Hilscher

A Capabilities-Based Approach to Identifying and Assessing Emerging Technologies

Session 3D

There are many existing methods for identifying emerging technologies. Most conventional approaches involve consultations with a set of subject matter experts. Examples of these include "blue-ribbon committees" of eminent researchers (such as the U.S. Defense Science Board), Delphi studies, and analyst reports that combine secondary research and interviews with relevant scientists and engineers. More recent "data-driven" approaches attempt to broaden their range of scanning beyond the expertise and network of individuals, leveraging the growing repositories of digitized technical Information. For example, the Foresight and Understanding through Scientific Exposition (FUSE) program (funded by the Intelligence Advanced Research Projects Activity, or IARPA, from approximately 2011 through 2016) created a system called Copernicus that extracts novel terms from scientific documents and predicts which ones have the greatest potential to achieve prominent usage in the future. Terms are assumed to be a proxy for an emerging technology or research topic. Market research company GartnerGroup charts emerging technologies on its proprietary “hype cycle” graphic, a broadly generalizable framework for classifying technologies by phase of emergence.

These methods produce forecasts in different formats, with varying types of evidence and conclusions. We have conducted interviews with current and potential users of technology forecasting reveals challenges in applying these forecasts to decision-making:

1. Lack of clarity on what constitutes a “technology.” Analyses use varying levels of analysis, ranging from an entire domain of research (e.g., nanotechnology) to systems combining multiple innovations (e.g., autonomous vehicles) to very specific, targeted applications (e.g., quantum cryptography).

2. Inconsistent criteria for labels such as “emerging” or “disruptive.” These terms are used with the assumption that they have standardized meaning, but that assumption is rarely true. For example, forecasters do not have well-defined criteria that distinguish an “emerging” technology from a “nonemerging” or “established” technology.

3. Ambiguity around data selection, processing, and analysis. Most methods generate results from a specific type of data collected with a particular mode, for example, transcripts of interviews with experts or analysis of terms appearing in patent claims. The method may not explain how or why its particular source dataset was constructed.

4. Absence of a useful means of comparing the reliability of detection methods. A recent report from the Tauri Group noted that many published technology forecasts are so vague about their assumptions and terms that the accuracy of a particular forecast may be impossible to determine, even in retrospect. Analysts are therefore unable to improve outcomes by aggregating forecasts.

Almost any extant forecasting approach focuses on identifying and characterizing discrete technologies and their potential development, with too little attention to the context in which a technology is created and its intended and unintended applications. We note that in the process of “emerging,” technologies undergo fundamental changes in their potential and actual usage, which in turn shapes downstream development of that technology.

Based on inputs from our user interviews, we present a new theory-driven framework for identifying emerging technologies of potential interest to a given audience. We start by defining a technology (following the work of Prof. W. Brian Arthur) as the embodiment of a principle of nature (revealed through scientific discovery) that is exploited to enable a new capability previously unattainable by humans. For example, the airfoil uses basic principles of fluid dynamics (drag and lift) to enable human flight. An aircraft uses the airfoil and also integrates other component technologies, such as turbojet engines, to enable faster flight over longer distances. The crucial aspect of interest is the capability rather than the particular technology. For any given innovation there are often competing approaches to enable a particular capability, although eventually the market standardizes on one or a few approaches.

Our framework uses a structured set of ontologies that link technologies to their intended and potential capabilities via measures of their functional performance. For a given technology, we identify (1) the capabilities enabled by that technology, (2) how we measure the degree to which the technology can provide each capability, (3) the underlying

scientific principles or natural phenomena that the technology exploits, and (4) some characterization of how the technology might be used in a specific context. By analyzing technologies in this way we are able to compare different technologies and describe their potential relationships to one another, and to the range of current and potential applications for those technologies.

In this paper, we present a background on technology forecasting issues from the point of view of decision-makers interviewed for our study. We then offer the theoretical basis for our framework, and examples of how it can inform future-oriented technology analysis. We also provide examples of how this approach to detecting and describing emerging technologies that can support related policy and strategy decisions, such as evaluating a portfolio of technology investments.

Erik Arnold and Katharine Barker

Using past learning in research and innovation policy to inform the development of third-generation system governance: Evidence from Sweden

Session 3A

This paper reports ongoing research on the role of evaluation and other factors in policy learning. There is growing consensus that increasing focus in research and innovation policy on the 'societal challenges' such as climate change, ageing population and the need for massively increased productivity in the healthcare sector requires significant changes in governance, policy instruments and evaluation styles. Some of these challenges will require deliberate transformations in socio-technical systems that have not been attempted before. While evaluators like to see their own role in the 'policy cycle' as key to learning, the literature suggests a much wider range of drivers. We aim to identify significant learning events in Swedish research and innovation policy over the last 30-40 years that have been marked by the innovation of new-to-the country policy instruments and to understand change drivers in each case. Cross-analysis of the cases will then enable us to identify and contextualise the drivers for policy learning and to draw inferences about the sources of learning likely to be helpful in devising and implementing policies to address the societal challenges.

Joaquín M. Azagra-Caro, Anabel Fernández-Mesa and Nicolás Robinson-García

Getting out of the closet: Scientific authorship of literary fiction and knowledge transfer

Session 1

Some scientists write literary fiction books in their spare time. If these books contain scientific knowledge, literary fiction becomes a mechanism of knowledge transfer. When this is the case, in the framework of the distinction of formal versus informal knowledge transfer, we conceptualize literary fiction as non-formal knowledge transfer. We model knowledge transfer as a function of the type of scientist (academic or non-academic) and the field of science. Academic scientists are those employed in academia and public research centers whereas non-academic scientists are those employed in other sectors with a scientific background. We also distinguish between direct knowledge transfer (the book includes the scientist's research topics), indirect knowledge transfer (scientific authors talk about their research with cultural agents) and reverse knowledge transfer (cultural agents give scientists ideas for future research). Through mixed-methods research and a sample from Spain, we find that scientific authorship accounts for a considerable percentage of all literary fiction authorship. Academic scientists do not transfer knowledge directly so often as non-academic scientists, but the former engage into indirect and reverse transfer knowledge more often than the latter. Scientists from History and Philosophy stand out in direct knowledge transfer. We draw propositions about the role of the academic logic and scientific field on knowledge transfer via literary fiction. We advance some tentative conclusions regarding the consideration of scientific authorship of literary fiction as a valuable knowledge transfer mechanism.

Ravtosh Bal, Alexandra Meikleham, Lisa Maria Negro, Charles C. Onu and Matthew Harsh

Visualizing research landscapes in sub-Saharan Africa: The case of computer science

Session 5B

Introduction

STI indicators are integral for formulating effective and appropriate policies for linking research funding and research agendas to social and economic challenges. The African Union, recognizing the need to strengthen Africa's S&T capacity, adopted a plan of action to develop STI indicators for the African continent leading to the publication of STI indicators for 35 countries in 2013. Bibliometric analyses based on these indicators reveal that the average growth rate of scientific production in Africa is faster than that of the world as a whole; the number of publications across all fields of science are increasing; and international collaborations are more common than regional collaborations (African Innovation Outlook II, 2014). Other bibliometric studies corroborate these findings (Adams et al., 2014; Confraria & Godinho, 2014; Onyancha & Maluleka, 2011; Pouris & Ho, 2014; Toivanen & Ponomariov, 2011). However, there remain unique challenges facing the development of STI indicators in the African context.

Standard metrics that focus on journal publications, citations, and patents do not present a complete picture of research productivity in Africa. Publication counts are the most common indicator to evaluate research productivity of universities and scientists, using databases like the Web of Science or Scopus. These databases are biased towards English-speaking publications placing research conducted in other languages at a disadvantage (Archambault et al., 2006). A large amount of research in Africa is published in gray literature (working papers, reports, publication of non-governmental organizations, etc.) or only published as MSc or PhD thesis (Abrahams et al., 2008; Harsh & Zachary, 2013). In addition, much of African research is published in local journals that remain invisible to the global scientific community (Tijssen et al., 2006). The invisibility of this research raises important issues about the criteria and methodology for measuring scientific productivity and research capacity, evaluating research performance and understanding the impact of research in Africa.

Objectives

The aim of our paper is to reduce this invisibility and map the contours of computer science research activity in sub-Saharan Africa. Computer science is central to the Information and Communication Technology for Development field that is producing important technological innovations that have the potential to transform the quality of life in the Global South. In addition, computer science with its low-capital costs of research and potential for a higher degree of collaboration over the internet, allows researchers from the Global South to surmount the barriers of geographical marginality, expensive infrastructure and high research costs. It is thus important to visualize the field of computer science in Africa, and measure its impacts in order to guide policy and practice in an area of scientific activity that has the potential to transform lives.

Our specific objectives are to map African computer science research productivity; visualize collaboration patterns and networks based on a variety of research outputs; and examine impact beyond scholarly impact to understand the transformation of knowledge into local applications.

Methods and Findings

Our methodology combines bibliometrics, altmetrics, web mining, and survey analysis to visualize the current landscape of computer science research in sub-Saharan Africa. In order to build an exhaustive database of computer science researchers we mined data from the webpages of 94 universities known to have graduate programs in computer science and related fields like information systems. We focused on specialized computer science databases such as ACM, IEEE Xplore, and Inspec to download articles from the region for the period from 1978 – 2015. In addition, we used academia.edu, an academic networking site, to download research articles, papers and other forms of research output to construct a database that is not restricted to journal articles. Lastly, a survey was administered to computer science researchers in the region. Vosviewer was used to visualize co-word analysis of titles and collaboration patterns while the survey responses along with altmetric data were analyzed to understand the broader impact of research.

The results suggest that traditional bibliometrics are inadequate to capture the range of research outputs that are an indicator of research productivity and of research capacity. The scale of computer science research productivity in sub-Saharan Africa is larger than that indicated by standard databases. The number of internationally published papers is only part of the total research productivity of computer science researchers. The use of altmetrics is effective to reveal some of the otherwise invisible research but these are not without drawbacks. Our analysis of collaboration networks reveals patterns similar to those indicated by earlier research on African scientific activity in general with a select number of highly productive countries, low regional collaboration, and higher collaboration with the North. Lastly, broader societal impact of research remains difficult to measure quantitatively, but online survey methods can provide useful data about the attitudes and perceptions of researchers regarding the impact of their work.

These findings contribute to developing a more complete picture of computer science research in sub-Saharan Africa that can help in formulating more effective STI policies to increase the growth and impact of this field. The analysis also illustrates the importance of developing different metrics to account for the specificity of a country's context, which can complement standard metrics when assessing the country's scientific performance.

References

1. Abrahams, L., Burke, M., Gray, E., & Rens, A. (2008). Opening Access to Knowledge in Southern African Universities. Southern African Regional Universities Association, Johannesburg.

2. Adams, J., Gurney, K., Hook, D. & Leydesdorff, L. (2014). International collaboration clusters in Africa, Scientometrics, 98 (1), 547–556.

3. African Innovation Outlook (2014). NPCA, Pretoria.

4. Archambault, E., Vignola-Gagne, E., Cote, G., Lariviere, V. & Gingras,Y. (2006). Benchmarking scientific output in the social sciences and humanities: The limits of existing databases. Scientometrics, 68(3), 329–342.

5. Confraria, H. & Godinho. M.M. (2014). The impact of African science: a bibliometric analysis. Scientometrics, 102(2), 1241-1268.

6. Harsh, M. & Zachary, G. P., (2013) Computer science research capacity as a driver of ICTD innovation: institutional factors in Kenya and Uganda. Internet and Communication Technology for Development 2013 Proceedings, ACM 978-1-4503-1907-2/13/12.

7. Onyancha, O.B. & Maluleka, J. R. (2011). Knowledge production through collaborative research in sub-Saharan Africa: how much do countries contribute to each other's knowledge output and citation impact? Scientometrics, 87(2), 315-336.

8. Pouris, A. & Ho, Y. (2014). Research emphasis and collaboration in Africa. Scientometrics, 98(3), 2169-2184.

9. Tijssen, R., Mouton, J., Van Leeuwen, T. & Boshoff, N. (2006). How relevant are local scholarly journals in global science? A case study of South Africa. Research Evaluation, 15(3), 163-174.

10. Toivanen, H. & Ponomariov, B. (2011) African regional innovation systems: bibliometric analysis of research collaboration patterns 2005–2009. Scientometrics, 88(2), 471-493.

Sondra Barringer, Erin Leahey and Misty Ring-Ramirez

How Interdisciplinary are University Research Centers?

Session 5E

Introduction

Administrators, researchers, and public officials view interdisciplinary research (IDR) as a panacea for higher education and the complex problems of the modern world. But we are just beginning to understand the process of interdisciplinary research: where it is undertaken, by whom, and to what end. Research to date focuses largely on scientists housed within university research centers (RCs), which are research-focused entities housed within a university outside the purview of a single department (Leahey, Beckman, and Stanko 2017; Kaplan, Milde, and Cowan 2017; Biancani et al 2013). Most of these studies presume, rather than investigate, that RCs are inherently interdisciplinary (Bozeman and Boardman 2013, Sabharwal and Hu 2013). Moreover, federal funding flows to research centers with the presumption that this will catalyze IDR; but this may be premature. Although some studies have found evidence of interdisciplinary engagement within RCs, there is also likely wide variation across RCs: some may foster interdisciplinary research more than others.

The interdisciplinary nature of RCs is an open, empirical question, one that should be addressed before RCs are implicated in the push toward IDR. Toward this end, we develop a sophisticated and nuanced approach to measure the interdisciplinary nature of RCs, one that joins the benefits of rich content analysis with the broad scope of machine learning for large textual datasets. We describe our new approach in detail so that others may implement it, and present results that reveal that university research centers are anything but homogenous when it comes to interdisciplinary research.

Data, Measures, and Approach

For the top 157 research universities in the United States (according to the Basic Carnegie Classifications), we collected data on all constituent RCs from the Gale Research Centers Directory (n=9,211 centers). The directory contains information on the RC name, contact information, and keywords describing center mission and activities.

In order to classify these RCs as interdisciplinary or not, we engaged in semi-supervised machine learning, which is a two-step process. Machine learning is a form of natural language processing that identifies patterns in labeled textual data and, along with “features” or rules provided by the researcher, classifies similar pieces of text into distinct categories. It is a useful tool when researchers hope to classify amounts of text that are too large to code manually (e.g., when you have over 9,000 RCs) —especially when researchers suspect there may be subtle patterns in the textual data that human coders are likely to overlook.

In the first step, we manually coded (or labeled) a small, separate dataset of RCs culled from six universities just outside our sample in terms of ranking. To do this, we developed a detailed set of coding guidelines that was built upon: (1) previous research on interdisciplinary fields (Brint et al. 2009, Olzak and Kangas 2008), (2) an understanding that centers’ self-identification as interdisciplinary matters, and (3) consideration of the distance among research fields (i.e., some fields are cognate fields, others are more intellectually distant). With these guidelines, our team manually coded each RC and reconciled discrepancies.

In the second step, we developed a computer algorithm (or “classifier”) to categorize each RC as interdisciplinary or not. As input, we provided the machine classifier with a set of 159 manually labeled RCs and an extensive set of features that likely indicate interdisciplinarity (e.g., inherently interdisciplinary fields like nanotechnology, or the pairing of two or more stem words, like BIO and CHEM). After an initial classification, we engaged in active learning, which involves interactively and manually coding ambiguous cases the classifier has identified, in order to improve the classifier. Our classifier reached an overall accuracy rate of 90.4%, meaning that the label the machine assigned to a piece of text matched the coding of a human coder more than 90% of the time.

Findings

Extant research, which largely presumes that RCs are interdisciplinary, has not been entirely in the wrong. Indeed,

almost two-thirds (63.55%) of the 9,211 RCs we examined – all housed at research universities nationwide – were classified as interdisciplinary. At the same time, more than a third (36.45%) of research centers are not interdisciplinary. This important finding demonstrates that 1) a tight link between RCs and IDR cannot be presumed, and 2) the mere existence of research centers alone cannot indicate interdisciplinary activity. We also found variation in the prevalence and interdisciplinarity of RCs in different fields. The highest percentage of RCs are in the broad fields of Medical and Health Sciences (20.95%) and Engineering and Technology (17.65%); however, RCs in Education as well as Regional & Area Studies are the most likely to be interdisciplinary.

Conclusions, Implications, and Future Directions

Our findings indicate that treating RCs as a proxy for interdisciplinarity, or unilaterally supporting RCs as an arena in which IDR takes place, is premature. Initial results point to significant variation in the interdisciplinarity of RCs as a whole, as well as across different sectors. Because of this, researchers, administrators, and funding institutions should consider re-evaluating their assumptions about the extent to which RCs are interdisciplinary. We implement and share a methodological approach for classifying textual data, with potential for utility in addressing a broad range of research problems. Next steps for our research team include looking more in-depth at differences in interdisciplinarity of RCs across disciplines and universities, cross-validating our classification scheme with other measures of interdisciplinarity at universities in our sample, and incorporating corrected university-level ratios of the interdisciplinarity of RCs as one of several explanatory measures in models predicting other university outcomes.

Works Cited

Bozeman, Barry and Craig Boardman. 2013. "Academic Faculty in University Research Centers: Neither Capitalism's Slaves nor Teaching Fugitives." The Journal of Higher Education 84(1):88-120. doi: 10.1353/jhe.2013.0003.

Brint, Steven G., Lori Turk-Bicakci, Kristopher Proctor and Scott Patrick Murphy. 2009. "Expanding the Social Frame of Knowledge: Interdisciplinary, Degree-Granting Fields in American Colleges and Universities, 1975-2000." The Review of Higher Education 32(2):155-83.

Olzak, Susan and Nicole Kangas. 2008. "Ethnic, Women's, and African American Studies Majors in U.S. Institutions of Higher Education." Sociology of Education 81(2):163-88.

Sabharwal, Meghna and Qian Hu. 2013. "Participation in University-Based Research Centers: Is It Helping or Hurting Researchers?". Research Policy 42:1301-11.

Gennady Belyakov and Sergey Kolesnikov

Pride or Prejudice: How Do Research Organizations Respond to Recipiency of Ig Nobel prize?

Session 10C

This paper is submitted as part of the session proposal: Science that makes you laugh then think! What can be found when science is seen through the looking glass of the Ig Nobel prizes?

Organised by: Philip Shapira, Jan Youtie, and David Hu

There is a long-standing controversy around some of the research which does not seem to have an obvious practical utility, especially if it is publicly funded. Public and policymakers often consider such curiosity-driven research to be a "wasteful science", despite numerous historical accounts of "pure science" suddenly finding applications decades after the discovery was made. The focus of this paper is on how research organizations perceive this type of science conducted by researchers affiliated with them. Some of them may recognize the potential future value of any "purely scientific" knowledge produced. Others may perceive it as a threat to their reputation, or even as a danger of having their public funding cut as a result, especially if accused of "wasteful science".

A recent example of such accusations is the U.S. Sen. Jeff Flake 2016 report on twenty publicly-funded studies that he found "hard-to-justify". Four of these studies were recipients of the Ig Nobel prize. Another high-profile case related to the Ig Nobel happened in 1995, when Sir Robert May, the Government Chief Scientific Adviser in Britain had to publicly ask award committee to stop including UK researchers as awardees after public controversy around the funding sources of the work that received the prize. Clearly, that did not stop researchers from accepting the prizes but could have affected the willingness of organizations to engage public in communication.

We look at the Ig Nobel prize as one of the most prominent examples of public recognition of witty curiosity-driven research, which, according to the prize motto, first makes people laugh then makes them think. The Ig Nobel prizes are usually awarded to individuals or teams of scientists, leaving universities and research organizations to decide how to respond to recipiency of the prize by affiliated researchers. Should they proudly recognize it as a major achievement of their researchers? Should they use it as an opportunity to carefully communicate the motivation and potential benefits of such research to the public to escape accusations of "wasteful science"? Should they simply ignore it, hoping that the questionable achievement would be quickly forgotten by the public? Or maybe they can even take some action to prevent this type of research from happening under their roof. We argue that decisions that they make in relation to these questions may depend on two factors: the scientific value and recognition of the work that was awarded the Ig Nobel prize, and a potential public reaction to the research as a result of the award.

To investigate the response of institutions to Ig Nobel prize recipience, we have collected data on scientific publications referenced on the website of the award (http://www.improbable.com/ig/winners/) for each prize. We operationalize scientific merit of these publications by Field-Weighted Citation Impact (FWCI), and Citation Benchmarking metric which positions the citation impact of an article against other publications of the same age and field of study. Data on both metrics was collected from Scopus bibliometric database. The second factor - public reaction - is proxied by the number of social media mentions on Twitter, also available among metrics offered by Scopus. We limit our analysis to Ig Nobel prizes awarded in 2008 and later, due to the availability of social media data dependent on the activity of Twitter user base. The list of publications referenced by these prizes that have complete coverage of both Twitter and citation data amounts to 62 items.

By adopting a two by two matrix approach, we position these publications along two dimensions by their citation impact and Twitter mentions (or 'popularity'). We classify them into four groups: 'clever and fun' (high citation impact / very popular), 'clever' (high citation impact / low popularity), 'fun' (low citation impact / very popular), 'neither' (low citation impact / low popularity). Publication is classified as 'clever' if its citation benchmarking metric is in the highest quartile (75% or more) for its field of research, or, alternatively, if its FWCI measure is very high when citation benchmarking is not available. Publication is classified as 'fun' if it has more than 200 Twitter mentions, which corresponds to the top quartile of Twitter mentions in our sample. Using this approach, we classified 8 publications as "clever and fun", 19 papers as "clever", 9 publications as "fun", and 26 publications as "neither".

We explore the interaction of this classification with the third dimension – mentions of the Ig Nobel prize in press

releases, news pages, and other communication genres on the websites of research organizations referenced as affiliations of prize recipients on the Ig Nobel prize website. Search was conducted using Google website search both in English and native languages of institutions. We have found 135 article-affiliation pairs for our sample of 62 articles. We classify them based on the “fun / clever” article classification and identify how research organizations in each pair respond to this type of recognition: whether they brag about the achievement, keep a low profile/are indifferent, or employ other strategies.

We find that, on average, 52% of organizations recognized the recipiency of the prize in some form. The highest recognition (65%) is observed for “clever” articles, suggesting that it is relatively safe for institutions to leverage the publicity gained from the award in this case. They can easily reject potential claims of “wasteful science” by appealing to high citation impact of underlying publications. In contrast, “neither” sector of the matrix received just 40% recognition. “Fun” and “clever and fun” articles received 53% and 50% recognition correspondingly. The lower than average recognition for “clever and fun” articles is perhaps surprising. A possible explanation is the small size of this group (8 publications with 20 affiliations). However, by looking at the recognition patterns across countries and organizations, we also find a potentially strong impact of exogenous factors. For example, we find no mentions of Ig Nobel prizes on websites of French institutions, which are well represented both in the full population of Ig Nobel awardees and in the “Fun and Clever” group. On the contrary, we find that institutions in the UK, the Netherlands, and to a lesser degree in the United States and Japan tend to be much more open about receiving the Ig Nobel prize. Such country-level variation suggests a strong influence of cultural and institutional environment and requires further explanation.

There is a variety of genres which research organizations use (or don’t) to communicate recipiency of Ig Nobel prize. Some use external platforms to distribute press releases; some publish them on their website. Often recognition of award comes in the form of a news piece that can be on the main site of an organization or a department. It can be included in the newsletter, annual report, or alumni magazine. Some universities tend to use more genres than other. Some try to avoid accusations in ‘wastefulness’ by providing a detailed explanation of the scientific and practical value of research. Sometimes recognition is reduced to a mention of the prize among other awards received by affiliated researchers, as a part of researcher profile or CV. These genres can be differentiated in terms of the level of organizational recognition of Ig Nobel award and can provide a further frame for investigation.

To conclude, we found that not all organizations are equally open to recognizing Ig Nobel awards received by affiliated researchers. Differences can be potentially attributed to the scientific merit of and public reaction to the awarded research, as well as country-level research environment specificity and focusing events.

Ira Bennett

Building practice: Offering process lessons-learned and a vision of pTA communities of practice

Session 7C

Participatory technology assessments (pTAs) in science and technology policy offer an innovative approach for integrating user value demands with policy and technological developments. The Expert & Citizens Science & Technology (ECAST). ECAST manages across some eight design parameters related to inputs, processes, and outputs to support co-production of useable knowledge through its pTAs. Input parameters include diverse expertise, demographics, and geographies. Process parameters include structured interactions, informed citizens, and deliberative learning. Output parameters include usability, and clear and comparable results and assessments. An idealized pTA design process entails a trans-disciplinary effort with three knowledge co-production steps: framing, deliberation, and integration.

The framing phase of knowledge co-production is shaped by a variety of inputs, relates to a variety of processes, and produces outputs that affect subsequent deliberation and integration. Which areas and types of expertise should be included in informing the way pTA issues are constructed? Which areas and types of expertise should be engaged in shaping background information and shaping deliberation activities? How and when might lay publics be involved in these decisions? Answers to these and other questions are critical to consider when framing issues, questions, and background material for pTAs. A variety of processes also affect framing. Structuring interactions among experts, stakeholders, and decision-makers early in a pTA will enable building of trust and buy-in for the products of deliberation, as well as help ensure relevance and legitimacy of knowledge co-produced. Pilot testing the construction of issues and questions with diverse types of experts can help enrich and strengthen pTA frames. Finally, the outputs of framing directly inform deliberation. Framing outputs include background materials, initial deliberation designs, and initial considerations of useable project deliverables.

During the deliberation phase, the emphasis in knowledge co-production shifts to the interaction among pTA conveners and participants. Key inputs to the deliberation phase come in part from the framing phase (background material etc.). In addition, inputs include considerations of which geographic locations to select for running deliberations. For example, does the policy client anticipate a particular geography important to engage? Does the client desire a broad cast of geographies to diversify data collected? These questions of diverse geographies also apply to the inputs of socio-demographics. The input of diverse socio-demographics directly affects the backgrounds and experiences of people involved in a deliberation.

Inputs from the framing phase ensure that participants are adequately informed in the deliberation phase. Participants are provided with educational materials and immersion videos providing balanced representation of scientific, technological, ethical, legal, and social issues of the subject of deliberation. Once inputs are set, structuring interactions is a critical process component of the deliberation phase. Structuring interactions, considering potential table compositions, the design of ground-rule expectations, and other dimensions are critical to avoid compromising the goal of creating a safe space for lay publics to freely discuss their views and opinions with peers. Structured interactions support subsequent deliberative learning, which is further enhanced by ensuring that neutral facilitators help make sure that each participant has a chance to register his or her views in small group discussions.

The integration phase of pTA attends to the above dimensions of framing and deliberation to create comparable results and assessments. Outputs from the integration phase need to be designed to be readily useable by agency officials and stakeholders. In addition, demographic and response data, views on themes, and group thematic plans must be comparable across sites and easy to communicate to agency officials and stakeholders.

Completing pTAs to support usable science faces challenge related to the composition of inputs and the usability of outputs across framing, deliberation, and integration phases. Challenges related to composition of the inputs have to do with compliance and feasibility of the engagement process. This comprises issues of context (legal, scientific, social), scope (objectives, framing, questions), publics (local, national, global, homogenous, diverse), data collection (quality, standardization, instruments, verification, analysis, transfer), and design (facilitation, communication, interaction). External challenges have to do with usability of the outputs. ECAST considers four components of usability: credibility (scientific and technical validity), salience (relevance to user, stakeholder, and decision-maker needs), legitimacy (ethical, representative, inclusive, fair, balanced, and unbiased) and timeliness (decision-making window).

As the ECAST network grows, it is increasingly looking for ways to innovate practice to navigate input and output challenges as well as enhance usability of results. In the case of pTA to complement and augment U.S. federal government science and technology policy decisions, ECAST is learning and adapting to account for legislative and regulatory considerations related to the Federal Advisory Committee Act (FACA); the Government Paperwork Reduction Act (PRA); and the various pieces of legislation affecting the federal rule-making processes. For example, a base case for ECAST pTA is a model of highly structured deliberations with standardized questions and voting; experts integrated as a scientific advisory board for the creation of background documents and questions only, and having no further interaction with the deliberating citizens; all completed in a large group setting. Variants in the engagement method (both in format and data collection) aim to address challenges raised by the PRA to provide new and rich forms of information about participant values.

In this talk, I will present a vision for plans to increase the capacity of the ECAST network and the number of projects undertaken to innovate in pTA specifically, with implications for upstream engagement for usable science, generally.

Michael Bernstein

Introduction: Usable Science and Participatory Technology Assessment

Session 7C

Decision-makers have become conditioned, in part by scientists themselves, to look to scientific knowledge for certainty (Pielke 2007). Science, however, an institution not for divining or establishing Truth but for systematic study and exploration, is ill-equipped to shoulder such an oracular burden (Oreskes, 2004). Calls for science for policy often pull science, wittingly and unwittingly into the position of what Alvin Weinberg observed as 'trans-science'—seeking knowledge about realities that are by their nature multiplex, contingent, and dynamic.

Attempting trans-science through science creates challenges of salience, legitimacy, and credibility of knowledge production (Cash et al 2003). Salience, the relevance of knowledge to decision makers, ties to the timeliness of knowledge delivered, as well as to how the users or audience of said knowledge perceive the work as helpful and responsive to their needs. Conducting trans-science makes knowledge production susceptible to rapid politicization and murkiness, placing decision-makers in a double-bind. The credibility of knowledge production, tied to the trustworthiness and rigor of the information generated through research (Cash et al 2003), is also implicated. As Dan Sarewitz recently observed, attempting trans-science entails pursuing scientific questions that "often reveal multiple truths, depending in part on what aspects of an issue scientists decide to do research on and how they go about doing that research" (Sarewitz 2016, p29). How are decision-makers to accept as credible information they have when they know that someone with an opposing viewpoint can just as easily procure counter evidence claiming equal credibility? Finally, the legitimacy of knowledge production—fairness in accounting for a plurality of values and concerns related to an issue (Cash et al 2003)—is threatened when singular and unrepresentative groups of experts are left to decide upon a trans-scientific question masquerading as science. Taking the example of peer-review consideration of broader impacts, Bozeman and Boardman (2009) observe" Why is the scientist who does research on the genetics of grasses any more qualified to judge social good than the person who mows the grass?" (p. 189).

Recognizing the risks to salience, legitimacy, and credibility of science attempting to cover trans-scientific issues, science policy scholars and practitioners have (re)turned to questions of a "rightful place of science" in society (Crow et al 2013). Built off of the analogy of a market economy, proposals to make science more usable—well scoped for contributing to but not being solely responsible for the resolution of trans-scientific issues—constitute an approach of reconciling the "supply of" and "demand for" science (Sarewitz and Pielke 2007). Pursuing "usable science" has been discussed as consisting of four approaches to knowledge production: linking to specific problems; supporting connections among users and researchers; incorporating user perspectives in research; and testing the usefulness of results to users.

As an enterprise seeking to reconcile domains of science to trans-scientific issues, usable science has been noted to benefit from a variety of contextual and intrinsic factors (Dilling and Lemos 2011). Chief among these factors are: recognition of the need for usable science; organizations and individuals with the capacity to bridge knowledge production and use contexts; early and often engagement with all parties involved; reward structures supporting this work; and trusted relationships and processes. Convening the entire spectrum of users (scientists, decision-makers and publics) and producers of research early and often, and responding to the inputs that arise from these interactions presents challenges that, as with tackling trans-scientific questions, strain the limits of normal pursuits of science.

A turn to participatory technology assessment reflects a response to these challenges of pursuing usable science to contribute to trans-scientific questions. Technology assessment (TA), generally, refers to a formal attempt to study in advance the potential implications of science and technology to improve decision-making relate dot said technologies. Participatory technology assessment (pTA) attempts to infuse the traditional expertise of science with the values and perspectives of more diverse groups of stakeholders and publics.

Knowledge production from pTA connected to policy-making is well suited to supporting usable science and thus contribute to resolving trans-scientific issues often rife with uncertain facts, high decision stakes related to disputed values in play (characteristics often of "post-normal" science, Funtowicz and Ravetz 1993). Participatory technology assessments recognizes the value-laden nature of information and knowledge used in policy making and seeks to directly include the users and producers of such knowledge, as well as input from broader sets of publics (Gano 2014). There are a range of modes of pTA (c.f., Bickerstaff et al. 2010). The present talk will focus on models pursued by the

Expert & Citizens Science & Technology (ECAST) network.

ECAST seeks to fill a gap in TA in the U.S. generally, and in the inclusion of publics and stakeholders in TA, specifically. This latter gap of limited inclusion of publics and stakeholders was present in U.S. policy-making even when the Office of Technology Assessment existed (1). ECAST represents an institutionally diverse, non-partisan group seeking to innovate in conceptualization, demonstration, and practice of pTA in government policy.

ECAST pTA deliberations support usable science production. Deliberations to date have been problem focused, for example to help the National Aeronautics and Space Administration identify goals and capabilities involved in the agency's asteroid initiative. A project with the National Ocean and Atmospheric Administration (NOAA) has engaged cross-sector and cross-governmental groups of stakeholders in brokering common grounds for framing issues and questions on which to engage the public. Results from these and other pTA deliberations have informed policy decisions and opened avenues of research on the need to test alternative designs of pTAs, and evaluate the value of these outputs to different audiences.

These introductory remarks on challenges of trans-science, usable science approaches, and the pTA model of ECAST, will set the stage for each subsequent speaker's perspective and remarks on upstream public engagement for decision and policy-support in science and technology.

Endnote

(1): The OTA was defunded in 1995. There is at present no formal technology assessment capacity in the federal government beyond that of a small group within the Government Accountability Office, producing studies at less than 1/10th the rate of the former OTA.

Florence Blandinieres and Maikel Pellens

Academic engagement with industry: implications for scientific productivity and research agenda composition

Session 7E

Extended Abstract

Universities increasingly need to rely on industry for the funding of research, and for individual scientists more and more importance is being assigned to academic engagement with the private sector technology transfer. In this paper, we contribute to the literature on the potential trade-offs of these activities with research output by examining the relation between engagement with industry and the direction of scientific research. While the point that engagement with extra-university partners is a source of ideas which might influence researchers' agendas has long been argued, empirical evidence is still developing (Blumenthal et al., 1996; Godin and Gingras, 2000; Gulbrandsen and Smeby, 2005; Boardman and Corley, 2008; Hottenrott and Lawson, 2014, 2017).

We contribute to this stream of research by providing empirical evidence on the relation between scientists' engagement with industry and the orientation of their research agendas. The analysis is based on 1539 respondents to an online survey of STEM fields professors conducted in Germany in 2011.

Measure scientists' engagement with industry through the percentage of industry in scientist's third part funding, we document significant relations in the orientation of scientists' research agendas towards industry as engagement increases. First, industry-funded scientists are more likely to consider industry to be the main user of her results. Second, they are more likely to develop their research agenda along fields with higher potential for future knowledge transfer. Third, these scientists indicate that they are more likely to turn to industry for funding of new research ideas.

We thus document that industry interests are an important consideration in the agenda setting of industry-funded scientist. This relation holds keeping constant a range of personal and professional attributes, such as career age and gender. We also control for professional attributes, such as teaching load, number of Ph.D. students, and field, and for organizational attributes such as the presence of incentives for engaging in knowledge transfer, and whether the scientists' working environment is industry-oriented in nature. At the same time, our results confirm the unclear relation between engagement and research productivity described in prior literature: we find little impact of an additional percent of industry funding on productivity, but do find that scientists without any industry funding are less productive.

An important consideration is that this orientation concerns the researchers' total research agenda, and not only the part being funded by industry. Thus, our results indicate a clear correlation between engagement and the determination of the academics' scientific agenda in function of industrial needs. Our results therefore indicate that academics face trade-offs in composing their agenda when they are funded by industry. At the same time, we find a negative correlation between engagement and having the scientific community as main user of results, suggesting some degree of substitution between the two audiences.

While indirect and correlative, our analysis thus provides evidence for a reorientation of academics' research agenda in the light of the entrepreneurial university. This perspective is more nuanced than an impact on the volume or quality of scientific outputs: industry-oriented scientists seem to re-orientate their scientific activities to those issues which are in demand among firms. The implications of this on the production of science are ambiguous: on the one hand, scientific research might gain in short-term relevance when there are private actors willing to fund research activities. On the other hand, this approach might jeopardize long-term scientific progress by diverting attention away from scientific goals and onto industrial goals. The degree to which this is a problem however depends on the differences between scientific and industrial goals. These tradeoffs in terms of the orientation of research in the light of industry engagement lead to a discussion about the implications of institutional arrangements to promote technological transfer on academic research.

References

Blumenthal, D., Campbell, E. G., Causino, N., and Louis, K. S. (1996). Participation of Life-Science Faculty in Research

Relationships with Industry. New England Journal of Medicine, 335(23):1734– 1739.

Boardman, P. C. And Corley, E. A. (2008). University research centers and the composition of research collaborations. Research Policy, 37(5):900–913.

Godin, B. And Gingras, Y. (2000). The impact of collaborative research on academic science. Sciences and Public Policy, 27(1):65–73.

Gulbrandsen, M. And Smeby, J.-C. (2005). Industry funding and university professors' research per- formance. Research Policy, 34(6):932–950.

Hottenrott, H. And Lawson, C. (2014). Research grants, sources of ideas and the effects on academic research. Economics of Innovation and New Technology, 23(2):109–133.

Hottenrott, H. And Lawson, C. (2017). Fishing for complementarities: Research grants and research productivity. International Journal of Industrial Organization, 51:1–38.

Carter Bloch and Qi Wang

International mobility of postdoc researchers and future research performance: Evidence from Denmark

Session 6B

This paper aims to explore the effect of research stays abroad on the future academic performance for postdoc researchers in Denmark. Previous studies suggest that knowledge production from different research culture could benefit research outcomes (e.g. Barjak & Robinson, 2008; Tang & Shapira, 2012; Abbasi & Jaafari, 2013), which would imply that having a research stay abroad is an important determinant of researchers' future academic performance. Motivated by this, a number of countries have programs that either allow or are directly targeted at international postdoc fellowships. One example is the Danish Council for Independent Research (DFF) international postdoctoral grant, which provides opportunities for researchers with a PhD to conduct research abroad for a period of up to two years. The objective of this grant is to "strengthen the international mobility of young talented researchers, as well as to maintain and develop the competencies of researchers who are in the beginning of their research careers" (DFF, 2017).

The existing literature shows that postdoctoral stays abroad has a positive effect on researchers' participation in international cooperation after the stay abroad (Martinez et al. 2016; Wooley et al. 2008). However, for the outgoing researcher's scientific production and career progression, the picture is less clear. Franzoni et al. (2013) concludes that migrant researchers have higher productivity. In contrast, no effect on productivity is found for participants in the American NSF International Research Fellowship Program (IRFP), where postdocs study abroad for 9-24 months (Martinez et al. 2016). It is also concluded that participation in IRFP neither benefits nor delays the researchers' subsequent career. In Spain, the results suggest that studying abroad can slow career progress for outgoing researchers, while resistance and commitment to the same institution can promote career advancement (Cruz-Castro and Sanz-Menéndez 2010). Parey and Waldinger (2010) explore the impact of studying abroad on international labor market, and exploit the European ERASMUS project as an instrument for studying abroad.

This paper will follow on this work to study the relationship between research abroad and future performance. We will examine potential effects in terms of four types of research outcomes: research productivity and citation impact; international collaboration (measured both in terms of the degree of international collaboration and the size of co-author networks); the propensity to remain in academia; and the propensity to advance to a tenured research position. The analysis will also take into account that these outcomes may be interrelated. For example, career advancement may be related both to research performance and international experience, while research performance can also be affected by international experience.

We employ a difference-in-difference matching strategy to tackle endogeneity problems and to construct a counterfactual for analysis of the effects of stays abroad. The matching procedure will utilize data on PhD, funding and prior publication and citation performance. In the model, the treatment for a postdoc researcher is if he or she had a long-term stay abroad. The analysis will then seek to examine whether early career stays abroad have had an effect on subsequent research performance, collaboration and career advancement. Based on the matched sample, the analysis will compare before and after differences in research performance measures and test for differences in propensities to remain in academia or for career advancement.

Our sample consists of 400 early career researchers in Denmark within the field of natural science, that have received their PhD in the period 2001-2009. The analysis is based on an extensive dataset including both register-based data on employment , PhD, research funding and demographic information, and publication and citation data from the in-house WoS database of the Centre for Science and Technology Studies (CWTS) at Leiden University (see also Bloch et al. 2016). The register-based data also allows us to identify longer-term (6 months or more) stays abroad within the first 5 years after their PhD. Of the 400 researchers, 160 have had a stay abroad during the early stage of their career, which for many (around 100) was in connection with a postdoc fellowship from the DFF.

Reference:

Abbasi, A., & Jaafari, A. (2013). Research impact and scholars' geographical diversity. Journal of Informetrics, 7(3), 683-692.

Barjak, F., & Robinson, S. (2008). International collaboration, mobility and team diversity in the life sciences: impact on research performance. Social Geography, 3(1), 23.

Bloch, C., Christensen, M.V., Wang, Q. & Lyngs, A.R. (2016). Analyse af betydningen af udlandsophold blandt postdocs finansieret af Det Frie Forskningsråd inden for naturvidenskaberne. Report.

DFF. (2017). DFF-international postdoctoral grant. Online available: http://ufm.dk/en/research-and-innovation/councils-and-commissions/the-danish-council-for-independent-research/for-applicants/what-can-you-apply-for/overview-of-instruments/dff-international-postdoctoral-grant

Parey, M., & Waldinger, F. (2011). Studying abroad and the effect on international labour market mobility: Evidence from the introduction of ERASMUS. The Economic Journal, 121(551), 194-222.

Tang, L., & Shapira, P. (2012). Effects of international collaboration and knowledge moderation on China's nanotechnology research impacts. Journal of Technology Management in China, 7(1), 94-110.

Martinez, A., Epstein, C. S, Parsad, A. (2016): Developing internationally engaged scientists and engineers: The effectiveness of an international postdoctoral fellowship program, Research Evaluation, 25(2), 2016, p. 184-195.

Woolley, R., Turpin, T, Marceau J., Hill, S. (2008): Mobility Matters – Research Training and network Building in Science, Comparative Technology Transfer and Society, volume 6, number 3 (December 2008): p. 159-86.

Franzoni, C., Scellato, G., Stephan, P. (2013): The mover’s advantage: The superior performance of migrant scientists, Economic Letters, Volume 122, Issue 1, January 2014, p. 89-93.

Cruz-Castro, L., Sanz-Menéndez, L. (2010), Mobility versus job stability: Assessing tenure and productivity outcomes, Research Policy, Volume 39, Issue 1, February 2010, p. 27-38.

Jaime Bonnin Roca, Parth Vaishnav, Granger Morgan, Joana Mendonça and Erica Fuchs

When risks cannot be seen: Regulating uncertainty in emerging technologies

Session 3D

Commercializing an emerging technology that employs an immature production process can be challenging, particularly when there are many different sources of uncertainty. In industries with stringent safety requirements, regulatory interventions that ensure safety while maintaining incentives for innovation can be particularly elusive. We use the extreme case of metal additive manufacturing (an emerging technology with many sources of process uncertainty) in commercial aviation (an industry where lapses in safety can have catastrophic consequences) to unpack how the characteristics of a technology may influence the options for regulatory intervention. Based on our findings, we propose an adaptive regulatory framework in which standards are periodically revised and in which different groups of companies are regulated differently as a function of their technological capabilities. We conclude by proposing a generalizable framework for regulating emerging process-based technologies in safety-critical industries in which the optimal regulatory configuration depends on the industry structure (number of firms), the performance and safety requirements, and the sources of technological uncertainty.

Barry Bozeman and Craig Boardman

"Risk Smoothing and Publishing Efficiency' Strategies Among Researchers: Does the Push for Productivity Undermine Quality?"

Session 3B

Focusing on academic STEM researchers' publishing strategies, the proposed study focuses particularly on the question of "publishing efficiency" strategies, their types, their causes and their results. Public efficiency is defined in much the same manner as efficiency in general: seeking the greatest output from a unit of input. A familiar example of a low risk, publishing efficiency strategy is the "least publishable unit" (LPU) strategy - dividing up scientific results into the smallest discrete amount that will be minimally sufficient to be accepted for publication. LPU is but one of several publishing efficiency strategies that some researchers employ (Stossel 1987), often with the active encouragement of peers, academic supervisors, and mentors (Refinetti 1990). Other such strategies include increasing team size, for more publications not scientific need, and the participation of "honorary authors" (Kovacs, 2013). The study examines (1) the extent of publishing efficiency strategies, (2) reasons for efficiency strategies, and (3) their impacts on scientific quality and reputation. Several contemporary trends may encourage publishing efficiency strategies. First, the substantial increase in research collaboration (Melin and Persson 1996, Newman 2004, Bozeman, Fay et al. 2013) may exert pressures for increased publications. Second, the increase in serial postdocs (National Academy of Sciences 2014) may encourage researchers to take short cuts to quickly accumulate publications. Third, the rise of multidisciplinary university research centers may result in another layer of supervisors with additional demands for variegated knowledge products (see Boardman and Bozeman 2007). The proposed paper relies on semi-structured interviews with more than 50 US academic researchers in four diverse universities. For interviewees, the author also examines the career productivity of the researcher (measured in terms of normal count and fractional count journal article publications and citations by various measures. It is expected that there are thresholds such that increasing numbers of articles will have a negative effect on the quality of the knowledge produced.

Stuart Bretschneider, Barry Bozeman and John David Selby

Does a late educational shift to STEM fields enhance career trajectories?

Session 8B

Much of the current policy prescription associated with increasing the STEM work force focuses on early exposure to STEM fields especially for woman and minorities. The theory suggest early and consistent exposure leads to increase likelihood for individuals to focus on STEM majors in school and ultimately STEM careers. There are though individuals who come to STEM fields latter in their academic life. This paper ask the question, do individuals who switch to STEM fields after earning college and advanced degrees in non-STEM field experience different career trajectories? We posit that such individuals are likely to face high threshold cost to STEM degree completion and therefore are likely to experience other traits leading to positive selection for successful careers. Using data on current salary from the 2003, 2006, 2008, 2010 and 2013 Survey of Doctoral Recipients (SDR) as a proxy for success we test whether individuals who successfully shift to STEM field experience more successful trajectories than those who start out and stay in the STEM disciplines over the full course of the educational careers. Using fixed effects panel estimators we found that individuals who either switched to a STEM field or from a STEM field had a 30% higher salary when compared with individuals who did not change their field at all. We also found there was a 15% return to individuals who changed with the STEM field but not within a non-STEM field. Change effects on salary during the education process seems to be less about sorting into a more appropriate field, since we control for the degree of relevance of their Ph.D. field to their current job, and more about generating general human capital through the change experiences.

Carolina Cañibano, Mary Frank Fox and F. Javier Otamendi

Gender and International Mobility of European Researchers

Session 6B

Recent findings point to trends and features of researchers' international mobility that bear upon women's research opportunities (Ackers, 2010; 2013; Cañibano et al. 2015). On the one hand, the more flexible ways in which researchers may be internationally mobile offer new possibilities for making work compatible with family and private lives, and open up prospects for both men's and women's access to international networks and infrastructures. On the other hand, the pressure to be internationally mobile in order to succeed in research may raise new barriers for women, and constitute potentially challenging conditions. These are consequential issues for research careers in the European Union, because the rise in the cross-country mobility of researchers is explicitly linked to the successful construction of the European Research Area and mobility is becoming a requisite for promotion and consolidation in academic careers.

The present paper focuses on patterns of gender and international mobility, using data from the sample of 10,547 European researchers who responded to the MORE2 survey in 2012. Women researchers represent 40% of respondents in this survey. In the sample, women represent 36 % of mobile researchers and 48 % of those who declared they had never experienced international mobility. The survey offers the unique opportunity to study the potential association between researchers' personal statuses, among other factors, and their experience with mobility, with a large and international sample.

Data and methods

Out of the population of respondents to the MORE2 survey, we select researchers who reported their countries of nationality, PhD, and current employment, and who disclosed their marital status, which adds up to a sample of 6769 researchers. We define four types of international mobility according with the available data: (1) PhD mobility (mobility during the PhD), (2) short-term post-PhD mobility (duration of less than three months), (3) post-PhD mobility of more than 3 months, and (4) change of residence (differences between one of the reference countries: nationality, PhD or current employment). Each type of mobility results in a binomial variable of whether the researchers have experienced it or not. Mobility types are thus the dependent variables of our study. Independent variables include gender, marital status (single or in couple), children (with or without), career stage (R1 to R4), field of research in current employment, and reported level of confidence about future prospects for the research careers. We conduct a series of difference tests and logistic regression models to address differences in the likelihood of registering the different types of mobility related to the independent variables.

Preliminary findings

The series of difference tests show that men are more likely to register all types of mobility with the exception of PhD mobility, for which no gender difference exists. Marital status does not govern mobility patterns. Researchers without children are more likely to be mobile, but women with children are less mobile than men with children. Compared to women, men are, in turn, significantly more confident about their future career prospects.

According to the logistic regression results, gender appears to be a more determining factor in mobility rates at stages R2 and R3 of the career. Women who manage to attain a leading position (R4) seem as mobile as their male counterparts when it comes to a change in residence or short research visits (less than three months). At earlier stages of the post-PhD career (R2 and R3), men are significantly more likely to register all types of mobility, except for short-term mobility, for which no significant gender difference occurs. The patterns of gender differences remain when taking into account the field of research.

Preliminary conclusions and next steps

The preliminary results from the study show that European, women researchers are overall less likely to be internationally mobile than men, particularly if they have children. The results hold across research fields. Gender differences in mobility patterns are more significant at mid-career stages (R2 and R3) and are reduced at the very early

stage of the career (PhD stage) and at the leading position level (R4). The next step of the research is to analyse whether these results hold across types of institutional settings, defined in terms of the European Science Foundation classification of EU countries in prevailing attitudes toward gender roles (EFS, 2013).

References:

-Ackers, L (2010) 'Internationalisation and equality. The contribution of short-stay mobility to progression in science careers'. Recherches Sociologiques et Anthropologiques, 41: 83–103.

-Ackers, L. (2013) 'Internet mobility, co-presence and purpose: Contextualizing internationalization in research careers'. Sociology and Technoscience, 3: 117–41.

-Cañibano, C.; M. F. Fox and J. Otamendi (2015) Gender and Patterns of Temporary Mobility Among Researchers. Science and Public Policy, doi: 10.1093/scipol/scv042

-European Commission (2011) Towards a European Framework for Research Careers, Directorate General for Research and Innovation, July 21st.

-European Science Foundation (2013) 'New concepts of researcher mobility – A comprehensive approach including combined/part-time positions'. Science Policy Briefing

No. 49: http://www.esf.org/fileadmin/Public_documents/ Publications /spb49_ResearcherMobility.pdf

Nicolas Carayol

The Impact of Project-Based Funding in Science: Lessons from the ANR Experience

Session 7B

Competitive allocation of funds to research proposals is a mechanism widely used

by government agencies to sustain the projects of researchers in universities and other research institutions. However, little is known about how efficient this mechanism is in practice, how it affects the recipients' behaviors and how it would be possible to improve the precise design of such funding allocation mechanisms. This article provides new answers to those questions, relying on empirical evidence stemming from the creation of a French generalist and nationwide research funding agency in 2005. The impacts of receiving a grant on the research outputs as well as on the collaborations of the grantees is precisely quantified. Moreover, the impact on citations turns out to be more than double when funds are distributed in the more competitive non-thematic programs and to be significantly larger when allocated to younger recipients.

Pablo Catalan and Ernesto Escobar

Hosting international research collaborations: Experiences in Chile

Session 6D

Globalization has driven university international collaboration during the last decades, making of it a strategic objective of well-recognized institutions all around the globe. As of today, different patterns rule it. Moving abroad may afford researchers better research fieldwork or the chance to have at their disposal knowledge they do not have locally. Besides, international collaboration may also contribute to shape a more fruitful multidisciplinary approach, whose impact may not come only from adding new disciplines, but from adding new disciplines with a different perspective than the one national experts may have given that knowledge coming from abroad would have originated within a different context.

When the review focused on North-South collaboration, such patterns are even more pronounced. Northern universities may be in the quest to solve complex problems that are no longer problems for them within their own borders, but whose solution would have a significant impact in the their partner's original country. On the other hand, what Southern universities do look for when in the quest for a Northern country collaborator is knowledge they do not have locally or that their researchers are not able to generate in light of their shortages of scientific and technological resources. However, we should emphasized that collaboration should and has not been restricted to Science and Technology (S&T) highly complex questions. Challenges in need of simpler responses -that is organizational or management innovations- may have a greater impact in a shorter period of time.

We expect to contribute to the ongoing discussion by reviewing two international collaboration processes between institutions based in a developed country, the United States, and a developing country, Chile. We present two case studies. The first one refers to the collaboration between the Georgia Institute of Technology (Georgia Tech), USA, and the University of Concepcion (UDEC), Chile. The review encompasses a 10-year period, during which several research projects were carried out, and student and faculty exchange took place. Lately, specifically since 2015, Georgia Tech has worked intensively with UDEC in shaping new UDEC innovation and entrepreneurship organizations, mainly a manufacturing extension center, a new entrepreneurship program and reformulating UDEC incubator strategic planning. UDEC and public officials expect that working with Georgia Tech will contribute not only to UDEC internal dynamics, but also to local economic development. The second case study refers to the historical collaboration that North Carolina State University (NCSU) and UDEC have developed for more than decade. In this case, the collaboration process considers in addition of student exchange, several research projects, and the establishment of a forestry genomics technological consortium, an initiative funded by the Chilean national government and three Chilean forestry companies.

Pablo Catalan, Carlos Navarrete and Mardones Cristian

Exploring Bonds and Development Dynamics: Knowledge, Technology and Products

Session 8A

The question of economic development has largely been discussed. Endogenous growth or evolutionary economics are just some of the modeling proposed to explain the drivers behind welfare and development. Lately, Hidalgo et al (2007) proposed a new systemic explanation of economic development in accordance to the national export portfolio each country may have over time. The rational behind Hidalgo's model is based on the co-occurrence of products, over which a country may have a comparative advantage, thereby generating a visual representation, a network, in which high-tech products are densely related to each other and located in the network nucleus, while low-tech products are located in the network's periphery and poorly connected. They called such network, the Product Space. Countries whose economic competitiveness respond to export portfolios based on low-tech products, that is located in the periphery of the Product Space, are less likely to go through stable economic growth than the ones whose portfolio are largely based on high-tech export portfolios. Their portfolio based on more complex products, that is demanding higher knowledge and capacities, would afford them to address the challenge of competitiveness by means of being able to integrate and later develop products with higher complexity, a phenomenon that may even widen the gap between developed and developing countries.

Hidalgo's rational has been replicated regarding knowledge –scientific publications- and technology –patent classes- with regard to specific regions or scientific disciplines (Rigby, 2015; Boshma, 2014). We propose a new analytical framework to review the evolution of knowledge/technology/product diversities at country level over the 1988-2014 period. To meet our research goal, we built three datasets covering the period under review: a) scientific publications, source ISI Web of Science, 23.770.813 records, b) patents, source USPTO, 1.545.477 records and c) exports, source UN COMTRADE, 5.394.480 records. First, we calculated three country indexes: The Knowledge Diversity Index (KDI), the Technology Diversity Index (TDI), and the Product Diversity Index (PDI), based upon the number of Web of Science categories, USPTO-IPC patent classes, and UN COMTRADE product categories, each country may be competitive each year. To define whether a country is competitive in each WOS category, USPTO-IPC patent class or UN COMTRADE product category, we calculated their Revealed Comparative Advantage (RCA) index for each one of them. Then, to explore the evolution countries may have experienced we applied cluster analysis –k means algorithm- over three specific years, 1994, 2004, 2014. Therefore, we gathered countries over three categories: non-complex, mid-complex and complex countries. That is how we tested whether countries may have evolved in regard to their scientific, technological and product diversities, which in accordance to Hidalgo's proposal may lead them to greater advantage to integrate new and more complex products. Second, to explore the knowledge-technology-product bonds over time, we built what we called the Cluster Space that is a network based on the co-occurrence of WOS categories, USPTO-IPC patent classes and UN COMTRADE product categories. We considered a lag between each component: five years between scientific publications and patents, and one year between patents and product exports. We replicated such exercise for 1994, 2004 and 2014.

Overall, our results show that some countries have evolved from being non-complex and mid complex countries to become mid complex and complex countries, respectively, due to their greater knowledge, technology and product diversities. At the same time, those countries with greater complexity are located in the nucleus, and more dense area, of the Cluster Space, thereby they are in a better position to achieve greater future competitiveness.

Darlene Cavalier

Democratizing pTA: On and off ramps for citizen science and crowdsourcing

Session 7C

This paper focuses on on the democratic end of citizen science. While much attention has been paid to operationalize, systematize, popularize and legitimize participatory citizen science, efforts have been lacking in terms of democratic citizen science, fearful of running into potential conflicts between scientific value and public value. Although lay citizens have been encouraged to work with credentialed scientists and graduate from collecting to analyzing to interpreting scientific data and observations, they are not yet perceived as they should be: potential collaborators for developing research questions or setting research priorities.

Tamy A. Chambers

Location as a Factor in a For-Profit Firm's Decision to Engage in Open Science

Session 1

Although knowledge is often defined as a resource that can provide a substantial competitive advantage to a firm, it is often the case that many for-profit firms choose to engage in open science through the publication of their research findings for use by the larger community. Research suggests, however, that such engagement is not done naïvely but with an intent to minimize the negative effects of spillover (Simeth & Raffo 2013) and is not simply a by-product of a firm's existing knowledge discovery activities, but rather reflects a deliberate organizational strategy (Ding, 2011; Simeth & Lhuillery, 2015) for purposes that, while nonpecuniary in nature, never the less serve a benefit to the firm (Hicks, 1995). Two purposes for such engagement highlighted in the literature include the increasing interdependence with academic scientists (McMillan, Narin, & Deeds, 2000; Simeth & Raffo, 2013) and the recruitment and retention of highly skilled internal researchers (Liu & Stuart, 2014; Sauermann & Roach, 2014).

Industries have always been geographically clustered for multiple reasons, however, Audretsch and Feldman (1996), years ago noted that in industries where innovation plays a greater role this clustering is often related to dependence on knowledge spillover either from universities or the movement of skilled labor. Today we often find high-tech industries clustered on both the East and West coasts of the United States (Csomós & Tóth, 2016) near prominent universities and high quantities of skilled workers. Given that both these features have been suggested as reasons for-profit firms engage in open science, this study proposes that the closer a for-profit firm is located to a prominent university the more likely it will be to engage in open science through the publication of research findings.

This study analyzes the distance between 804 US high-tech firms and US universities housing the top 25 computer science/mathematics departments as determined by the CWTS Lieden University Rankings (www.leidenranking.com). Firms were determined based on a set of optimal Standard Industrial Classification (SIC) codes (Kile & Phillips, 2009). The publication records of each firm were acquired from SCOPUS for the years 2011-2015. It was found that 511 of the firms were affiliated on at least one paper during this time, meaning 64% of the firms in the study had published.

Distribution statistics for the dataset show that 79% of the firms located less than five kilometers from a prominent university published research findings. These percentages drop significantly, as distance increases. Between five and twenty-five kilometers, the percentage of firm's publishing is 70% and at greater than 150 kilometers only 50% of firms had published research findings. Modeling using binary logistic regression predicts that firms located within five kilometers of a prominent university are1.6 times more likely to publish than firms beyond that distance and that firms located more than 150 kilometers from a prominent university are 0.4 times less likely publish than those within the five-kilometer radius.

When firms were plotted on a map, hot spots appear, as expected, on both the East and West coasts. Many firms that publish are located in California around San Francisco and in and between Los Angeles and San Diego. Most of these firms are in close proximity to one of the three University of California campuses (Los Angeles, San Diego, and Berkley) on the CWTS list or Stanford University. Seattle Washington is also a hot spot for firms who publish, which is in the same place as the University of Washington, also among CWTS' top 25. On the East coast, there a number of firms who publish around Boston and down the coast to New York, Philadelphia, and Washington DC. Universities in the area on the list include MIT, Columbia, Rutgers, Princeton, and the University of Maryland. Smaller hot spot areas which engulf university areas include Minneapolis, Phoenix, and Atlanta. Hot spots for which there are few close universities include Chicago, which is more than 225 kilometers from both the University of Wisconsin and the University of Illinois; Indianapolis, which is 100 kilometers from Purdue University, Dallas, which is more than 300 kilometers from both the University of Texas at Austin and Texas A&M; and Miami, which is 540 kilometers from the University of Florida. Several spots stand out with high firm publication activity far from prominent universities, these include, Denver, where the closest prominent university is more than 900 kilometers away, in Minnesota and Salt Lake City where the closest prominent University is more than 800 kilometers away, in Arizona. Both of these places, however, are near major universities not on the CWTS list.

Although geography is known to correlate with a firm's innovation potential (Audretsch & Feldman, 1996; Csomós & Tóth, 2016), the present study presents strong evidence for a geographical factor influencing a for-profit firm's decision to engage in open science through the publication of their research findings. Additionally, it sets the stage for further

research identifying the relationship between recruitment of internal researchers and university collaboration in both firm's publishing and location decisions.

References

Audretsch, D. B., & Feldman, M. P. (1996). R&D spillovers and the geography of innovation and production. The American Economic Review, 86(3), 630–640.

Csomós, G., & Tóth, G. (2016). Exploring the position of cities in global corporate research and development: A bibliometric analysis by two different geographical approaches. Journal of Informetrics, 10(2), 516–532. http://doi.org/10.1016/j.joi.2016.02.004

Ding, W. W. (2011). The impact of founders' professional-education background on the adoption of open science by for-profit biotechnology firms. Management Science, 52(2), 257–273. http://doi.org/10.1287/mnsc.1100.1278

Hicks, D. (1995). Published papers, tacit competencies and corporate management of the public/private character of knowledge. Industrial and Corporate Change, 4(2), 401–402.

Kile, C., & Phillips, M. (2009). Using industry classification codes to sample high-technology firms: Analysis and recommendations. Journal of Accounting, Auditing & Finance, 24(1), 35–58. http://doi.org/10.1177/0148558X0902400104

Liu, C. C., & Stuart, T. (2014). Positions and rewards: The allocation of resources within a science-based entrepreneurial firm. Research Policy, 43(7), 1134–1143. http://doi.org/10.1016/j.respol.2014.04.013

McMillan, G. S., Narin, F., & Deeds, D. L. (2000). An analysis of the critical role of public science in innovation: The case of biotechnology. Research Policy, 29(1), 1–8.

Sauermann, H., & Roach, M. (2014). Not all scientist pay to be scientists: PhDs' preferences for publishing in industrial employment. Research Policy, 43, 32–47. http://doi.org/10.1016/j.respol.2013.07.006

Simeth, M., & Lhuillery, S. (2015). How do firms develop capabilities for scientific disclosure? Research Policy, 44(7), 1283–1295. http://doi.org/10.1016/j.respol.2015.04.005

Simeth, M., & Raffo, J. D. (2013). What makes companies pursue an open science strategy? Research Policy, 42(9), 1531–1543. http://doi.org/10.1016/j.respol.2013.05.007

Jessica Chappell, Laura German and Catherine Pringle

Integrating Science into Water Governance by Identifying Accountability: A Case Study of Puerto Rico

Session 5D

The amount of influence scientific evidence has on natural resource governance is questionable worldwide. However, this issue is particularly visible in Puerto Rico where research conducted by ecologists over the past several decades suggests minor adjustments to current water management strategies could dramatically improve stream ecosystems and ecosystem services (March et al. 2003). The stream ecosystem services are provided by a unique assemblage of aquatic animals which are dependent on a constant flow of freshwater. However, to date, managers have implemented few of the alterations supported by scientific research, especially outside of federally managed areas. Potential barriers to the adoption of scientific community suggestions for improving water management include: water scarcity magnified by climate change, the $80 billion debt of the local government, or a lack of understanding by scientists on how water governance functions on the island. We employ the notion of accountability to make sense of water governance in Puerto Rico. Once the accountability structure of Puerto Rican water governance is better understood, ecologists will be able to more effectively discuss scientific evidence to facilitate management schemes which maximize ecosystem services.

The first step to identifying accountability is to define it. Accountability has been differently interpreted by many (Bovens 2007). At its most basic, it may be defined as “to answer to or liable to be called into account” (Bäckstrand 2008). Others have made the term more operational by specifying its two component parts: accountability “to whom” and “for what” (Black 2008). Bovens (2007) breaks down the former into two constituent elements: (1) the responsible party must be evaluated by a separate actor and (2) the separate actor is able to enforce consequences if the assigned responsibilities are not met. To operationalize accountability “for what,” we draw on the environmental services literature to specify the desirable outcomes of environmental governance. We include minimum environmental flows, water supply to the human population, water use efficiency, high water quality, and aesthetic benefits.

We also develop a conceptual framework for accountability, and use it in the examination of water governance on the island – using the analysis of legislation and key informant interviews with “multi-sited” actors to assess the “to whom” and “for what” de jure and de facto dimensions. We began by identifying responsible agencies for water management at the state level. The analysis of the de jure water governance arrangement entailed reviewing legal statutes and regulations related to freshwater management, as well as statues outlining the relationship of relevant agencies. The analysis of the de facto realities through which water allocation and governance decisions are made drew on interviews with key informants from the responsible agencies. A major goal of this analysis was to identify the type of accountability, as multiple dimensions exist (Cedón 2000).

Preliminary results indicate the dominant “to whom” accountability is political. Political accountability is where responsible parties answer to their political party (Cedón 2000). This result is supported by indicators found through both de jure and de facto methods. While other forms of accountability may exist between agencies responsible for water management in Puerto Rico, our results suggest political accountability is the only true “to whom” accountability dimension as both requirements 1 (answer to a separate actor) and 2 (separate actor is able to enforce consequences) are met. Specifically, requirement 2 did not seem to be evident for other accountability dimensions. We found this to be most clearly illustrated through our de facto method. Results also suggest that accountability “for what” is primarily focused on freshwater for human demands, specifically quality and supply, and less on meeting environmental needs. These findings represent a vital step in understanding how accountability influences water governance on the island, and should be examined by ecologists who hope to integrate management practices informed by scientific research in the future.

References:

Bäckstrand, K. 2008. Accountability of Networked Climate Governance: The Rise of Transnational Climate Partnerships. Global Environmental Politics 8:74–102.

Black, J. 2008. Constructing and contesting legitimacy and accountability in polycentric regulatory regimes. Regulation & Governance 2:137–164.

Bovens, M. 2007. Analysing and Assessing Accountability: A Conceptual Framework. European Law Journal 13:447–468.

Cedón, A. B. 2000. Accountability and public administration: concepts, dimensions, developments. Openness and Transparency in Governance: Challenges and Opportunities:22–61.

March, J. G., J. P. Benstead, C. M. Pringle, F. N. Scatena, and P. Jonathan. 2003. Damming Tropical Island Streams : Problems , Solutions , and Alternatives. BioScience 53:1069–1078.

Shihhsin Chen and Duenkai Chen

Analyzing the Cluster Effects on Biotechnology Innovation Networks in Taiwan

Session 1

Literature maintains that geographical proximity has strong impacts on enhancing interactive learning and innovation in the clusters (Howells, 2002). However, what is less clear is how do interactions occur in the networks to develop linkage between actors and how do cluster effects enhance the collaborations in emerging high-tech sectors? To explore the associations that regional cluster brought to enhance the formation of R&D networks in the emerging high-tech sector, this paper examines the R&D collaboration network of biotechnology industry in Taiwan between 1998 and 2015. Combining more than 50 interviews and applying social network analysis on a longitudinal dataset gathered from financial reports of the 30 biopharmaceutical and 25 medical device firms who have initiated public offering (IPO), this paper aims to explore the R&D collaboration networks between the actors in the innovation system to understand whether cluster effects would enhance the R&D collaborations in the high-tech science-based sectors. Comparing the networks of the firms in this group, a shift from relative sparseness in 2000 to connectedness in 2012 can be readily observed. The networks have been held together essentially by leading domestic research institutes (e.g. Academia Sinica and National Taiwan University) and the institutional intermediaries (e.g Industrial Technology Research of Taiwan and Development Center for Biotechnology). The finding of this paper suggest that while the nascent sector stays in a small size, geographical proximity is not the most important factor to determinate the networking establishments between the actors in the innovation system. In contrast, the fit of specialties and the mutual complementary of the business is the key factor to drive the formation of collaboration networks and alliances in the biotechnology sector- a science-based sector. One size does not fit all. Evidence from Biotechnology innovation network in Taiwan are provided in this paper.To further enhance the collaboration network in a nascent science-based sector, cluster effects through policy intervention attempting to stimulate the collaboration networks between the actors may not be the mostly efficient enhancement. Instead, the strength of local knowledge base and the mutual complementary between the actors would be most important enhancements to strengthen the local collaboration networks and the knowledge transfer in the networks. Instead of repeating the policy model used to successfully establish the ICT sector in 1980s, future technology policy to promote emerging sectors needs to focus on building the capabilities of the local sector, taking into account the distinct structural features of local innovation context, rather than copying policy models from the successful experiences from other sectors or from other countries.

Laura Cruz-Castro and Luis Sanz-Menéndez

Searching for the best colleague: professors' views about tenure and promotion criteria

Session 10B

Relevance

The processes of university hiring and promotion have attracted the attention of scholars for several decades now. The issue has theoretical as well as policy implications and has become even more relevant in the context of increased competition for resources among higher education organizations, and greater accountability and performance demands. At the same time, universities are more and more defining distinctive profiles regarding their orientation and this has implications for academic hiring and vice versa. The academic profession has also experienced some transformations including tighter labor markets, multiple role demands, and an increasing focus on outputs. Although there is much literature on career dynamics and its determinants at the individual level, there has been insufficient attention to the meaning and importance given to criteria of evaluation in selection and promotion processes, although some exemptions are noteworthy (Lamont 2009, 2012, Musselin 2005/2009).

Research question and key concepts

The Mertonian sociology of science has traditionally been the main framework to analyze academic judgment. This approach is particularly interested in article publications, citations, prizes, awards, etc. The empirical literature is divided among studies which argue that selection and promotion processes are governed by universalistic norms, and those which show the role of particularistic criteria in the selection processes outputs. In this paper, we analyze the normative views of Spanish academics about the evaluation criteria that should be applied in departmental tenure and promotions' decisions. We do not analyze selection processes empirically. Instead, we explore the extent to which views about promotion criteria among faculty are structured around consensus or division. We explore a descriptive hypothesis about homogeneity or heterogeneity and look at the association of the different views with significant variables.

Academic supply is not homogenous, and supply and demand adjust around variable concerns. Although it is sensible to assume that all committees search for the best candidate, the criteria used are multiple. Evaluation criteria are intertwined with at least three types of dimensions: firstly, they might be related to the multiplicity of university missions (knowledge production, teaching, knowledge transfer, training of new academics); secondly, they can also be linked to some of the functional needs of the organization: reproduction, growth, stability, loyalty, innovation, performance, reputation, fund raising, etc.; lastly, evaluation criteria and evaluation objects (outputs, processes, signals, potential) are entangled. In reality, all dimensions appear combined, and therefore the analytical challenge is to integrate them and build a meaningful empirical taxonomy in which we could identify distinct profiles.

Methodology and empirical material

Our research is based on data coming from a survey carried out in 2015 Spanish academics. We obtained more than 5000 valid responses in a representative sample of universities across the national territory. An online questionnaire with 30 questions was specifically designed. The reference universe was the population of academics holding a PhD in either temporary or permanent positions. The final number of the sample used in this paper is 4,460 individuals from 20 universities. Among other questions, respondents were asked to select up to three criteria from a list of thirteen that they thought should be the most important considerations in tenure and promotion departmental decisions.

We first use cluster analysis to identify groups of respondents according to their views of what makes the best candidate for tenure and promotion. Cluster analysis is an exploratory technique to identify structures within the data and homogeneous groups of cases. We identify five clusters which differ in the relative value given to research performance, teaching, or transfer, but also to, local commitment or contribution to collective tasks, or the ability to bring funding. Secondly we analyze the factors associated with choosing publication and citation merits as the most important; we find significant associations with gender, age, field and rank, among other variables.

This research will provide novel evidence on the preferences and views of academics regarding university missions and how faculty should contribute to them examining the value attributed to mobility, research grants, PhD supervision,

committee participation, productivity or research impact in tenure and promotion decisions.

Expected contribution

This research is part of an ongoing larger project. On the interest of the case it is worth mentioning that Spanish governments have implemented two reforms in the regulation of academic hiring and promotion systems in seven years; our results will show light on the key issue of evaluation and their connection to university missions by providing empirical evidence on the preferences and opinions of academic community itself. Universities have also become more active in profiling themselves around particular orientations and our results will grasp the existence of diverse views among faculty members regarding these missions. Preliminary results allow us to identify five different profiles of desired candidates; we have provisionally named them as “competitive” “localist” “productivist” “good citizen” and “cooperative”. With this exploratory research, we expect to contribute to the literature on the institutional and social bases of academic judgment in a changing the university context.

References

Lamont, M. (2009). How Professors Think: Inside the Curious World of Academic Judgment. Cambridge (Ma): Harvard University Press.

Lamont, M. (2012). Toward a Comparative Sociology of Valuation and Evaluation. Annual Review of Sociology, 38(1), 201-221.

Musselin, C. (2005/2009). The market for academics. Routledge.

Dirk Czarnitzki, Paul Huenermund and Nima Moshgbar

Public procurement as policy instrument for innovation

Session 7A

During the last decade, policy makers discussed the potential of public procurement as instrument in the area of technology policy. As a consequence, the European Commission has recently passed a new legislation that explicitly allows to include R&D and innovation components within public procurement contracts. Germany had already implemented this new legislation from 2009 onwards. Consequently, we evaluate the potential of public procurement for innovation empirically. We estimate the average treatment effect on the treated (ATET) of innovation-directed public procurement on German firms' share of sales of innovation and imitation using the Mannheim Innovation Panel. We apply cross-sectional OLS regressions, Matching, IV regression as well as difference-in-difference estimators with panel data. Interestingly, we find that firms with such procurement contracts indeed sell more innovative products than other firms. However, these new product sales refer to incremental innovation, i.e. the products are mainly new for the respective firms' product portfolio, but those are not really market novelties. We do not find any positive effects on sales with market novelties. Thus we conclude that public procurement may be a powerful policy tool for accelerating the dissemination of new technologies rather than a trigger for original innovation.

Bernhard Dachs, Eric Iversen and Georg Zahradnik

Main trends in the internationalisation of business R&D

Session 8E

Introduction

The internationalisation of research and development (R&D) activities in the business sector has considerably shaped national innovation systems in the last 20 years: Today, foreign-owned firms are a central part of clusters and industrial agglomerations in many regions (Ascani et al. 2016); they are a source of considerable knowledge spillovers and they employ a large share of the R&D staff in many countries. In addition, there are signs that the presence and role of multinational companies abroad is currently being re-evaluated (cf. Economist, 2017).

Despite the importance of R&D internationalisation, knowledge about it remains fragmented. The paper utilizes available data from a range of sources to present a complete picture of the internationalisation of business R&D during the past decade until 2013. The aim is to synthesize a range of available data to better understand (emerging) trends in this important area of policymaking.

Data

In contrast to previous papers (Patel and Pavitt, 1991; Guellec and van Pottelsberghe de la Potterie, 2001; Alkemade et al., 2015; Laurens et al., 2015) - which relied on patent data - we employ business R&D expenditure (BERD) data. Data for this paper has been collected from national statistical offices, the OECD, and from EUROSTAT, the statistical office of the European Union (EU). There is a complete coverage of EU and most other OECD countries, and some non-OECD countries including China. We see a number of advantages in expenditure data, including a more accurate identification of foreign-owned firms and their home countries, and an easier comparison of the data with total business R&D expenditure and between countries and sectors.

Results

The paper highlights three major results:

First, we find that R&D expenditure of foreign-owned firms (inward BERD) has increased faster than R&D expenditure of domestic firms since 2001; the data indicate a considerable increase in R&D expenditures of foreign-owned firms world-wide from around 70 bn. EUR to 110 bn. EUR. As a result, the share of foreign-owned firms on total BERD increased from 20% to around 28% between 2001 and 2013. So, R&D internationalisation has accelerated since 2001, and a higher share of total BERD is performed by foreign-owned firms in 2013 compared to 2001. This is in sharp contrast to other studies based on patent data, which find that R&D internationalisation stagnates (Alkemade et al., 2015; Laurens et al., 2015). The majority of R&D activities of firms, however, remains domestic.

Second, we find that R&D internationalisation at the global level - despite the rise of emerging economies - is still dominated by R&D activities of US firms in Europe, and European firms in the US. The US accounts for around 38% of total R&D expenditure by foreign-owned firms word-wide, followed by Germany and the UK. Altogehter, high-income countries amount for more than 85% of total R&D expenditure by foreign-owned firms word-wide. Thus, the concentration on OECD countries is the largest difference between the internationalisation of R&D and global value chains (Timmer et al., 2014). Some uncertainty, however, exists with respect to emerging economies, since data is not available for India and other countries of this group.

Third, we see the emergence of more diversity over the last decade, both in terms of the sectors and the countries involved. Globally, high-tech manufacturing sectors such as pharmaceuticals are the sectors with the largest R&D activities of foreign-owned firms. However, the most dynamic sectors in R&D internationalisation are service industries such as information, computer and software services.

At the country level, the share of the top investor country declines in the majority of countries between 2003 and

2013. Thus the internationalisation of R&D evolves from regional integration between neighbouring countries to more true international integration. Dependencies on countries from a single firm declined and the concentration of controlling countries decreased.

References

Alkemade, F., Heimeriks, G., Schoen, A., Villard, L., Laurens, P., 2015. Tracking the internationalization of multinational corporate inventive activity: national and sectoral characteristics. Research Policy 44, 1763-1772.

Ascani, A., Crescenzi, R. and Iammarino, S. (2016) Economic Institutions and the Location Strategies of European Multinationals in their Geographic Neighborhood. Economic Geography 92(4): 401-429.

The Economist (2017) The retreat of the global company: The biggest business idea of the past three decades is in deep trouble, The Economist, Jan 28th 2017.

Guellec, D., van Pottelsberghe de la Potterie, B., 2001. The Internationalisation of Technology Analysed with Patent Data. Research Policy 30, 1253-1266.

Laurens, P., Le Bas, C., Schoen, A., Villard, L., Larédo, P., 2015. The rate and motives of the internationalisation of large firm R&D (1994–2005): Towards a turning point? Research Policy 44, 765-776.

Patel, P., Pavitt, K., 1991. Large Firms in the Production of the World's Technology: An Important Case of "Non-Globalisation". Journal of International Business Studies 22, 1-22.

Timmer, M.P., Erumban, A.A., Los, B., Stehrer, R., de Vries, G.J., 2014. Slicing Up Global Value Chains. Journal of Economic Perspectives 28, 99-118.

Ivan Danilin and Zaur Mamedyarov

The National Technology Initiative (NTI): new perspectives and challenges of innovation policy implementation in Russia

Session 5A

The post-2008 period was marked by the intensification of the Russian innovation policy. But attempts to reset a number of incumbent mechanisms (science parks, special economic areas, namely accelerated development zones (ADZ), clusters, etc.) obviously could not be the right answer in the face of new challenges. The demand for non-standard solutions arose from both, the state and the R&D and business communities. NTI became an answer to this demand.

NTI is a program of measures designed to create Russian "Champions" on fundamentally new markets and bring Russia into the number of innovative and technological leaders by 2035. In terms of ideology and narratives, NTI is a complete alternative to the past experience of the Russian innovation policy, and, in many respects, of other countries.

First of all, the NTI focuses not on certain technologies, scientific directions or branches, but on prospective markets. Given the other factors, Russian companies are able to occupy significant share / niche and become the leaders only in the new emerging markets with high-growth potential and competition.

Secondly, the focus of NTI is on building networks and ecosystems of innovation. The importance of networks and ecosystems for innovation development is worth to be emphasized, and it had not been stated so in Russian political statements before NTI.

In terms of the structure and priorities, the NTI is divided into two domains: Markets and Technologies. In the Markets there are following areas: AeroNet (unmanned aerial vehicles), AutoNet (unmanned vehicles), EnergyNet (smart energy), FinNet (decentralized financial systems), FoodNet (systems of personal production and delivery of food and water), HealthNet (personalized medicine), MariNet (unmanned vehicles), NeuroNet (distributed artificial components of consciousness and psyche), SafeNet (personal security). NTI Technologies domain includes digital design and simulation, new materials, additive technology, quantum communication, sensing, biotech, bionics, genomics and synthetic biology, neuroscience, BigData, artificial intelligence and control systems, new energy sources, electronic components (including micro-processors).

The development of NTI took several stages.

Primary selection for the “Net” list was implemented by ASI. The Russian Foresight Fleet 2015 was dedicated to the analysis and forecasting of selected markets. As a result, the institutionalization of NTI began. It started with the support of ASI and Russian Venture Company (RVC). Basic organizational structure, implementation plan for the "Nets" (working groups) were devised. Later the working groups started to prepare roadmaps – long-term planning documents which also became the basis of interaction with the authorities.

In October 2015, the first four roadmaps were approved: AutoNet, MariNet, AeroNet and NeuroNet. Since that, we can talk about the actual launch of NTI as a federal action.

The next stage encompassed the development of NTI Strategy. At the same time, a system of cooperation between authorities and NTI was formed. Since autumn 2015, there have been identified basic contours of the state support of NTI. Various actors (from universities to regional authorities and a number of state-owned companies) showed interest to the implementation of measures and the Initiative, finally, became a fact of life.

NTI activities are implemented in several directions.

Considerable attention is paid to human resources programs, from the content point of view, they are probably central to the NTI.

Informative and networking events of ASI and RVC, as well as efforts for the preparation and training of personnel managers and interested parties, are expanding.

State support of project activities under the NTI faced some difficulties. Formally, initially the focus was on the participants of NTI, which were supposed to get support from the government through the formation of public-private partnership projects and initiatives. But almost from the start it became obvious that the state will play a greater role in the direct support of the Initiative.

It was decided to create a specialized subsidiary fund within the RVC, which involved flexibility and ease of budgeting. However, taking into account the supervisory procedures that affect very negatively the state support of innovative processes in the Russian Federation through any institution, this tool cannot be called perfect.

By now the triple-team 'the NTI Foundation — the Foundation for Assistance to Small Innovative Enterprises — the RVC' stays a basic formation for state support of the NTI projects in the future. It is complemented by measures of the VEB, Skolkovo and other development institutions, regions, companies with state participation and certain departments to support the activities of the NTI.

The 2017 federal budget calls for 12.5 billion rub. to implement the roadmap projects of the NTI (plans for 2018 — 8.2 billion rub., for 2019 — 8 billion rub.), but considering the above, the total cost for the entire set of the NTI activities will be higher.

A number of innovative entrepreneurs and experts agree that the NTI should be at least considered as an important attempt to turn away from the rigid and inefficient routine of the state-aided innovations in favour of more market-oriented and network-based attitude. However, there is a variety of questions surrounding the NTI implementation, both today and in the future.

The NTI development is still closely related to the Russian political convention. This brings up a sensitive issue of state priorities, for the state is still considered to be a prominent actor within the NTI framework, while its involvement plays a crucial part in the NTI effectiveness.

The amount of funding is also among the challenges. The roadmaps of all "Nets" do not include any investment information, nor do they have any detailed review of the issue or suggested solutions. It is worth noting that the project is very cost-demanding, since the multibillion sales and revenues call for commensurable spends and investments.

Due to investment ambiguity, the risks of NTI development and successful realization become higher, while at the same time the importance of budget and development institutions support increases, making NTI dependent on the existing problems of the Russian innovation policy.

The lack of well-defined priorities, NTI's network character and breakthrough nature of the markets and technologies in question collectively lead to another important managerial challenge. The weakness of the national innovation system calls for self-organization of the innovator communities which should develop potent social networks and ecosystems in the absence of proactive and smart state policies in the field. In the Russian realities, the situation clearly requires constant reproduction of trust capital and support from the state leaders, which implies significant results in the short to medium term.

All these considerations do not indicate that NTI should be labeled as a waste of energy. NTI should be regarded as an important stage in the development and restructuring of the Russian innovation policy.

Many problems can be solved during the evolution of NTI, while more and more economic subjects, including science and technology organizations, are being involved in the initiative. This calls for consolidation and growth of pragmatism rather than alienation of the innovative science and technology community.

Hailemichael Demissie

‘Inclusive by design’: Access to Emerging Technologies to Spur Inclusive Development

Session 6C

Access to technology determines whether a country or region remains relevant to the global economy of the present century. However, access to technology has never been unproblematic: frontier economies used various methods of exclusion to maintain and enhance their prohibitive lead and the competitive advantage that comes with it. Proprietary technologies were mainly guarded by law and now other means of protecting proprietary rights are being deployed. The leading economies are rightly accused of ‘kicking away the ladder’ they used to reach at their current level of development by excluding developing and emerging economies from the opportunities afforded by technology.

Imitation and adaptation that the advanced countries used during the earlier stages of their development was now virtually impossible as technological artefacts become imitation proof. The infamous ‘terminator gene’ that Monsanto used to execute its right over its proprietary biotechnology product epitomises the ‘exclusion by design’ policy. The number of technologies with features that exclude or otherwise restrict users, innovators and researchers is growing. Such a system of exclusion goes against the promise of technology as ‘the great leveller second only to death’. If so designed, technology can now be made accessible irrespective of culture, language, educational background or any other conceivable barrier that may prevent the use of technology. The ‘mass customisation’ trend endorses this reality and in terms of affordability, it is argued that modern technologies should not just be affordable but also extremely affordable to create ‘value for money and for many’.

For technology to deliver on this promise, it needs to be designed with the value of inclusiveness incorporated into it at the design stage. Reversing the ‘exclusion by design’ practice and turning technologies ‘inclusive by design’. Given the critical importance of technology for tackling global existential challenges as reflected in the ‘inclusive development’ concept mirroring the sustainable development concept, the ‘inclusive by design’ hypothesis is of utmost significance. Inclusiveness is a major pillar of the sustainable development discourse, especially in the context of the SDGs: A UN high level panel on the SDGs envisions ‘a world where no one is left behind’ and enlists the service of technology in advancing this vision.

The presentation will be structured as follows: With a brief background on the role of technology in the concept of ‘inclusive development’, the presentation examines the use of design as a means of exclusion and inclusion and the theoretical basis upon which such use is promoted. It will discuss historical episodes and the systematic deployment of design in complementing laws sanctioning exclusion or inclusion and the emergence of design as a standalone device. The presentation will explore the rise of the ‘inclusive by design’ concept and the legal, regulatory and policy contexts that propelled the concept to the foreground of global development policy. The opportunities that emerging technologies are offering in enhancing inclusivity and in resolving the tension between the opposing trends between proprietary technology and technology that incorporates the ‘inclusive by design’ value will be discussed. The presentation will also evaluate whether technology development is on track to fulfilling the promise as the great leveller in light of the newly approved SDGs.

Ameet Doshi and Usayd Casewit

How much does Georgia Tech publish on Climate Change and Sustainability? Profiling using Bibliometrics and Text-mining

Session 1

This poster presents the process and preliminary findings of a collaboration between a Public Policy graduate student and the Public Policy subject librarian at the Georgia Institute of Technology. The project involved profiling research publications on climate change and sustainability-related research by Georgia Tech faculty and researchers over a five year period. Key concerns included: basic competency with the text-mining software VantagePoint, validating completeness of the dataset, cleaning the data, and visualizing results. This uniquely large and unwieldy topic domain may provide insight into strategies for structuring search terms and using text-mining tools for broad and dispersed topics. In addition, the project aims to illustrate the productivity of Georgia Tech's research activities related to climate change and sustainability. This type of research profiling of large-scale topics may increase in prevalence as research universities continue investments in solving "grand challenges." We also conclude that research librarians can serve as valuable partners in helping to: identify related subject headings, provide instruction on appropriate text-mining tools, and co-creating boolean search terms to encompass challenging topic domains such as climate change and sustainability.

Jakob Edler, Kate Barker and Maria Karaulova

Better understanding impact of scientific knowledge on policy by conceptualising policy making conditions

Session 3C

This paper develops a conceptual framework to understand the impact of scientific knowledge on the policy making process. It does so by analysing the institutional conditions in the policy-making systems itself which – we argue – co-determine research agendas, patterns of co-production of knowledge, demand for and use of scientific knowledge, and thus its impact. The framework therefore fills a gap in the vast existing literature on science impact on policy which has focused more on the science system itself, the perspective of scientists or the science – policy interaction.

The basic motivation for the paper emerges from four observations regarding impact of science on policy making. First, despite a long history of looking at science – policy relationships and the use of scientific expertise and evidence for policy making there still seems to be a huge dissatisfaction with the way scientists and scientific results actually do inform policy making (Almeida and Báscolo, 2006; Smith, 2013, p. 4). Second, STI policies are increasingly formulated towards addressing global challenges, and funding systems are being re-shaped to support directionality of scientific knowledge production towards contributing to tackle challenges and serve missions. While science since the second world war has always had an element of mission orientation, the last decade, at least in Europe, has seen a broadening of this challenge and directionality approach in science funding, often framed in the language of crisis, response urgency and severity of the challenges to be tackled (Kuhlmann and Rip, 2014). In consequence, impact on policy of society more broadly, as one critical dimension in challenge orientation, has come to the fore again as a major justification of scientific activity. Third, and as a consequence of this trend, there is an increasing demand for the individual scientists to produce knowledge that has impact. Many Research councils (such as ESRC, NSF) now ask for explicit impact pathways and engagement strategies in funding applications, while in performance based funding systems, such as the UK REF, the explicit demonstration of impact ex post is becoming increasingly important for the assessment of organisations, and by implications, the scientists working within them. This puts the onus of generating impact fully on the scientists, as it is for them to choose topics and create engagement strategies that increase the likelihood of impact to occur. Fourth, in policy making, certainly in the UK, there is a strong revival of the idea that objective evidence can be produced on the basis of rigorous approaches, translated into layman language, and used by the policy making system co-determining decisions on policy (Parsons, 2002; Sanderson, 2009). In this reasoning, the more convincing the evidence, and the more convincing the translation into layman's language, the more likely the scientific evidence has effect in the policy making process. Here, it is the nature of the evidence that determines the role it plays in policy making.

Against this background, there is a need for a change of perspective, to balance how we understand impact of science on policy. We think it is time to focus much more strongly on those non-scientific actors that co-determine research agendas, co-formulate the policy problem and absorb and utilise scientific knowledge in the policy making and implementation process – which has been found as being more important than the nature of the "product" (scientific knowledge) itself (Landry 1999).

We follow a reflexive institutionalist approach, which assumes that while policy making is interest and power driven, the policy problems and normative and material interests are constantly redefined in the policy making process (Edler, 2003; Hall, 1993). Importantly, this definition process is influenced by the stock and flow of normative and cognitive ideas and their persuasive and legitimating power. Scientific knowledge is one important input in this (re-)construction of problem definition, interests and solutions, whereby scientists themselves do not occupy a neutral, objective position, but have their own – changeable - normative and material interests.

Within this theoretical understanding of the policy making process, our framework takes the qualities and processes of the policy making arena in the focus and consists of three pillars – which are interdependent: (1) the four core institutional dimensions of the policy making arena and their meaning for the individual policy maker, (2) two mechanisms of mutual influence (funding and engaging) and (3) the polity, politics and governance of the policy making process more broadly.

(1) The first pillar of the framework conceptualises the nature and role of four institutional dimensions shaping the identities and strategies of actors in the policy making process (very loosely following and extending Scott (1995)):

Cognition: This concerns the basic understanding of cause and effect relationships and how this basic understanding within the policy arena can be shaped (Edler 2003), and extends to the absorptive capacity of the individual actor in the policy making arena (Uzochukwu et al., 2016).

Normative world views and basic paradigmatic positions, whereby we understand that the policy making arena is characterised by normative world views that determine what kind of knowledge is asked for and act as filters for the absorption of scientific knowledge (Rein and Schon, 1993). However, those world views are themselves not stable but can be replaced by competing ideas gaining more legitimacy (Baumgartner / Jones 1993).

Role perceptions, whereby we understand that actors in policy arenas, in bureaucracies, think tanks, parliaments etc. are not driven by their immediate professional function and task only, but they are members of epistemic communities (Haas 1993) and community of practice (Meagher-Stewart et al., 2012) which in turn shapes their world view and their absorptive capacity.

Incentive structures, i.e. the system of rewards and recognition within bureaucracies and more broadly in the policy arena.

The second pillar consists of the mechanisms of mutual interaction and influence of science and policy:

Patterns of communication with the science system: From the above it follows that our framework rejects the idea of a simple linear model (which is still somewhat dominant in the literature (Almeida / Cruz 2006), even if there are instances of transfer of a particular research result to the policy arena. We assume that the established patterns of communication and engagement are critical to understand processes of co-definition of problem views and research agendas as well as the acceptance of research results. This builds on a wealth of theoretical and empirical academic work that understands knowledge production as a collective, iterative process between researchers and stakeholders in science studies, ranging from mode 2 frameworks (Gibbons et al., 1994) to the most far reaching approaches of Actor Network Theory in the STS literature (Latour, 2005) . Here we will also take into account the role of intermediation and non scientific expert provision in those interaction processes.

Science funding patterns, which concern the role played by ministries, foundations and agencies and individual policy makers who are concerned with a certain policy problem in funding research and research organisations and in so doing in co-defining research agendas and needs.

The third pillar contains the broader framework conditions of the policy making process itself, as this moderates the way in which the first two pillars exert effect: polity, i.e. the constitutional structure of the policy making system and the nature of decision-making and politics, i.e. the nature of coordination and decision making processes, degree of formalisation of deliberation, allocation of competencies, power constellations, resolution of material and normative conflicts.

The conceptual paper will close with proposition for our empirical work, demonstrating the usefulness of the framework and its operationalization and its potential added value for the academic debate on impact of science on policy.

References

Almeida, C., Báscolo, E., 2006. Use of research results in policy decision-making, formulation, and implementation: a review of the literature. Cadernos de Saúde Pública 22, S7-S19.

Edler, J., 2003. How do economic ideas become relevant in RTD policy making? Lessons from a European case study. na.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M., 1994. The new production of knowledge: The dynamics of science and research in contemporary societies. Sage.

Hall, P.A., 1993. Policy paradigms, social learning, and the state: the case of economic policymaking in Britain. Comparative politics, 275-296.

Kuhlmann, S., Rip, A., 2014. The challenge of addressing Grand Challenges: a think piece on how innovation can be driven towards the" Grand Challenges" as defined under the prospective European Union Framework Programme Horizon 2020.

Latour, B., 2005. Reassembling the social: An introduction to actor-network-theory. Oxford university press.

Meagher-Stewart, D., Solberg, S.M., Warner, G., MacDonald, J.-A., McPherson, C., Seaman, P., 2012. Understanding the role of communities of practice in evidence-informed decision making in public health. Qualitative health research 22, 723-739.

Parsons, W., 2002. From muddling through to muddling up-evidence based policy making and the modernisation of British Government. Public Policy and Administration 17, 43-60.

Rein, M., Schon, D., 1993. Reframing policy discourse, in: Fischer, F., Forrester, J. (Eds.), the argumentative turn in policy analysis and planning, Durham, pp. 145-166.

Sanderson, I., 2009. Intelligent policy making for a complex world: pragmatism, evidence and learning. Political Studies 57, 699-719.

Scott, W.R., 1995. Institutions and organizations. Sage Thousand Oaks, CA.

Smith, K., 2013. Beyond evidence based policy in public health: the interplay of ideas. Springer.

Uzochukwu, B., Onwujekwe, O., Mbachu, C., Okwuosa, C., Etiaba, E., Nyström, M.E., Gilson, L., 2016. The challenge of bridging the gap between researchers and policy makers: experiences of a Health Policy Research Group in engaging policy makers to support evidence informed policy making in Nigeria. Globalization and Health 12, 67.

Jakob Edler, Magnus Gulbrandsen, Tara Thune and Jordi Molas-Gallert

Beyond established impact assessment approaches in STI policy

Session

This track aims to discuss new theoretical and empirical approaches related to studies of the impact of research. It is situated in one of the main topics of the Conference: "Evaluating economic, social, and environmental research outcomes". It is organised by the Oslo Institute for Research on the Impact of Science- OSIRIS (http://www.sv.uio.no/tik/english/research/projects/osiris/) inviting two papers from colleagues of the Research quality and policy impact R-Quest (http://www.r-quest.no/).

The social and economic impact of research has become an increasingly significant issue in the STI policy debate, and the analysis of the effects of research has long been the subject of many scientific investigations and numerous evaluations of research fields, organisations and funding instruments. Early studies tried in particular to measure the economic returns to research and development (R&D), but current perspectives encourage mixed methods and highlight different types of impact for a variety of stakeholders in a larger system. The impact literature and the use of the term in policy environments reflects such wider expectations from research including but going beyond the economic effects. The concept also emerges at the interface between science and innovation policy.

There are, however, several problems with the current state-of-the-art of impact studies.

First, the field remains divided between communities that primarily favour quantitative approaches and indicators and those that favour qualitative and case study approaches. Second, the field is fragmented as many of the investigations of impact are tied to specific evaluations and published in "grey" literature, often in a national language. In addition, there are relevant empirical studies of impact in a range of other areas of inquiry than in the research evaluation field, such as science and technology studies, science history, innovation and science policy. Even areas with strong empirical overlap, such as research evaluation and academic engagement/university-industry relations seem to lack concepts and approaches that allow us to bridge them.

Second, the conditions under which impact is supposed to be generated have changed. For example, because of the spread of performance based funding systems across the OECD world, the emphasis has been on certain type of – scientific – outputs and changed the notion of impact to mean foremost scientific impact (citations). This is only partly and slowly addressed through strengthening the societal and economic impact dimension again. We have yet to comprehend how different approaches of assessing and rewarding the science system impinge upon the impact scince makes on society.

Third, there is a strong need for conceptual development and renewal. As STI policy has increasingly turned towards addressing societal challenges, the impact concept has been expanded beyond economic impacts to include long-term effects related e.g. to health, environmental aspects, policy and economic issues for different public and private stakeholders. But rather than reflecting the complex interaction in knowledge production that comes with this shift, the theoretical concepts themselves – impact, effects, outputs and others – still allude to linear and simplistic notions of research delivering knowledge and solutions to society, neglecting the complex interactive process of impact development over time. Further, the practice of impact assessment reflects the division in the governance and funding of research activities that contribute to (desired) societal effects. Even more, impact studies seem to have focused on the conditions of knowledge production in the science system and the activity of scientists to make their research impactful. There is much less research about the conditions in policy, industry and society more broadly that are conducive to impact development in the first place.

Finally, impact studies often focus on desired and expected impacts, analysing both the pathway and the degree with which research contributes to desired and expected effects. Non-expected and negative (or better: controversial) impacts are often not conceptualised ex ante, and thus not measured. However, as the recent debates on responsible research and innovation have shown, in democratic and open societies, research and its impact on society are by nature contested. Therefore, there is a need to open up impact studies more explicitly and systematically to broader normative debates.

This session will address some of those fundamental issues through four invited papers:

Paper 1: Magnus Gulbrandsen, Taran Thune, Richard Woolley: Research impact as a process

This paper seeks to discuss the conceptual and methodological implications of a process view of research impact and to tie the science and innovation policy debate about impact to wider process frameworks and process theories of institutional and organizational change.

Research impact is a complex phenomenon that denotes how research results and the people and organizations that produce them contribute to changes elsewhere. These changes come in the form of innovation and economic growth but also in areas such as health and care, agriculture, national security, environmental issues, and policymaking. Traditional studies of impact have studied the consequences of research and the antecedents of its effects, often with an aim to quantify the contributions of research and development (R&D) in different sectors of society.

If we want to understand how research can make a difference, not just to what extent, it is best seen as a long-term process involving intricate forms of interaction and knowledge transfer along different trajectories, loops and reciprocal relationships. Central terms in process studies are events, contexts and time, and we will discuss their meaning and operationalization for impact studies where processes have often been conceptualized in stages rather than events.

Paper 2: Jakob Edler, Kate Barker and Maria Karaulova: How to benefit? Conceptualising the demand for and absorption of research for policy making.

This paper develops a conceptual framework to understand the demand for and use of research in policy making. There is a huge literature on the use of scientific evidence in policy. Much of this research looks at the supply side, e.g. the nature and quality of the research, or at the pathways through which research has impact on policy making. This has become more important in recent years with increased pressures on research organisation and individual researchers to «deliver» in terms of policy making. As a consequence, a major focus of research on impact has been on the qualities of science and the conditions of the production of science. Fewer contributions have looked at the structural and systemic conditions for the demand for and use of scientific evidence in policy making systems. Often those contributions focus on political conditions and power games, i.e. the relative importance of scientific evidence in the policy deliberation and making process.

This paper shifts the focus to prepare the ground for a more systematic understanding of the demand side of impact. Based on a systematic review of the theoretical and empirical literature on the uptake and use of scientific evidence – in particular for policy - , we will present a concept to analyse the conditions that determine the demand for and uptake of scientific evidence in the policy making process, and how those conditions influence the mechanisms for impact to develop. This paper is part of a research design process in the Research Centre OSIRIS and will be the basis of a long term empirical programme to understand scientific impact on policy making.

Paper 3: Gunnar Sivertsen: Frameworks for the understanding and evaluation of the societal impact of research in the humanities

The aim of this paper is to test out different frameworks of understanding the societal relevance of research. The study is based on more than 300 individual cases of societal impact in the humanities that have been reported to national research evaluation exercises in two countries, the United Kingdom in 2014 and Norway in 2016. The typical pathways, beneficiaries and effects of research in the humanities are identified within a framework of understanding that corresponds to the implicit 'linear model' of societal impact in the methodology of the two research assessment exercises. The same material is then confronted with alternative frameworks for understanding by which on can more easily identify societal impact as modes of interaction and co-creation in the areas of society where the humanities are typically organized and expected to respond to societal needs not only in individual cases, but on a daily basis.

Paper 4: Maria Nedeva and Duncan Thomas: Assessing the Impact of Complex Policy Instruments on the Science System: REF and the 'British Science System'

There is much that has been written on issues of impact on science and society. A relatively under-investigated relationship is this between policy instruments and the science system and more specifically the impact – or the lack of

it – of policy on part of the science system.

In this paper we take a step towards unpacking this relationship by investigating the impact of a specific, and complex, policy instrument (the REF in the UK) on the universities in the UK. We suggest that the assessment of the effectiveness and efficiency of policy instruments can use a 'matrix of impact' along two dimensions: intentionality and desirability of impact. This draws attention to four kinds of impact: 'low fruit', 'long shots', 'collateral' and 'accidentals'. We posit that for a policy instrument to be deemed to be 'successful' its impact ought to fall mainly under 'low fruit' and 'long shots'.

Background on the two research cetnres:

OSIRIS

The Oslo Institute for Research on the Impact of Science –studies how and under what conditions research may have an impact on society. The main goal of OSIRIS is to become an internationally leading centre for studies of the impacts of research and to look at how and under what circumstances, research produces effects in society at large. OSIRIS brings together cross-disciplinary expertise for a concentrated, long-term effort. OSIRIS will pursue four secondary goals:

Form an interdisciplinary platform of researchers working with impact studies and use this platform for recruitment and training of and for expanding empirical studies of impact.

Systematise and develop new conceptual and methodological knowledge together with lead users.

Carry out empirical research utilising refined methods and using these studies to advance beyond the state-of-the-art, looking in particular at effects of research within health, economic development and policymaking.

Use an open science approach to engage experts and users in all phases of research and offer training and sharing of best practice with stakeholders."

OSIRIS is an eight year centre funded by the Research Council of Norway's ForInnPol programme. It is hosted and led by TIK Centre for Technology, Innovation and Culture at the University of Oslo, and it is carried out in partnership with Statistics Norway (SSB), INGENIO at the Polytechnic University of Valencia and MIOIR at the University of Manchester.

R-Quest

R-Quest, Centre for Research Quality and Policy Impact Studies, is funded by the Norwegian Research Council and aims to explore a key concern of science policy, namely: how to enable the production, dissemination and use of scientific knowledge with particular properties (as excellence), with limited budgets. This concern frames the policy debates and is often used to argue for, and justify, changes of the governance and funding rules, setting up (dismantling or re-structuring) research funding agencies and policy organisations, and the over-haul of the institutional arrangements of the science system. R-Quest addresses these concerns by tackling the following questions:

How are notions of research quality negotiated and established?

What are the mechanisms through which these notions affect policy, the institutional conditions for research and the science system?

What are the effects of high quality research on society and economy?

Mahmud Farooque and Michael Bernstein

Participatory Technology Assessment: Upstream Public Engagement Advancing Useable Science

Session

In the U.S. and abroad, the institution of science in democracies faces a rising number of threats to internal and external validity. Threats to internal validity relate to difficulties with verifiability, replicability, and generalizability of research. Threats to external validity can be seen in the varying levels of trust in the institution of science: although trust in scientists has been relatively stable since the 1970s, there are high levels of ambivalence in a growing number of fields about science as a means of safeguarding well-being and safety. The lens of "usable science" offers one approach to enhancing both the internal and external validity of science by focusing on convening the entire spectrum of users (scientists, decision-makers, and publics) and producers of research early and often, and responding to the inputs that arise from these interactions. The practice of "upstream public engagement in science and technology" broadens the values and contexts that research attends to, enhancing potential for usability, compliance, and feasibility and addressing threats to internal validity. Additionally, upstream public participation, by including more values and voices as inputs to policy and practice, can also identify means for improving public confidence, enhancing trust and thus addressing threats to external validity.

Participatory Technology Assessment (pTA), a specific form of upstream public engagement for decision and policy-support in science and technology, provides an innovative approach for integrating user value demands with policy and technological developments. In this panel, we will explore the opportunities and challenges of using pTA and the usable science approach to strengthen the internal and external validity of the institution of science in democracies. The panel will open with an introduction by session co-organizer Bernstein to the usable science framework and to a U.S. model for pTA: the Expert & Citizen Assessment of Science & Technology Network (ECAST). Bernstein will introduce usable science dimensions of linking to specific problems; supporting connections among users and researchers; incorporating user perspectives; and testing the usefulness of results can be realized through upstream public engagement. Remarks about ECAST will review the motivation, organization, and project experiences of this diverse array work to convene of experts, stakeholders, and everyday citizens in assessing the responsible design and use of emerging developments in science and technology.

In the first presentation, Darlene Cavalier will review public engagement in the context of broader efforts to democratize science. Reviewing citizen science and crowdsourcing activities, Cavalier will explore how pTA practices can better integrate across the chain of possible opportunities for stakeholders, and publics to participate in science in a democracy. Next, David Sittenfeld will present a novel approach to broadening participation of stakeholders and publics through informal science education (ISE) institutions. His talk will focus on the role and potential of science museums as trusted boundary organizations and creators of boundary objects to support upstream public engagement and generate usable information for decision support. David will present a NOAA funded 3-year project to build to create public forums at eight science centers for environmental literacy, improved resilience and decision-making.

After the stage is set around public engagement, David Tomblin will present on ways of connecting the input from pTA exercise into decision-making processes at NASA. Integrating inputs from technical and policy stakeholders with pTA outputs is a key link in the connection between usable science and upstream public engagement. Building upon these integration activities, Ira Bennett will close the session with a presentation on lessons-learned for pTA and upstream public engagement as it relates to usable science. He will present a vision of pTA communities of practice inclusive of the range of upstream participation tools, issue areas, and multiple scales of community, state, national, and international involvement.

Charles Featherston and Eoin O'Sullivan

Technology strategy development exercises through the lens of technological innovation systems: articulating system structure, functions, and performance

Session 5A

Introduction

National strategies have been developed for many technologies, including synthetic biology (SBLC, 2016), composite materials (CLF, 2016), quantum technologies (Quantum Technologies SAB, 2015), and robotics and autonomous systems (METI, 2015). These strategies are often developed by 'steering committees' of industrialists, academics, and civil servants, with support from government; and focus on groups of technologies with common features and functionalities (e.g., additive manufacturing). These strategies aim to reveal information to address particular challenges, including sharing information about technical and market opportunities, establishing and sharing a vision for the technology, and identifying coordination needs for further technical development (Featherston & O'Sullivan, 2015).

Technology strategies can potentially involve a large number of actors in their development, and potentially influence many different actors related to technology development and deployment. Furthermore, they can focus on many different activities related to technology development and innovation. Finally, strategies can focus on different timeframes and different stages of the technology lifecycle, influencing various behaviours related to innovation. These actors, activities, and performance timeframes and lifecycle perspectives need to be defined to scope a strategy development exercise, collect and analyse information, and develop a strategy. That is, the boundaries of the strategy development exercise needs to be articulated to clarify the activities involved in developing a technology strategy.

This paper uses theory from innovation systems, in particular technological innovation systems (TIS), to describe and explain the boundaries of technology strategy exercises. National technology strategies are developed to influence a national TIS. Drawing on a general innovation systems foundation, TIS theory provides insights into system structure (Bergek et al., 2015; Carlsson & Stankiewicz, 1991) and its functioning (Bergek et al., 2007, 2010; Hekkert et al., 2007). Other literatures, in particular literature on lifecycle analysis (e.g., Gort & Klepper, 1982), are used to explore the performance timeframes and lifecycle perspectives of technology strategy development exercises.

Methodology

The paper draws on detailed analytical case studies of four recent UK strategy development exercises, namely composite materials, quantum technology, synthetic biology, and bioimaging. A case study methodology was selected because they provide a rich context for analytic generalisation and can be built from the data sources available for technology strategies, namely interviews with those involved in their development, and primary and secondary documents (Yin, 2009). Multiple case studies were selected because they help develop theories and investigate rival theories (Yin, 2009). Recent historical case studies were chosen because information about their final scope was available. Composite materials, quantum technology, synthetic biology, and bioimaging were selected because of they provide a broad analytical basis by being technologies at different stages of their lifecycle, with different underpinning knowledge structures, and different actor compositions. UK case studies were selected to remove national context from these reasons for variation between the case studies, helping to support theoretical replicability.

The data sources used to collect evidence on the case studies includes: interviews with individuals involved in the strategy steering committees; content analysis of primary documentation ('the' strategy document, underpinning analyses, etc.) and secondary documentation (contracts, exercise reports, etc.); and output from a lessons learned and emerging practices workshop for emerging technology strategies.

Results and conclusions

The various approaches to defining an innovation system offered by the TIS framework – structure and function – help define and explain the boundaries drawn in technology strategy exercises. From a structural perspective geographical and technological boundaries were common; and sectoral boundaries were only not defined when it was thought the technology could be exploited in primarily entirely new sectors (e.g., synthetic biology). Defining boundaries by actors

was common, however this was often done in an ad-hoc fashion. Similarly, broad functional attributes, such as output technology functionality, were common, whereas more detailed descriptions, such as TIS functions, were not. Finally, this work drew on the concept of lifecycles, technology diffusion patterns, and repeated market deployment dynamics to articulate the 'service' an innovation system provides, namely progress in development, diffusion, and deployment.

This work illustrates some of the utility of TIS notions of structure and functions for describing practice, at least in the context of technology strategies. It also points to some extensions required to further help describe and explain TIS systems definition and operation. This work enriches the TIS framework by providing insights into boundaries dynamics. It builds on Bergek et al.'s (2015) conceptual advances to describe how the varying relevance and flexibility of actors dictates the regularity and degree of their engagement and some of the explanatory reasons for their inclusion and exclusion in certain aspects of the strategy development process. Furthermore, it adds to the structure-function dyad the service provided by an innovation system.

References

Bergek, A.; Hekkert, M. & Jacobsson, S. (2007), Functions in innovation systems: a framework for analysing energy system dynamics and identifying goals for system-building activities by entrepreneurs and policy makers, in: Foxon, T., Köhler, J., Oughton, C. (eds.), Innovation for a Low Carbon Economy: Economic, Institutional and Management Approaches, Edward Elgar: Cheltenham, UK.

Bergek, A.; Hekkert, M.; Jacobsson, S.; Markard, J.; Sandén, B. & Truffer, B. (2015), Technological innovation systems in contexts: conceptualizing contextual structures and interaction dynamics, Environmental Innovation and Societal Transitions, 16: 51–64.

Bergek, A.; Jacobsson, S.; Hekkert, M.P. & Smith, K. (2010), Functionality of innovation systems as a rationale for and guide to innovation policy, in: Smits, R.E., Kuhlmann, S., Shapira, P. (Eds.), The Theory and Practice of Innovation Policy: An International Research Handbook, PRIME Series on Research and Innovation Policy in Europe, Edward Elgar: Cheltenham: pp. 115–144.

Carlsson, B. & Stankiewicz, R. (1991), On the nature, function and composition of technological systems, Journal of Evolutionary Economics, 1(2): 93–118.

CLF, Composites Leadership Forum (2016), The 2016 UK Composites Strategy, CLF and Department for Business, Innovation and Skills: Hemel Hempstead, UK.

Featherston, C. & O'Sullivan, E. (2015), The implications of innovation system maturity for the development of national strategies for emerging technologies: lessons and insights from past experiences, Atlanta Conference on Science and Technology Policy: Atlanta, GA.

Gort, M. & Klepper, S. (1982), Time paths in the diffusion of product innovations, Economic Journal, 92(367): pp.630–653.

Hekkert, M.P.; Suurs, R.A.A.; Negro, S.O.; Kuhlmann, S. & Smits, R.E.H.M. (2007), Functions of innovation systems: a new approach for analysing technological change, Technological Forecasting and Social Change, 74(4): 413–432.

METI, Ministry of Economics, Trade and Industry (2015), New Robot Strategy, METI: Tokyo, Japan.

Quantum Technologies SAB (2015), National strategy for quantum technologies: a new era for the UK, Innovate UK & the Engineering and Physical Sciences Research Council: Swindon, UK.

SBLC, Synthetic Biology Leadership Council (2016), BioDesign for the Bioeconomy: UK Synthetic Biology Strategic Plan 2016, SBLC: London, UK.

Yin, R.K. (2009), Case Study Research: Design and Methods (4th ed.), Sage: Los Angeles, CA.

The policy agenda set forth by the President of the United States in his speech to Congress on February 28th called for $1 trillion in spending on infrastructure[1]. This policy agenda draws from the President's own observations and assessments by the American Society for Civil Engineers[2] and the Department of Energy's Office of Electricity Delivery and Energy Reliability[3] that the nation's energy and transportation infrastructure suffers from critical vulnerabilities. Scholars in risk management and members of the U.S. Army Corp of Engineers with expertise in infrastructure planning have already called into question how this political promise will manifest[4]. Yet, as the 2014 National Academies of Engineering report[5] suggests, energy infrastructure planning is intertwined with the legacy policies that govern these large-scale technological systems and their interactions with people and the environment. Thus, the very near-term decisions on infrastructure might best be understood with the public values framework[6], since electricity services are not delivered through markets, rather they are legitimate monopolies.

Drawing from the eight public values offered by Bozeman[6], this research paper will interrogate how specifically three public values––*values articulation and aggregation, time horizons,* and *distribution of benefits*––contribute to the conflicts that are more and more frequently reaching national media attention. Debates about energy security, climate change, and environmental and societal risk are being played out across the US in regards to energy infrastructure. For example, the Keystone XL and Dakota Access pipeline have faced opposition that caught the attention of the national media organizations. Public values born from science policy[7,8], may offer insights into the planning and authorization processes upheld by the Federal Energy Regulatory Commission, U.S. Army Corp of Engineers, and Pipeline Hazardous Materials Safety Administration.

To date, there is a paucity of research on how public values, which go far beyond market pricing schemes, affect energy infrastructure planning and authorization. The guiding question for this research is: How can the political conflicts surrounding energy infrastructure be understood through the lens of public values and what pathway forward might offer reliable and affordable energy that accounts for those values? This research draws upon evidence from the Atlantic Coast Pipeline as a case for critical reflection on how public values failures are influencing energy infrastructure, before opening up a conversation on how this framework can reshape the science – policy interface for energy infrastructure planning. This research is critical as it offers insights into the current decision making processes and the corresponding societal responses.

In brief, the Atlantic Coast Pipeline LLC, is a consortium of energy companies that is proposing to build a pipeline to transport natural gas from the Marcellus Shale formations in western Pennsylvania and West Virginia to users in Virginia and North Carolina. In Virginia, some communities and organizations located in or near the 594-mile project corridor stand in opposition to the project in general, while others oppose specific routes selected and other factors. The evidence derived from this case consists of policy document analysis, an exploratory survey with 272 responses out of a population of 115,000 persons in two counties in the preferred route of the pipeline. Additionally, three workshops (hosted in the affected region) explored alternative means for stakeholders to articulate values, consider time horizons, and engaged with decisions regarding distribution of benefits and the regulatory and decision-making processes that govern them. The foundation for this paper rests on three specific public values and how each relates to energy infrastructure planning, specifically decision-support sciences, engineered systems, and rural-urban characteristics.

First, energy infrastructure planning is influenced by *decision support sciences* that account for emergent conditions including markets, environmental conditions, technological innovation, regulation and behaviors[9]. The empirical study of emergent conditions (either in isolation or

combinations) relies upon scenarios to identify how these conditions affect planned investments. Such approaches utilize multi-criteria analysis to support decisions made by select stakeholders based on risk, performance, cost, and schedule[11]. This approach can suppress the modes and methods for *values articulation and aggregation* when decision-makers assume a fixed set of values that is at odds with affected stakeholders and the values inherent in alternative positions[7]. The Atlantic Coast Pipeline offers evidence for how current planning processes are sparking political conflicts rather than affording space for values articulation, aggregation and facilitating robust negotiations.

The second key factor is *engineered systems,* which accounts for multiple levels from micro, meso, and macro or more tangibly from community-based to utility-grid to nation-wide scales. Engineered systems calculate electricity generation, transmission, and distribution networks that serve critical needs in communities' for education, safety, quality of life, and economic productivity. Utilities companies engineer systems at that harness energy sources, carve out distribution networks, and establish contracts with users that support their financial stability. At the national scale, energy infrastructure needs to be assessable to rural and urban users, while facilitating interstate commerce, provisioning national security, and enabling global economic competitiveness. Engineered systems usually account for variability in physical, technological, institutional, regulatory, and environmental conditions. Yet, energy infrastructure, including its sources (e.g. coal or solar) and uses (e.g. steel production or residential appliances) creates environmental and social impacts that will play out over decades, if not centuries[11]. Of interest is how time horizons can be accounted for in *engineered systems,* which traditionally are designed with contemporary technological functionality readilty available and lack recognition for how innovation will affect the future operation of the system. Further, shifts in societal values overtime will be constrained by past decisions embedded in the engineered system. The inclusion of time horizons in large-scale engineered systems creates an opportunity to consider how legacy policies and infrastructures are coupled and how shortening the time horizon (or life expectancy) of energy infrastructure may create greater flexibility and adaptability in the future.

The third key factor is *distribution of benefits*[7,12]. Perhaps nowhere is this more apparent than in the characteristics that define rural and urban communities. Rural areas are where low population density and geography reduces the relative risks of loss of life from catastrophic failures resulting from energy infrastructure. Yet, rural areas do not offer sufficient financial returns for the shareholders of traditional investor owned utilities. Thus, many rural areas are served by municipal or cooperative electricity providers that are typically not subject to oversight from state public utility commissions[13]. At the same time, rural communities are often confronted with proposals by investor owner utilities to locate large-scale energy infrastructure, i.e. pipelines or high-tension power lines, which transect sparsely populated geographies to connect high-wealth, energy consuming urban regions. This gives rise to inequitable distribution of benefits between rural and urban communities. The socio-demographic characteristics in the case of the Atlantic Coast Pipeline and other proposed pipelines shows that low-income, elderly populations will be exposed to higher levels of relative risk, while high-income, younger populations will reap greater benefits in terms of employment opportunities and reliable energy supplies.

One of the only agenda items shared by the two 2016 presidential candidates was the need to reinvest in infrastructure[14]. Yet, the federal agencies responsible for authorizing planned investments in energy infrastructure are failing to uphold three critical public values. If this nation seeks to rebuild its energy infrastructure and address critical vulnerabilities, then the very processes and procedures that underlie those decisions must too be rebuilt to uphold public values.

References

1. Trump, D. (2017). Remarks by President Trump in Joint Address to Congress. Available at: https://www.whitehouse.gov/the-press-office/2017/02/28/remarks-president-trump-joint-address-congress

2. American Society of Civil Engineers (2016). 2017 Infrastructure Report Card: Energy" Available at: http://www.infrastructurereportcard.org/cat-item/energy/

3. Office of Electricity Delivery and Energy Reliability (2010). Energy Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan. Department of Energy and Homeland Security.

4. Trump, B.D., Keisler, J.M., Lambert, J.H., Linkov, I. (2017). Campaign to governance: Science, engineering, and policy innovation for America's top infrastructure projects. *Environment Systems and Decisions,* 37(1), 42-45.

5. National Academy of Engineering (2014). The Climate Change Educational Partnership: Climate Change, Engineered Systems, and Society. National Academies Press, Washington DC.

6. Bozeman, B. (2007). *Public Values and Public Interest: Counterbalancing Economic Individualism.* Georgetown University Press, Washington, D.C.

7. Bozeman, B., Sarewitz, D., 2011. Public Value Mapping and Science Policy Evaluation. *Minerva,* 49, 1-23.

8. Bozeman, B., Sarewitz, D. Public values and public failures in US science policy. *Science and Public Policy* 32 (2), 119-136.

9. Thorisson, H., Lambert, J.H., Cardenas, J.J., Linkov, I. (2016). Resilience analytics with application to power grid of a developing region. Risk Analysis, DOI: 10.1111/risa.12711

10. Karvetiski, C., Lambert, J.H., Linkov, I. (2010). Scenario and multiple criteria decision analysis for energy and environmental security of military and industrial installations. *Integrated Environmental Assessment and Management,* 7(2), 228-236.

11. Miller, C., Richter, J. 2014. Social planning for energy transitions. *Current Sustainable/ Renewable Energy Reports,* 1 (3), 77-84.

12. Cozzens, S.E., Cortes, R., Soumonni, O., Woodson, T., 2013. Nanotechnology and the Millennium Development Goals: Water, Energy, and Agri-food. *Journal of Nanoparticle Research,* DOI: 10.1007/s11051-013-2001-y

13. Willis, H.L., Philipson, L. (2005). *Understanding Electric Utilities and De-regulation, 2nd Edition*. Taylor & Francis, New York.

14. Thompson, D. (2016). One issue Trump and Clinton agree on. The Atlantic, Aug. 16th.

Author Biographies

Dr. Rider W. Foley is an assistant professor in the science, technology & society program in the Department of Engineering and Society at the University of Virginia. He is the PI for the "4C-Project" in collaboration with Notre Dame, Xavier University (LA), and Saint Mary's College. He is the co-leader of the "Nano and the City" thematic research cluster for the Center for Nanotechnology in Society at Arizona State University. Rider is also a Research Collaborator with the Sustainability Science Education program out of the Biodesign Institute. His research interests attend to wicked problems by testing solutions at the intersection of society and technology. Before earning his doctorate, he worked for a decade in environmental services for Triumvirate Environmental Inc.

Dr. Elise Barrella is Assistant Professor of Engineering at James Madison University, focusing on design, sustainability, and transportation systems. Prior to joining the Engineering faculty, Dr. Barrella completed her Ph.D. at Georgia Institute of Technology as part of the Infrastructure Research Group. Her scholarly interests focus on two areas: community-based design and urban planning, including the use of sustainability rating systems, and engineering education for sustainability. Dr. Barrella is engaged in research projects sponsored by National Science Foundation investigating engineering students' application of sustainability concepts across courses and project contexts. She also mentors students on applied sustainable transportation projects and is involved in national service through the NAS Transportation Research Board.

Dr. Heather McLeod is an assistant professor at James Madison University, who received her undergraduate degree in civil engineering from the University of Nebraska-Lincoln and later worked for a medium sized architectural and engineering company doing structural design. Afterwards, McLeod earned her Master's and Ph.D. in civil engineering from the University of Kansas in 2005 and 2009 respectively. McLeod then worked for the Kansas Department of Transportation for 5 years until coming to JMU. McLeod is also on a number of committees at the Transportation Research Board (TRB), is a part of American Concrete Institute (ACI), and participates in ACI's Concrete Cares program, which focuses on raising awareness for cancer and cancer treatment.

Rodney Wilkins is a PhD student and research assistant in the Civil and Environmental Engineering department at the University of Virginia. He graduated from Virginia Polytechnic Institute and State University with a BS in Mechanical Engineering, has 35 years Engineering experience in industry, and is a licensed Professional Engineer. Research interest is in the development of sustainable energy sources and systems, in particular enhancing the flow of hydrocarbons through porous media with reduced environmental impact.

Dr. Andres Clarens is an Associate Professor of Civil and Environmental Engineering at the University of Virginia. His research is focused broadly on anthropogenic carbon flows and the ways that CO2 is manipulated, reused, and sequestered in engineered systems. To carry out this work, his group studies environmental surface processes, complex fluids, flow through porous media, and aqueous chemistry as they relate to carbon sequestration, enhanced oil recovery, and hydraulic fracturing. The results of his work are important for developing strategies for mitigating the emissions that are driving climate change and for understanding how infrastructure systems must be adapted to meet these changes. He is the recipient of the National Science Foundation CAREER award and the American Chemical Society Petroleum Research Fund Young Investigator Award. He received a B.S. in Chemical Engineering from the University of Virginia and an M.S.E. and Ph.D. in Environmental Engineering from the University of Michigan.

Christina Freyman, John Byrnes and David Hart

Machine Learning for Solar Technology Portfolio Management

Session 10A

Conceptually, Technology Readiness Levels (TRLs) provide a linear map of technology evolution, which recent work reveals to be in many ways a nonlinear process. TRLs also tend to be applied and interpreted inconsistently within organizations, despite the availability of detailed guidance. For these reasons TRL estimates and forecasts are highly subjective. A computationally-assisted model of a TRL-like classification for estimation and tracking could enable a Research and Development (R&D) portfolio manager to estimate more accurately the relative level of development for technologies in that portfolio.

SRI intends to create a data-driven tool that can inform R&D portfolio managers' evaluation of the risk and potential impact of the technologies in their portfolios, which, in turn, will allow them to make more informed decisions on how to allocate their limited resources. This tool will identify indicators of technology transition between technology development levels and, using those indicators, provide explanations for prior technology development cycles. By looking at a technology's development over a period of time, the tool will also be able to assess the probable "trajectory" of technologies going forward. SRI's process will include text analytics to generate consistent, comparable estimates of readiness based on an empirical model of how solar technologies evolve and on predictions of their future trajectories.

Initially, the team has done an extensive literature review of readiness scales and interview stakeholders to create a scale tailored to solar energy development goals. In tandem and using labeled training data, the team will expand the Helios model [1] to (1) identify variables that indicate technology transition between development levels, (2) explain transition of a technology across development levels based on understandable indicators, (3) make predictions about the likelihood of technology maturation within a given timeframe based on a number of indicators, and then (4) assess the probable "trajectory" of each technology across technology development levels in the future. In addition, if data is located, we anticipate that the model can make connections between changes in cost in the more advanced levels. When looking at technologies across an R&D portfolio, the model will provide quantitative data to evaluate the structure of that portfolio in different timeframes.

For this conference, SRI will present the following:

- The current understanding and features of readiness levels of a technology, moving the R&D management and evaluation community toward a unified framework for photovoltaics.

- A framework for analyzing the readiness level of a technology.

- Identification of variables indicative of current and future technology development level.

- Results from previous work with Helios including Topic modelling on document groups, which highlighted the emergence of various technical approaches within each field, the replacement of one approach with another approach, and a preliminary mechanism by which we could use the Helios platform to automatically identify instances of this topic replacement.

[1] The Helios system to be used in this project was developed using Copernicus, a platform that was created with funding from IARPA's Foresight and Understanding from Scientific Exposition (FUSE) program. Helios itself was initially developed with funding from DOE's SEEDS program. Copernicus and Helios operate on the scientific and technical literature, identifying emerging concepts using a combination of text analytics, network analyses, and machine learning. These systems measure indicators of emergence over time and expose the data that underlie emergence determinations.

Rainer Frietsch

The Impact of Fraunhofer on the German Innovation System

Session 8D

The competition for funding – in particular institutional funding – between public research and other public tasks, but even more so within the German research landscape between re-search organizations, has become fiercer in recent years. Public research organizations (PROs), but also universities, seem to be increasingly in need to justify public investments in the form of institutional funding that is granted to them (Schubert 2009a; Schubert 2009b).

In many countries and also at the transnational level many attempts have been made to measure and empirically assess the impact of individual PROs or universities (Bilsen et al. 2015; Leung et al. 2015; Schillo, Kinder 2017). While the scientific impact based on bibliometric data is the most obvious measure that has been used – for example also in Germany in the context of the Pact for Research and Innovation (Gemeinsame Wissenschaftskonferenz (GWK) 2016; Schmoch et al. 2016) –, quantifying the impact in oth-er dimensions is much harder.

Fraunhofer is the largest application-oriented research organization in Europe. To fulfill this mission or application orientation, the status, the framework conditions, and the organization of today's Fraunhofer Gesellschaft are based on the so-called Fraunhofer Model. This model was developed in the early 1970s and envisages an equal distribution of the budget stemming from institutional funding, public projects and projects for industry. However, in the years since the early 2000s, the Fraunhofer Gesellschaft has almost doubled in terms of staff members – both, by mergers with existing organizations and by organic growth – while the institutional funding has not grown to the same extent, resulting in decreasing shares of insti-tutional funding – in the budget period of 2014 the share was at about 31% after a low in 2011 of 29.7% (Bundesministerium für Bildung und Forschung (BMBF) 2016). Within the Fraunhofer Gesellschaft, several observers see the traditional Fraunhofer model at stake or at least identify clear challenges to fulfill the original tasks.

This presentation takes a longer-term perspective and analyzes the impact of the Fraunhofer Gesellschaft on the German Innovation System. It thereby tries to build a showcase also for other comparisons and puts the results into a general perspective in the context of the Ger-man innovation system. It is shown that Fraunhofer fulfills additional tasks within the German Innovation System that go beyond applied research and technology transfer – thereby gen-erating impact that raises its benefits far beyond its costs.

We follow a mixed-methods approach, analyzing the impact from three angles. First, the technology diffusion model by Meyer-Krahmer and Dreher (2004) – a paper that builds on work for example by Utterback and Abernathy (Utterback 1994; Utterback, Abernathy 1975) or has a similar intention like Linden and Fenn (2002) – is employed to show the contribution of Fraunhofer to particular technologies and to the competitiveness of German industry, es-pecially in early phases of technology cycles. For this purpose, eight Fraunhofer experts have been interviewed. Thereby we identified areas like laser for production, new materials, renewable energy or also data compression as technologies that went through (almost) all six phases of the cycle. Using patent and bibliometric data, the cycles have been empirically re-modeled, which paralleled the findings from the interviews. In addition, we identify additional technology cycles in early or medium phases of their cycles, where Fraunhofer also makes above average contributions.

A second approach uses micro-economic data of about 1,500 companies in the German manufacturing sector (German cohorts of the European Manufacturing Survey). We have at our disposal data for 2006, 2009, 2012 and 2015, which we matched with patent data from PATSTAT, the German public research funding database (Foerderkatalog), administrative data from the Fraunhofer headquarter on projects with industry partners, as well as with BvD's Orbis database to add financial data. This integrated dataset is employed to conduct a regression analysis with matched pairs (control group approach), identifying the impact of collaborations with Fraunhofer on the economic performance and the innovation activities of firms. We conclude that collaboration partners of Fraunhofer – in particular SMEs, while the effects for large enterprises are hardly significant – are significantly more often product inno-vators, have a complex product portfolio, are active in an early part of the value chain (sup-plier in B2B), and more frequently use high-tech production technologies. The analysis of the financial data shows that SMEs collaborating with Fraunhofer have a significantly higher turnover and also higher Earnings before Interests and Taxes (EBIT), while the Return on Equity (RoE) is negative – an expected effect due to the fact that collaborations with Fraunhofer are organized as research projects that generate R&D costs, which reduce the benefits in the particular year, but might generate long-term

positive effects, as can be seen by the analyses of the EBIT.

A third analytical dimension takes a macro-economic perspective, using longitudinal data on the level of German regions (NUTS3 level) with and without Fraunhofer institutes, analyzing the economic performance (regional GDP, patent output, labor productivity, unemployment rate). While the results for labor productivity and unemployment rates are not significant and also show varying signs, the effects on patents are strictly positive. At the core of this analy-sis, however, it was possible to show that Fraunhofer institutes in the regions lead to signifi-cantly higher regional GDP per capita.

Based on this model, we estimate for Fraunhofer an 18:1 relation of investments in institu-tional funding on the economic performance of Germany and a 3:1 relation of institutional funding on taxes. This means that the government receives about 3 euros in taxes for every euro invested in Fraunhofer.

References

Bilsen, V.; Debergh, P.; De Voldere, I.; Van Hoed, M. (2015): Economic footprint of 9 Euro-pean RTOs, prepared for EARTO - European Association of Research and Technol-ogy Organisations, Brussels: IDEA Consult.

Bundesministerium für Bildung und Forschung (BMBF) (ed.) (2016): Bundesbericht For-schung und Innovation 2016. Berlin.

Gemeinsame Wissenschaftskonferenz (GWK) (ed.) (2016): Pakt für Forschung und Innovati-on Monitoring-Bericht 2016. Bonn: GWK.

Leung, F.; Bazzacco, M.; Leis, M. (2015): RTOs within National Innovation Systems: Measur-ing Performance and Impact, The Proceedings of The XXVI ISPIM Conference 2015 Budapest, Hungary - 14-17 June 2015.

Linden, A.; Fenn, J. (2002): Emerging Technologies Hype Cycle: Trigger to Peak, Stamford: Gartner Group.

Meyer-Krahmer, F.; Dreher, C. (2004): Neuere Betrachtungen zu Technikzyklen und Implika-tionen für die Fraunhofer-Gesellschaft. In: Spath, D. (ed.): Forschungs- und Techno-logiemanagement. Potenziale nutzen - Zukunft gestalten. München: Hanser.

Schillo, R.S.; Kinder, J.S. (2017): Delivering on societal impacts through open innovation: a framework for government laboratories. In: Journal of Technology Transfer.

Schmoch, U.; Gruber, S.; Frietsch, R. (2016): 5. Indikatorbericht Bibliometrische Indikatoren für den PFI Monitoring Bericht 2015. Hintergrundbericht für das Bundesministerium für Bildung und Forschung (BMBF), BMBF (ed.), Karlsruhe, Berlin, Bielefeld.

Schubert, T. (2009a): Empirical Observations on New Public Management to Increase Efficiency in Public Research – Boon or Bane? In: Research Policy, 38 (8), pp. 1225-1234.

Schubert, T. (2009b): New Public Management and Deutschen Hochschulen: Strukturen, Verbreitung, Effekte, Stuttgart: Fraunhofer IRB Verlag.

Utterback, J.M. (1994): Mastering the dynamics of innovation. How companies can seize opportunities in the face of technological change, Boston, Mass: Harvard Business School Press.

Utterback, J.M.; Abernathy, W.J. (1975): A dynamic model of process and product innovations. Omega, 3 (6), 639-655.

Eriko Fukumoto

Research proposal submission at research-intensive universities

Session 1

A recognized administrative burden in the research grant administration is one of the significant science and innovation policy challenges (Bozeman and Jung, forthcoming). This study explores the interplay of federal research policy and research universities by examining the development of organizational structures for government-sponsored research administration at 115 research universities in the U.S., and a more in-depth case study with semi-structured interviews with research administrators and researchers at selected universities. The growth of the government-sponsored research since the World War II has formulated a sort of principal-agent relationship where the universities and researchers are required to comply with a set of rules and regulations of government and funding agencies for the research grant management procedures, research integrity, and so on (Guston, 2000; Price, 1954; Beasley, 1982). Funding agencies such as the National Science Foundation and National Institutes of Health have the rules and regulations regarding the research grant administration, and universities have developed their organizational structures to cope with these grant rules and regulations. While all research-intensive universities have certain organizational structures for research administration, there seem to be variations of organizational structures including the situations of university-wide research administration offices and the departmental research administration.

In the interplay of the federal research policy and universities for government-sponsored research, universities have developed organizational structures for research administration. In general, theoretical approaches about the causes of organizational changes consider the factors such as managers' actions and other environmental and resource aspects (Fernandez and Rainey, 2006). However, to what extent and how are the changes in organizational structures the direct response to the environment, and what is the influence of the individual actors on these organizational structures? From the perspective of the ecology of the organization, organizations change their activities in response to environmental factors in order to acquire and maintain resources for organizational survival (Pfeffer and Salancik, 1978). On one hand, the organizational structures and designs of university-wide and departmental research administration offices can be the direct response to federal research policies and requirements for grant administration as a part of their adaptation to the environment. On the other hand, the actions and strategies of university leaders may shape the organizational structures and operation of research administration. Universities face same sets of rules and regulations by funding agencies, but the organizational structures and operation of research administration are not identical among the universities. The university-wide office of research administrations and sponsored-research are generally governed by the provost for research, and the leaders such as provosts may take more active roles in developing the research administration system at some universities. University governance and roles of the university president, for example, vary among universities, including the president as an entrepreneur in the market metaphor of university governance, and the president pursues the organizational objects that are determined by the trustees in the administration model (Cohen and March 1974).

The first part of this study investigates the situations of research administration at the 115 doctoral universities (highest research activity) in the Carnegie Basic Classification 2015 through the data available in the individual universities' websites such as the existence and supervision of the sponsored research offices and the amount and ratio of government-sponsored research grant at the university. The examination of these data from 115 research universities provides an overview of the current situations of research administration at research-intensive universities. Further, the second part of this study is a more in-depth case study of one or more selected research-intensive universities with the data from semi-structured interviews with research administrators and experienced researchers. For the selected universities, four research administrators or more and five research faculty or more will be interviewed. The study addresses following questions- to what extent the organizational structures reflect the situations and changes in the rules and regulations of research funding agencies? To what extent the individuals such as the university president and vice provost for research shape the organizational structures and operations of research administration at the research universities? Do research universities have variation in the task decisions, divisions and coordination for research administration? If so, how and why? In so doing, the planned study sheds light on the administration issue of sponsored research at research universities which potentially has a significant impact on the sponsored research system and outcomes. The in-depth case study will provide insights on how and why the organization structures for research administration have developed to the present situations at research universities.

References: Beasley, K. L. (1982). The administration of sponsored programs (1st ed.). San Francisco: Jossey-Bass.

Bozeman, B. and Jung, J. (in press) Bureaucratization in Academic Research Policy: What Causes It? , Annals of Science Policy. Cohen, M. D., March, J. G., & Carnegie Commission on Higher Education. (1974). Leadership and ambiguity: The american college president. New York: McGraw-Hill. Fernandez, S., & Rainey, H. G. (2006). Managing successful organizational change in the public sector. Public Administration Review, 66(2), 168-176. Guston, D. H. (2000). Between politics and science: Assuring the integrity and productivity of research. New York;Cambridge, U.K;: Cambridge University Press. Pfeffer, J., & Salancik, G.R. (1978). The external control of organizations. New York: Harper & Row. Price, D. K., & American Council of Learned Societies. (1954). Government and science: Their dynamic relation in american democracy. New York: New York University Press.

Eriko Fukumoto and Ryuma Shineha

Government policy and national universities: A case of national universities in Japan

Session 8A

While the universities pursue basic roles of research, teaching, and service, there has been emerging expectations for universities to serve for new roles such as the knowledge and innovation hub (Youtie and Shapira 2008) and entrepreneurial university (Etzkowitz et al. 2000). In the countries where the national government directly or indirectly manage national universities such as Japan and South Korea, the national government attempts to manage and reform their national university systems. The relationship between the national government and the individual universities may involve the specific governance structures, contracts, funding relationships, evaluation system and other rules and regulations. Leydesdorff and Meyer (2010) discussed the change of universities' roles after the Bayh-Dole Act which brought pro-patent policy of universities, their discussion also related to the change of universities' research plans according to policy. However, to what extent government policies shape the strategies, planning, and output of national universities?

This study explores the interaction of national university policy and national universities in Japan, by analyzing strategic plans and research outputs at national universities. Japanese universities are generally classified into three categories, with 86 national, 91 public and 600 private universities as of FY 2016 according to the School Basic Survey. Historically, national universities often receive prestige and reputations. Japanese context presents an insightful case for the interaction of national policy and universities, as the National University Corporation Law of 2004 transferred the control of national universities from the national government to individual universities partly to stimulate and enforce the unique initiatives and reforms by individual national universities. According to this political change, funding to universities shift from general university fund (GUF, "Uneihi-Kofukin") to direct government fund (DGF) (Shineha and Hayashi 2013). Although the total national budget for research and development increased according to the growth of DGF, the GUF as the universities' stable budget have been decreased 1 % annually. As a result, universities had to start to encourage their professors to apply competitive DGF. Hayashi and Tomizawa (2006) examined the relationship between changes of Japanese national research system around 2000 and universities research performance, using bibliometrical data of SCI. However, their discussion depended on data before 2002, and the planned study investigates the relationship between changes of national research system after 2004 and universities' research plans and performances.

The first part of this study is the quantitative text analysis. The correspondence analysis and co-word network analysis examine the strategic plans at 86 national universities of 2005, 2010 and 2015, in total 258 documents that are publicly available through the official website of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). Under the 2004 Law, national universities are required to submit the 'mid-term goals and mid-term plans' every five years. The correspondence analysis of these documents produces the graphical representations of the frequently observed concepts and their covariance in cross tabulations, and distribution of the universities based on the distribution of these concepts. And co-word analysis represents changes of keywords in contexts of mid-term plans in 2005, 2010 and 2015. In the preliminary analysis of eight top research universities, Kyoto university, Tohoku University, and Kyushu University showed their unique positions, while other five universities (University of Tokyo, Osaka University, Nagoya University, Tokyo Institute of Technology, Hokkaido University) represented similar trend of keywords. New questions are generated from these results. Why do several universities make their unique strategies while others do not? Did these strategies reflect their own research portfolio? Why did other universities show the similar map? Was there any relationship between each university plans and national science policy?

The second part of this study is an in-depth examination of the selected cases. For the further analysis, the universities with different results are selected based on the results of the correspondence analysis and co-word analysis, including the universities with similar trends, those with unique positions, and those with and without changes from 2005 to 2010 and 2015. For the selected cases, we examine the publication outputs at each university as a whole and by individual research area, and their transitions in order to investigate whether the changes and uniqueness in the strategic plans are related to any uniqueness or changes in the publication trends. The 2004 and on-going reforms of national university systems are expected to bring certain changes in the national universities, and research output is one of the significant indicators in measuring the university performance. While some universities are expected to show unique strategies, publication trends and transformation, we expect to see that many universities have similar words in the strategic plans without changes. The in-depth inquiry of the selected cases will compare these non-unique

and unique cases too. The contribution of this study is to examine the impacts of national policy on the national universities within the system, and how and why the changes emerge.

References:

Etzkowitz, H., Webster, A., Gebhardt, C., Terra, B. (2000). “The future of the university and the university of the future: evolution of the ivory tower to entrepreneurial paradigm”. Research Policy, 29, 313-30.

Hayashi, T., Tomizawa, T. (2006) “Restructuring Japanese national research system and its effect on performance”. Scientometrics, 68(2), 241-264.

Leydesdorff, L., Meyer, M. (2010) “The decline of university patenting and the end of the Bayh-Dole effect”. Scientometrics, 83, 355-362.

Shineha, R., Hayashi, T. (2013) "Research evaluation in front: institutionalization, pluralisation, and hierachization". Japanese Journal of Science and Technology Studies, 10, 52-68. (in Japanese)

Youtie, J., & Shapira, P. (2008). Building an innovation hub: A case study of the transformation of university roles in regional technological and economic development. Research Policy, 37(8), 1188-1204.

Víctor Gómez-Valenzuela, Henry Rosa Polanco and Anne Sophie Tejeda

Policy mix for innovation policy in the Dominican Republic: an attempt using Conjoint Analysis

Session 6A

1. A brief introduction

This research aims to explore the process of building a policy mix (instruments) to foster innovation in the Dominican Republic. It is important to point out that the field of designing policy instrument has a strong background in industrialized economies but has been merely exploring in the context of small open economies such as the Dominican Republic. The literature on STI policy design covers a broad range of possibilities from more conventional qualitative approaches to diagnostic analysis and road-mapping techniques and similar methods. Therefore the question to be answered here is how to built an optimal policy mix to foster innovation in the relatively small and open economy of the Dominican Republic from an empirical perspective?

2. The Dominican Republic

The Dominican Republic is country located in the Caribbean and shares the Hispaniola Island with the Republic of Haiti, of which occupy around two-thirds of the Island. According to the World Bank database, the country has a 10.5 million population, and it is considered a “middle-income” country and the largest economy of Caribbean with a GDP of US$ 68.1 billion and an economic growth rate of 7% in 2015. According to the United Nations Development Program in 2015 the Dominican Republic was ranked as a high human development country. However, in spite of the achievements of last two decades regarding economic growth, the Dominican Republic is one of the countries in the region which less advantage of the opportunities from economic growth to reduce poverty in efficiency and sustaining way. Regarding economic activities and based on data and reports available in the Central Bank, in 2015 services sector represents the 62% of the total economic activities in the country and manufacturing the 25.4% the left 12.4% corresponds to unclassified activities

3. Methodology

To build a policy mix to foster innovation from an empirical perspective, an analysis of the structure of preferences of incentives to innovation of manufacturing and service firms of the Dominican Republic was conducted. To perform the analysis of the structure of preferences the Conjoint Analysis (CA) technic was used and 326 companies participated in the study. A factorial design consisting of attributes and levels was built to define the stimuli to innovation resulting in 16 choices set, which were presented in a survey to firms.

4. Main findings

Regarding preferences of incentives to innovation, the main findings point out that the structure of preferences is very similar between manufacturing and services firms. Manufacturing and service firms will prefer tax exemption, public funds for co-financing R&D, guarantee funds. Although preference structures are very similar, manufacturing and services firms were affected by its characteristics in different ways: manufacturing firms were more affected by the size, while service firms were hit by the tax regime and the shareholder's composition. Based on the forecast of preferences Dominican firms will prefer a policy mix of incentives that provides a balance of options that minimizes the tax liability and support vary ways of innovation activities such as grants to R&D activities, business-university collaboration, technology infrastructure and knowledge acquisition.

5. Concluding remarks

In the context of the Dominican economy, the analysis of the structure of preference seems to be a useful approach to

building a policy mix to foster innovation. One key lesson learned is that in spite of the structure of preference of the two group of analyzed firms tends to be similar, the probabilities of choice are sensitive to the characteristics of firms such size, shareholder composition, market niche and others. It is simple: one size does not seem to fit all regarding preference of incentives to innovation. One-second lesson to be taken into account to build a policy mix was mentioned before: the preferences of firms will focus on the combinations of stimuli that minimize risk and reduce the costs of innovative activities. This lesson is relevant for the Dominican context given the high transaction cost in certain production activities.

Magnus Gulbrandsen, Taran Thune and Richard Woolley

Research impact as a process

Session 3C

Research impact is a complex phenomenon that denotes how research results and the people and organizations that produce them contribute to changes elsewhere. These changes come in the form of innovation and economic growth but also in areas such as health and care, agriculture, national security, environmental issues, and policymaking. Traditional studies of impact have studied the consequences of research and the antecedents of its effects, often with an aim to quantify the contributions of research and development (R&D) in different sectors of society. Many central relationships between specific outcomes (such as innovation incidents) and specific inputs (such as funding and public support for firms or research performing organizations) have been highlighted. But the processes and mechanisms that link inputs and outcomes in complex and sometimes surprising ways are therefore intricate to disentangle conceptually and empirically.

If we want to understand how research can make a difference, not just to what extent, it is best seen as a long-term process involving intricate forms of interaction between producers and users of knowledge. Moreover, impact processes do not only relate to how knowledge is transferred and potentially put to use, but rather how scientific knowledge co-evolves with other forms of knowledge (Morlacchi & Nelson 2011). For research to make impact, substantial changes in technology, practices or organizational arrangements are often necessary, and such changes do not by necessity follow from new knowledge, but can also predate it. We will argue in this paper that the linear image of impact often conveyed in the impact pathway perspective (Matt et al. 2015) is too mechanistic and not based on an adequate conceptualization of the co-evolutionary nature of impact processes. The ambition of this paper is thus to discuss the conceptual and methodological implications of a process ontology on research impact. In addition, we want to couple the science and innovation policy debate about impact with wider process frameworks and process theories of institutional and organizational change.

Fundamentally, a process denotes how a phenomenon progresses over time. Analyses of research impact have highlighted that it takes years to emerge, sometimes decades, which means that the processes involved are complex, lengthy, and hard to observe (e.g. Alston et al. 2009). Recent perspectives have pinpointed the multifaceted nature of impact and the varying and interlinked “impact pathways” that are involved in translating research to different kinds of impacts (e.g. Donovan 2011; Gaunand et al. 2015).

Related evaluation methodologies utilize network and interaction perspectives to create data on the distributed and complex aspects of impact. Examples include the SIAMPI framework oriented at studying the productive interactions between researchers, research units and wider stakeholders (Spaapen & van Drooge 2011; Molas-Gallart & Tang 2011) and the Payback framework oriented at understanding knowledge flows in different stages from research to conceptualization to impact (Donovan & Hanney 2011). Increasingly these methodologies use sophisticated non-linear understandings of the relationship between science and society as a starting point for elaborate (and often costly) empirical approaches, such as the ASIRPA approach (Gaunand et al. 2015). Often the practical recommendation is a comparative longitudinal case study methodology where the case may be the further fate of a research organization, project, program, or result.

However, there seems to be a missed opportunity in the science studies and science policy community in learning from similar studies of processes elsewhere. There have been an increasing number of longitudinal process-based studies of innovation, institutional and organizational change (see e.g. Garud et al. 2013) since the 1980s, but the perspectives and lessons inherent in these traditions rarely find their way into the science policy community.

This paper seeks to discuss in a wide sense the potential of a contingent and contextual process perspective (cf. van de Ven & Huber 1990) on impact and what such a perspective entails for research and evaluation methodologies. A process ontology implies an emphasis on complexity and non-linear causality, providing a link between historical narratives and quantitative reductionism (cf. Burgelman 2011). Here, “stages” are less interesting phenomena than events and their contexts.

Impact events can generally be related to the uptake, transfer or interchange of knowledge emerging from a research setting. This can be conceptualized in different ways: as interorganizational contacts (Spaapen & van Drooge 2011), as

a “translation” or reconfiguration of networks of social and material elements (Callon 1986), or as a multidimensional array of communication between researchers and wider stakeholders (Abreu & Grinevich 2013; Bekkers & Bodas Freitas 2008). Recognizing opportunities for utilization and articulating or operationalizing needs and problems are likely to emerge from the contact and translation activities.

There is also a wider context characterized by, for example the disciplinary setting, the context of application, the maturity of linkages between researchers and non-researchers, as well as funding and policy structures. Process studies highlight how events need to be tied to contexts in order to form causal explanations (van de Ven & Poole 2005). Time can here be a simple chronological account of events and their contexts but must also be accounted for in the analysis in more complex ways, e.g. by looking at wider trajectories and loops, unexpected events, serendipity and constructed time related to project deadlines and similar phenomena.

Our aim with a conceptual discussion of these issues is to outline a conceptual framework for studying impact processes of research. Much of the micro-level process literature has been based in organizational and institutional studies, and the change processes here most likely unfold much more quickly than most impacts of research. Longitudinal studies of impacts need to develop particular and unique designs, combining different forms of data that may allow both a “backward” and “forward” dimension.

References

Abreu, M. & Grinevich, V. 2013. The nature of academic entrepreneurship in the UK: widening the focus on entrepreneurial activities, Research Policy, 42:408-422

Alston, J.M. et al. (2009). Persistence pays: US agricultural productivity growth and the benefits from public R&D spending. New York, NY: Springer.

Burgelman, R.A. (2011). Bridging History and Reductionism: A Key Role for Longitudinal Qualitative Research. Journal of International Business Studies, 42(5):591-601.

Callon, M. 1986. The sociology of an actor-network. In Callon, M., Law, J. & Rip, A. (eds.), Mapping the Dynamics of Science and Technology. London: Macmillan.

Donovan, C. 2011. State of the art in assessing research impact: introduction to a special issue. Research Evaluation, 20(3):175-179.

Donovan, C., & Hanney, S. 2011. The ‘Payback Framework’ explained, Research Evaluation, 20(3):181-183.

Garud, R. et al., 2013. Perspectives on innovation processes. The Academy of Management Annals, 7(1):775-819.

Gaunand, A., Hocdé, A., Lemarié, S., Matt, M. & de Turckheim, E. 2015. How does public agricultural research impact society? A characterization of various patterns, Research Policy, 44:849-861.

Matt, M., Colinet, L., Gaunand, A., & Joly, P. B., 2015. A typology of impact pathways generated by a public agricultural research organization (No. 2015-03).

Molas-Gallart, J. & Tang, P. 2011. Tracing ‘productive interactions’ to identify social impacts: an example from the social sciences. Research Evaluation, 20(3):219-226.

Morlacchi, P., & Nelson, R. R., 2011. How medical practice evolves: Learning to treat failing hearts with an implantable device. Research Policy, 40(4), 511-525.

Spaapen, J. & van Drooge, L. 2011. Introducing ‘productive interactions’ in social impact assessment, Research Evaluation, 20(3):211-218.

Van de Ven, A. & Huber, G.P., 1990. Longitudinal Field Research Methods for Studying Processes of Organizational Change. Organization Science, 1(3):213-219.

Van de Ven, A. & Poole, A., 2005. Explaining development and change in organizations. Academy of Management Review, 20(3):510-540.

Jose A. Guridi and Julio Pertuze

A framework for innovation, institutional, and cultural spillovers from Big Science Centers: The case of the Chilean astronomy cluster.

Session 8D

Chile is endowed with a natural laboratory for astronomic observation. The Atacama Desert is the driest non-polar place in the world. Lack of humidity is important for observation since water absorbs light. The country also has two mountain chains, which allows locating observatories in remote mountaintops away from urban light pollution. At high altitude, the air is thinner which reduces atmospheric distortions. Furthermore, Chilean mountaintops are located near the Pacific Ocean, where the cold Humboldt Current and the Pacific Anticyclone reduce air mass distortions and clouds, allowing more observation time. As a result, more than two thirds of the world's astronomical infrastructure will be soon located in Chile, representing an investment of about 6 billion dollars by 2020 (CONICYT, 2012). The question is how could Chile take advantage of these massive technological investments. The purpose of this paper is to build a framework describing the elements and mechanisms by which countries endowed with natural laboratories could generate innovation, institutional and cultural spillovers.

Given the scale, amount of resources, lifespan, and organizational complexity, astronomic observatories can be characterized as Big Science Centers (BSCs). BSCs are usually international, multidisciplinary, funded by diverse institutions, and centered around a common scientific objective and research infrastructure (Jacob & Hallonsten, 2012). BSCs are gaining influence how scientific research is conducted in several countries, and have a profound impact on how scientific communities organize themselves (Autio, 2014).

Existing literature on BSCs, is scant, fragmented, and the underlying theoretical frameworks lack coherence (Autio, 2014). While several case studies have analyzed industrial spillovers from BSCs (Autio, Bianchi-Streit, & Hameri, 2003; Autio, Hameri, & Nordberg, 1996; Autio, Hameri, & Vuola, 2004; A.-P. Hameri & Vuola, 1996; A. Hameri, 1995; Nordberg, 1994; Schmied, 1982; Vuola & Hameri, 2006), there is little information on how BSCs can have broader societal impacts including cultural and institutional change. This is especially important for developing countries as BSCs offer opportunities to shape their National Innovation System. Furthermore, existing literature has focused mostly on the European Organization for Nuclear Research (CERN). Big Science Centers built around natural laboratories, however, are affected by the characteristics of the host country, such as its technological sophistication, geography, institutions and culture. All of these elements can affect the generation and capture of spillovers, impose restrictions on the organization of BSCs, and affect how different stakeholders interact.

In this article, we conducted an in-depth case study on Chilean astronomy ecosystem, interviewing more than 40 different stakeholders including observatories, universities, government and industry (Yin, 2009). The purpose was to identify theoretical concepts related to the generation of spillovers and their broader impact on the host country (Corbin, Strauss, Anselm, & Juliet, 1998). We also gathered secondary quantitative data from government statistics and public information to allow data triangulation (Eisenhardt, 1989). Utilizing pattern matching techniques (Trochim, 1989) we contrasted the contents of the interviews to the theoretical framework for explaining industrial knowledge spillovers developed by Autio et al. (2004). In doing so, some theoretical propositions were confirmed, while others disconfirmed as interviewees narrated their experiences (Van Maanen, Sørensen, & Mitchell, 2007). The latter offered opportunities to propose new theoretical propositions to extend this framework by adding spillovers that go beyond industry, such as cultural and institutional impacts of BSCs.

Data analysis yielded the following findings. In the case of astronomy, opportunities for innovation spillovers are concentrated on the early stages of an observatory's lifetime. During the planning phase experimentation is heightened as scientists define the instrumentation and technological systems for the observatory. During the construction phase, technologies are developed through a tendering process in which teams from different countries and institutions compete offering different technological designs. Usually, participation in the tendering process is limited to teams from countries members of the consortium building the observatory, which creates barriers of access to technology development for non-member countries. The tendering process follows the logic of an "innovation tournament" (Terwiesch & Ulrich, 2009), and constitute a critical element determining who generates and captures innovation spillovers.

The rate of technological innovation decreases after the construction phase. Consequently, opportunities for

innovation spillovers are reduced. New waves of innovation, however, might emerge depending on the modularity of the technological system of the observatory, and on the interest of the sponsoring organization to update technologies as they become obsolete.

The capacity to capture innovation spillovers is contingent on the absorptive capacity of the region where the technology is developed. For a same technological component, we found differences in terms of spillovers depending on whether it was constructed in Chile or abroad. The former allowed the capture of innovation spillovers, whereas the latter not.

Local industries benefited from BSCs in three ways. First, firms that directly engaged in collaborations with the BSCs improved their innovation capabilities via combination of unrelated technology and radical learning. Second, industry benefited from new customers and markets obtained via improved image and access to networks. Third, we also observed the emergence of new industries related to the BSC. In Chile, there is a growing market for astronomical tourism in the regions where the observatories are being located.

BSCs also generate institutional and cultural spillovers. The installation of astronomic observatories led to the development of different laws, public agencies, and international agreements that regulate their operation. When the Science Technology and Innovation (STI) institutions of the host country are weak, BSCs will exert influence on how they develop and evolve.

In terms of cultural spillovers, BSCs can increase science awareness in the population and also improve the host country's image abroad. In the case of Chile, astronomic observatories are being used in political discourses by government agencies as a means to promote science awareness. Furthermore, the installation of observatories has meant an influx in advanced human capital, which offers opportunities to build networks and internationalize local science. At an international level, most of the news related to Chilean science is related to astronomic observatories, which contributes to the country's image abroad.

This paper contributes to the literature on Big Science and technology transfer by extending the framework developed by Autio et al. (2004). Specifically, we revised existing and incorporated new elements that explain the generation of innovation spillovers from natural laboratories. We also contribute by broadening existing frameworks by incorporating cultural and institutional spillovers generated by BSCs. This is especially important for developing countries as they can take advantage of natural laboratories to shape their National Innovation Systems.

References

Autio, E. (2014). Innovation from big science: enhancing big science impact agenda.

Autio, E., Bianchi-Streit, M., & Hameri. (2003). Technology Transfer and Technological Learning Through CERN's Procurement Activity, (September), 92.

Autio, E., Hameri, A.-P., & Nordberg, M. (1996). A framework of motivations for industry-big science collaboration : a case study. Journal of Engineering and Technology Management, 13(3–4), 301–314. http://doi.org/10.1016/S0923-4748(96)01011-9

Autio, E., Hameri, A. P., & Vuola, O. (2004). A framework of industrial knowledge spillovers in big-science centers. Research Policy, 33(1), 107–126. http://doi.org/10.1016/S0048-7333(03)00105-7

CONICYT. (2012). Roadmap for the Fostering of Technology Development and Innovation in the Field of Astronomy in Chile. Santiago.

Corbin, J., Strauss, A., Anselm, L., & Juliet, M. (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory. California: SAGE Publications.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. Academy of Management Review, 14(4), 532–550. http://doi.org/10.5465/AMR.1989.4308385

Hameri, A. (1995). Innovating from Big Science Research *. Journal of Technology Transfer, 22(3), 27–35.

Hameri, A.-P., & Vuola, O. (1996). Using basic research as a catalyst to exploit new technology-based innovations — a case study. Technovation, 16(10), 531–539. http://doi.org/10.1016/S0166-4972(97)82893-3

Jacob, M., & Hallonsten, O. (2012). The persistence of big science and megascience in research and innovation policy. Science and Public Policy, 39(4), 411–415. http://doi.org/10.1093/scipol/scs056

Nordberg, M. (1994). Contract benefits and competence-based supplier strategies: CERN as a Case Study. Espoo.

Schmied, H. (1977). A study of economic utility resulting from CERN contracts. IEEE Transactions on Engineering Management, EM-24(4), 125–138.

Schmied, H. (1982). Results of attempts to quantify the secondary economic effects generated by big research centers. Engineering Management, IEEE Transactions on, (4), 154–165.

Schmied, H. (1987). About the quantification of the economic impact of public investments into scientific research. International Journal of Technology Management, 2(5–6), 711–729.

Terwiesch, C., & Ulrich, K. T. (2009). A systematic approach to innovation. MIT Sloan Management Review, 50(50404), 17. http://doi.org/10.1108/00197850910983910

Trochim, W. M. K. (1989). Outcome pattern matching and program theory. Evaluation and Program Planning. http://doi.org/10.1016/0149-7189(89)90052-9

Van Maanen, J., Sørensen, J. B., & Mitchell, T. R. (2007). The interplay between theory and method. Academy of Management Review, 32(4), 1145–1154. http://doi.org/10.5465/AMR.2007.26586080

Vuola, O., & Hameri, A. P. (2006). Mutually benefiting joint innovation process between industry and big-science. Technovation, 26(1), 3–12. http://doi.org/10.1016/j.technovation.2005.03.003

Yin, R. K. (2009). Case study research : design and methods / Robert K. Yin. Applied social research methods series: 5.

Yasushi Hara and Shinichi Aakaike

The Golden Age of Star Scientist - Scientific Productivity and Spill Over Effect of Nobel Prize Laureates

Session 1

Nobel Prize is commonly interpreted as indicator of nation's scientific and technological performance and frequently encourages improving nation's basic science performance. But literature review in this field shown in Table 1., there are still few articles that aim to figure out the role of Nobel Prize as the indicator of the performance of nation's scientific community and its interplay with science, technology and innovation policy. Previous study is mainly still focus on the preference of Nobel Laureates and rarely to use bibliographic data of Laureates to evaluate his/her research works and its spillover process. Unless the selection process of Nobel Prize is behind-closed-doors (Källstrand 2012), (Akaike 2013) for 50 years after its decision statement, it is still meaningful to trace scientific behavior of Nobel Laureates as the cohort of star scientist (Zucker and Darby 1997).

In this research, I aim to figure out the following research question that is; how and why Nobel Laureates could be achieved outstanding result and how interacted with scientific community?

(Table 1.)

In doing so, employing qualitative approach to trace out the scale and presence of scientific community where Nobel Laureates resides. Firstly, to trace out the transition of scientific carrier of several Nobel Laureates (focus mainly on three scientific prizes; Nobel Prize in Physics, Nobel Prize in Chemistry and Nobel Prize in Physiology or Medicine), using bibliographic data of scientific paper by Web of Knowledge's Science Citation Index Expanded (SCI-EXPANDED) from 1900 to 2016, and Scopus from 1996 to 2016. Visualizing the co-author/citation network of Laureates (using Name-matching/Visualization Software: Vantage Point), then taking snapshot of his/her behavior in certain period to identify the scientific source of his/her study and propagation of finding. It would indicate the process of the emergence of Nobel Laureates, how they interact with other scientists in same and/or another country in scientific community and "break point" of his/her research, in which emerges the strength and the major accomplishment of Laureates. In addition to stylize the fact, oral interview has been made with Japanese Nobel Prize Laureates; Prof. Makoto Kobayashi, Satoshi Omura, and Ryoji Noyori.

In addition, to ensure the role of science, technology and innovation policy for each country, Nobel Laureates' funding data should be taking into the account of Laureate's scientific performance. As many previous study (Latour 1987) suggests that superior scientist has a capability to find funding for encouraging their own research. Hence, we build dataset which involves (1) Laureates' personal preference (includes age, field, and discipline), (2) Laureates' scientific performance (number of patents and scientific papers published, the number of backward and forward citation of patents and scientific papers), and (3) Laureates' funding performance (timing and the volume for each funding). By using these datasets, we aim to realize Laureates' scientific performance in a nutshell.

Matthew Harsh, Thomas Woodson, Susan Cozzens, Jameson Wetmore, Diran Soumonni and Rodrigo Cortes

South Africa's National Nanotechnology Strategy: Assessing Inclusiveness and Equity for Emerging Technologies

Session 6C

The concept of inclusive innovation is gaining traction in academic and policy communities (Heeks et al. 2014; Paunov and Rollo 2016). Inclusive innovation focuses on how poor and marginalized communities can benefit from innovation. Where mainstream or traditional innovation often widens inequalities, inclusive innovation reduces inequalities. Inclusive innovation has been interrogated, modelled and compared to other related concepts, such as inclusive development, responsible innovation, and bottom of the pyramid innovation (Chataway et al. 2014). To date though, there has been little attention to the role that emerging and advanced technologies – which involve high levels of uncertainty and are expensive to develop – might play in inclusive innovation, particularly in developing countries. This paper begins to fill this gap. It compares inclusive innovation with related work on equity and emerging technologies (Cozzens 2010) and utilizes both frameworks to examine a case study about nanotechnology in South Africa.

Nanoscience is the study of matter at atomic scale, that is, at measurements less than 100 nanometers. Nanotechnology is the application of the resulting knowledge in new devices and processes (Balogh 2010). Many substances have distinctive and useful properties at the nano level. However, the same properties that make nanoscale phenomena interesting also make them potentially dangerous and most questions about risk in the field have not been effectively answered so far (Hodge, Maynard & Bowman 2014).

Nanoscience and engineering are heavily concentrated in high-income countries because they require sophisticated and expensive equipment. However, from its inception, the proponents of nanotechnology have argued that it will provide benefits for poor communities in developing countries (Salamanca-Buentello et al. 2005). Indeed, a number of low and middle income countries, have started nanotechnology programs or initiatives, including South Africa.

South Africa is precisely the kind of place where one would expect to find efforts to create inclusive nanotechnology innovation. The country is sometimes thought of as two economies, one a high-income, technologically sophisticated place, and the other an income- and technology-poor country within a country. The separation is a legacy of apartheid, and the two economies are being knit together only slowly in the democratic period. Our focus area, nanoscience and engineering, would fall automatically into the South Africa's first (wealthy) economy unless active efforts were made to spread its benefits. Given that South Africa is a democracy with high scientific and technological capability and high levels of poverty, the political process would be expected to push science, technology, and innovation policies towards producing benefits for the poor.

We examine the South African National Nanotechnology Strategy and analyze whether and how it has created inclusive innovation and just outcomes. We first present our conceptual framework. We overlay Foster and Heeks's six levels of inclusive innovation (Foster and Heeks 2013) with Cozzens's three pathways to increased equity through emerging technologies (Cozzens 2010), which together provide a rich framework to analyze the South African case. Through document analysis and interviews, we find that some nanotechnology projects address problems of poor communities. The future nanotechnology workforce also reflects South Africa's diversity. Most nanotechnology research supports large businesses, but there are some new nanotechnology-based firms, which might increase employment. Overall, the effort created nanotechnology innovation that is somewhat inclusive in its intent, impact, process and structure. However, innovation could be more inclusive and just with stronger attention to transfer of technologies to disadvantaged communities and rural development.

The conclusion reflects on how synthesizing inclusive innovation with equity perspectives on emerging technologies provides greater analytical depth and helps provide more specific policy recommendations than either framework alone. Inclusive innovation is strong on product-based mechanisms for inclusion (how products and specific technologies can create benefits), and an equity framework is strong on structural considerations (identifying dimensions and pathways to fairer societal outcomes). The frameworks collectively help us elucidate the barriers to using nanotechnology to create wider benefits and draw out lessons for middle and low income countries which may be engaging with nanotechnology or other emerging technologies.

References

Balogh, L.P. (2010). ‘Why do we have so many definitions for nanoscience and nanotechnology?’ Nanomedicine Nanotechnology, Biol. Med, 6: 397–8.

Chataway, J., Hanlin, R., & Kaplinsky, R. (2014). 'Inclusive innovation: an architecture for policy development'. Innovation and Development, 4/1: 33-54.

Cozzens, S. E. (2010). Building Equity and Equality into Nanotechnology. In Nanotechnology and the Challenges of Equity, Equality, and Development. S. E. Cozzens and J. Wetmore eds., pp. 443-46. New York: Springer.

Foster, C., & Heeks, R. (2013). 'Conceptualising inclusive innovation: Modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers'. European Journal of Development Research, 25/3: 333-55.

Heeks, R., Foster, C., & Nugroho, Y. (2014). 'New models of inclusive innovation for development'. Innovation and Development, 4/2: 175-85.

Hodge, G.A., Maynard, A.D., Bowman, D.M.. (2014). 'Nanotechnology: Rhetoric, risk and regulation.' Sci. Public Policy, 41: 1-14.

Paunov, C., & Rollo, V. (2016). 'Has the Internet fostered inclusive innovation in the developing world?'. World Development, 78: 587-609.

Salamanca-Buentello, Fabio, et al. (2005). 'Nanotechnology and the developing world'. PLoS Med, 2.5: e97.

David Hart

Environmental Regulation and Technological Innovation

Session 7A

Research on the relationship between environmental regulation and technological innovation has been framed for a generation by the “Porter hypothesis,” which posits that regulation may make firms more competitive by stimulating innovation. This research has produced inconsistent results. This paper argues that this inconsistency flow from defects in the hypothesis, which considers too narrow a range of conditions that shape firm responses. This presentation explores four sets of conditions that shape the pace and direction of innovation by regulated industries – technological opportunity, industrial competition, political environment, and regulatory design. These conditions are illustrated by reference to the empirical literature, with an emphasis on the automobile industry. The presentation concludes with suggestions for future research priorities and an appraisal of the prospects for a more effective linkage between research and policy in this domain.

John Helveston, Yanmin Wang, Valerie Karplus and Erica Fuchs

Innovating Up, Down, and Sideways: The (Unlikely) Institutional Origins of Experimentation in China's Plug-in Electric Vehicle Industry

Session 3D

A vast literature has attempted to understand the factors that accelerate experimentation and innovation in technologically-sophisticated emerging industries—but less is known about these processes in the context of industrializing nations. We apply inductive, grounded theory-building techniques (Eisenhardt, 1989; Glaser & Strauss, 1967) to characterize and explore the origins of divergent innovation trajectories in once such context: the plug-in electric vehicle (PEV) industry in China. Triangulating annual vehicle make and model sales data for 2003-2014 (plus monthly data for the most recent five years); 112 English and Mandarin archival documents from industry, academic, and news outlets; and 51 semi-structured interviews across industry, government, and academic stakeholders, we develop four in-depth case studies of independent domestic firms (those with no historic international joint venture partnerships): Chery New Energy Vehicles (NEV), Haike Technologies, Jiayuan Electric Vehicles, and Kandi Technologies. All four case study firms are innovating in different subsectors of the PEV industry. Each firm has a unique history that has led to its individual capabilities and innovation directions. We use evidence from the divergent development paths of these case studies to demonstrate how the configuration of national and local institutions can channel not just the direction of innovation, but also who engages in it, with implications for the direction and pace of clean energy transitions that may originate from the developing world.

We observe independent domestic firms in China's PEV industry pursuing a much greater variety of innovation strategies than those being pursued within large, established automotive firms with JV partners. The four case studies provide a snapshot of the variety of these innovations. We propose a typology involving three distinct innovation directions and describe these directions as innovating up, down, and sideways. Firms innovating "up" are those whose innovation strategy is to approach and eventually advance the technological frontier to compete in the market. Firms innovating "down" are those that combine or redefine existing technologies in innovative ways to compete in the market, a direction similar to much of the innovation observed in other industries where products are redesigned for "cost out" (Brandt & Thun, 2010; Ge & Fujimoto, 2004; Nahm & Steinfeld, 2014; Steinfeld, 2015). Finally, firms innovating "sideways" apply new organizational and business models to compete in the market.

These results are surprising. In contrast to work by Nam (2011) and Howell (2016), which find that the national JV regulations are hindering domestic innovation, these results suggest that national JV regulations are creating a protected and under-served PEV market in China upon which independent domestic firms are able to capitalize, collectively capturing 87% of the PEV market in vehicle sales. In addition, local institutional support such as providing additional market protection and subsidizing localized production are extending incubation periods for independent domestic firms to experiment in different directions. The details of each case study firm provide insights into how at the local and national level both market and institutional factors have created local laboratories for experimentation involving significant innovation in China's PEV industry by independent domestic firms and, consistent with Nam (2011) and Howell (2016), the lack thereof in the overseas and domestic Chinese arms of JV firms.

While these findings illustrate how overlapping national and local institutions can unexpectedly lead to positive outcomes in terms of diverse experimentation in emerging technologies, the same diversity of localized conditions that leads to innovative variety may impede the emergence of strong regional or national market players in the domestic and global PEV industry (Barwick et al., 2016). Researchers have argued that eventually exposing firms to global competition is important for sustaining a strong national innovation system in the long term (Amsden & Chu, 2003; Nelson, 1993). Similar arguments have been made specifically in the context of technology catch-up (Brandt & Thun, 2010; Feng, 2010) and the need to transition from regional to national markets in China (Meyer, 2008). It is thus unclear if the current protection from JV firms in the PEV industry will harm independent domestic firms in the longer term by preventing them from having exposure to foreign competition or incentives to compete in the global marketplace. Greater national integration of PEV regulations, technology standards, and R&D support will be needed to support the industry's development at scale.

Diana Hicks, Nicolas Robinson-Garcia, Julia Melkers, Rodrigo Costas and Kim Isett

The Unbearable Emptiness of Tweeting – about journal articles

Session 8C

Enthusiasm for using Twitter as a source of data in the social sciences extends to measuring broader societal engagement of research with Twitter data being a key component in the new altmetrics approach. In this paper, we critically examine tweets containing links to research articles in the field of dentistry to assess the extent to which tweeting about scientific papers signifies engagement with, attention to, or consumption of scientific literature. The main goal is to better comprehend the potential value of tweet counts as traces of broader engagement with scientific literature. In particular, the pattern of tweeting to the top ten most tweeted scientific dental articles and of tweeting by accounts is examined. The ideal that tweeting about scholarly articles represents curating and informing about state-of-the-art appears not to be realized in practice. We see much presumably human tweeting almost entirely mechanical and devoid of original thought, no evidence of conversation, tweets generated by monomania, duplicate tweeting from many accounts under centralized professional management and tweets generated by bots. Some accounts exemplify the ideal, but they represent less than 10% of tweets. Therefore, their influence on any conclusions drawn from twitter data is swamped by the mechanical nature of the bulk of tweeting behavior. In light of these results, we discuss the compatibility of Twitter with the research enterprise as well as some of the financial incentives behind these patterns.

Rosalie Hooi and Jue Wang

Models wanted!: How women respond to obstacles differently from men

Session 8B

Governments worldwide are encouraging greater collaboration between universities, industry and governmental agencies to tap the potential for knowledge and growth. However, collaboration involves a number of obstacles, which can negatively affect the probability of engaging in cooperation. These stem from the different motivations, values and cultures held by both industry and universities. The scientific collaboration activities of academics have generated much scholarly interest, particularly because research is a social process which involves communication, interaction and exchange, thus organizational membership and participation are important. As academic science traditionally sees a disproportionate number of men to women, gender therefore becomes a salient and personal issue.

A number of studies have examined the barriers women scientists face which may be associated with their participation in research collaborations, for instance, gender discrimination, interpersonal connections and time spent on research. However, very little has been said about how women scientists handle obstacles. In this paper, we contribute to the literature on research collaboration by providing empirical evidence that the genders differ in how they handle barriers to industry/government engagement.

Obstacles are stressors as people must channel additional or increased effort to overcome the hindrances. Whether people can successfully surmount the barrier depends on whether they are confident of their abilities to respond to the environmental threats. According to Bandura's social cognitive theory, people are more likely to perform tasks that they believe they are capable of accomplishing while avoiding tasks that they feel less competent in. Beliefs about competencies in a specific domain affect the choice individuals make, the effort they will invest, their persistence at the task and their resilience to failures. Central to social cognitive theory is the concept of self-efficacy, which refers to people's judgment of their capabilities to attain desired levels of performance. Self-efficacy perceptions are obtained from four sources: mastery experience, vicarious experience, verbal persuasions, and physical and emotional states. Mastery of a task can create a strong sense of efficacy to accomplish similar future tasks. Vicarious experience occurs in the observation of others performing similar tasks. Observing the successes and failures of similar others contributes to individuals' beliefs of their own capabilities. Verbal persuasions are spoken messages and social encouragement which help individuals to put in the extra effort and persevere for success. Negative messages to convince people that they lack capabilities can conversely undermine efficacy beliefs. In terms of physical and emotional states, optimism and a positive mood can enhance efficacy beliefs while depression, despair or a sense of despondency reduces them.

Vicarious experiences, and verbal and social persuasions develop women's self-efficacy beliefs. However, the low number of women in STEM fields means that there are fewer women role models, which may be especially important in a male-dominated field as the gender similarity determines the kind of social comparison they make. Successful females may be a proxy for determining their own potential for future success. The lack of multiplicity of models is also problematic as diversified modeling is superior to exposure to the same performance by a single model since it shows that people with widely differing characteristics can succeed thereby increasing observers' sense of self-efficacy Thus, a lack of female models engaged in research collaboration gives the perception that they are unlikely to succeed, making it difficult to develop efficacy beliefs. Furthermore, the rather exclusive environment of an "old boys' network" in certain disciplines, and a preference for gender homophily leading to a lack of social capital and isolation mean that women receive less social support and professional recognition. Thus, verbal persuasions, which could increase efficacy beliefs may not be available from peers and superiors.

On the other hand, men, who have wider and more cosmopolitan networks, greater access to collaboration and research funds, have more opportunities to obtain mastery experiences which contribute to their self-efficacy. As mastery experiences produces stronger and more generalized self-efficacy beliefs than other modes of influence such as vicarious experiences or persuasion, men, whose significant source of self-efficacy development is mastery experiences, may develop greater confidence in their capabilities and ability to overcome obstacles than women.

Taken together, it is likely that the self-efficacy beliefs of women to collaborate are lower than men, and when faced with obstacles to collaboration, would display less perseverance in overcoming them, leading to reduced collaboration engagement. We expect women to have greater difficulties overcoming obstacles to collaboration, and postulate that when faced with barriers of unsuitable university procedures, difficulty in identifying suitable partners for

collaboration, and potential conflicts with intellectual property rights, women will collaborate less than men.

For the analysis in this paper, we draw on information from a survey conducted with the two largest comprehensive universities in Singapore — the National University of Singapore (NUS) and Nanyang Technological University (NTU). The two universities were selected as they have a comparatively longer history so their STEM departments are more established. For the survey, the list of faculty members was drawn by manually checking the websites of the two universities in the country in 2015. We collected basic demographic information such as name, gender, title, education and employment history, and contact information including email, telephone and office addresses from CVs and other profile information on websites. Emails were sent to these faculty members inviting them to participate in an online survey that asks about their collaboration experiences. The survey had a response rate of about 30% with 314 responses by March 2016. We restrict our sample to only academics from STEM as collaboration is especially crucial in these fields, and academics may be involved in a wide range of formal and informal engagements.

In addition, interviews were conducted with 14 female STEM academics from three universities, namely NUS, NTU and Singapore Management University as part of a larger study. Individuals were identified through CV searches on the universities' website as well as references from the research team. A snowball method was also used to obtain additional names. The objective of the interviews was to better understand women scientists' experiences, as well as provide a deeper contextual understanding of the general picture emerging from the statistical analysis.

We applied a linear regression model where obstacles to partnership was regressed on collaboration. We also included the interactions between gender and predictors of collaboration as we are interested whether gender differences would moderate the relationship between obstacles and collaboration.

We found that women generally collaborate less than men in the face of unsuitable university procedures, difficulty in identifying suitable partners and IPR conflicts with partners, corroborating what other researchers found about men and women having different sources of self-efficacy. Past studies have identified a host of reasons why women collaborate less, however, they have not considered that due to environmental factors, women may be less confident to handle obstacles and deal with failures. This study provides empirical evidence that collaboration is affected by the way different genders handle obstacles. Having female participation in collaborative activities is not enough; when faced with difficulties and setbacks, women must be able to overcome these obstacles and persist. Understanding that the lack of women in academic sciences has impact on performance contributes to the discussion on gender difference in research collaboration, and at the same time, offers more compelling reason to assist women in specific, crucial dimensions to enable them to perform optimally.

Inga Ivanova and Yuriy Yakubovskiy

Iterative Method for Science and Technology Policy Evaluation

Session 7A

The demand to innovate and to provide a healthy ecosystem to foster innovative behaviors goes together with the need for the quality of government regulation, efficiency and consistency of decisions. Many of the problems in the current regulatory practice in the field of S&T are related not to a lack of well-known regulators, but to their poor drafting. There is a need for better measurements and indicators to allow for evidenced based public policy.

Government regulation of S&T is performed with the help of corresponding policy instruments. Innovation policy instruments of various types are often combined into mixes to address different problems of innovation system. New instruments are often added to already existing mixes and may address overlapping targets which entails interaction among instruments. So that the outcomes of instrument bundle which emerge from the interactions at instruments level are not equal to the simple sum of the effects of individual instruments. The important task is to achieve coherence and balance in innovation policy mix (OECD, 2010; Borras, Edquist, 2013). This balance can be achieved through the composition of policy mix which should take into account the comparison among instruments. The research question of the present paper is to provide a method for comparing different instruments in the policy mix with respect to the effects of their implementation.

To address the research question one can consider that in an evolutionary perspective policy mix is a dynamic structure which is not in equilibrium but in motion, driven by economic and institutional changes. And as a dynamic structure it can be analyzed with the help of complexity science which is used to address problems in economy. The relative complexity of a country's economy (with respect to other countries in the set) can be derived from a bi-partite network connecting countries to products. Hidalgo and Hausmann proposed linear iterative method (Method of reflections) for evaluating a country's Economic complexity index which implicitly accounts for country technological capabilities and is correlated with country's economic growth and income (Hidalgo and Hausmann, 2009). Further this method was modified to a non-linear metrics for country fitness which properly accounts for empirical link between diversification of export data and countries industrial competitiveness (Tacchella et al., 2012). The innovation policy instruments can be broadly associated with effects rendered by them. One can trace the analogy between "country - product" and "policy instrument - effect" bi-partite networks. The effects provided by instruments can be considered as due to corresponding instruments universality or complexity. However, this universality can't be reduced to the simple sum of the effects. The methodology proposed by Hidalgo and Hausmann, and Tacchella et al. for analyzing the "policy instrument – effect" bi-partite network can be adapted. The paper analyses innovation policy instruments which are implemented in the Russian Federation to support STI. The network comprises the key policy instruments and major effect groups.

The obtained policy measure can be interpreted as a "policy complexity index". An empirical experiment is provided here, and the metrics describe the value of the scope of analyzed instruments. Finally, the suggestions of STI policy decision making approaches' improvements are given.

The major contribution of present study is an attempt to rank the policy instruments in the given set of instruments, used for regulation of STI policy, with respect to their measure of complexity. The paper raises the expectation that the proposed measures can be used to enlighten policy makers into designing more responsive instruments for public intervention.

The study is also an attempt to implement the complexity science methods in the field of STI policy. The empirical findings can be policy relevant. It's shown the possibility of identification and prediction of more complex (and more coherent) policy measures with the help of a policy complexity index.

References

Borrás S., Edquist C. (2013). The choice of innovation policy instruments // Technological forecasting and Social Change. №80 (8), p. 1513-1522 (doi: 10.1016/j.techfore.2013.03.002).

Hidalgo, C. and Hausmann, R. (2009). The building blocks of economic complexity. Proceedings of the National

Academy of Sciences 106(26). 10570–75.

OECD (2010), The Innovation Policy Mix, in OECD (Ed.), OECD Science, Technology and Industry Outlook, OECD, Paris, pp. 251-279.

Tacchella, A., Cristelli, M., Caldarelli, G., Gabrielli, A., Pietronero, L. (2012). A new metrics for countries' fitness and products' complexity. Scientific Reports 2, 723

Yeong Jae Kim, Evgeny Klochikhin and Kaye Husbands Fealing

Food Safety Patenting

Session 10D

1. Introduction

Although numerous research has been done evaluating the impact of science using patents (1, 2), this is not the case in food safety. Since patents are not the primary output of food safety research and development activities, this paper focuses on the following questions: (1) What has happened to the pace and direction of patenting in the food safety sector? (2) What are the characteristics of U.S. and foreign firms that are most active in food safety patenting? (3) What is the geographical and sectoral distribution of food safety patents? We investigate these questions by employing computational methods of text analysis and a dataset from the U.S. Patent and Trademark Office (USPTO).

2. Data

Food safety patents are identified using the USPTO's PatentsView database, including information on patent assignees, inventors, their locations, and patent classifications for the years 1976-2016. The biggest advantage of the PatentsView database is its embedded disambiguated inventor and assignee information and their locations (3). The new inventor disambiguation algorithm, authored by the research team at the University of Massachusetts at Amherst and integrated into PatentsView in 2016, uses discriminative hierarchical co-reference as a new approach to increase the quality of inventor disambiguation (3,4). The current assignee disambiguation uses the Jaro-Winkler approach by comparing string distance between patent assignee names and clustering similar organizations together (e.g., Google Inc. and Google should be considered as one entity). For locations, city/state/country text as it appears in source files is algorithmically matched against a master geocode file from Google and MaxMind open-source files.

Both text analysis and patent classifications are used to identify food safety patents, since highly technical legal language in the patent data documents are difficult to analyze with automated computational techniques (5). Keywords are used in searching food safety research based on text analysis techniques developed for this project. Patent titles and abstracts were extracted from the PatentsView database, and then the search term strategy was applied. The initial set of potentially relevant patents for food safety contained 1,543 documents retrieved using the search term strategy. We also use patent classifications to reduce only the most relevant patents. Also related CPC classifications among the initially retrieved patents were manually checked. The finalized list of food safety patents are robust to inventors, organizations, and patent class biases.

3. Results

The results show the most important areas of research that yield food safety patents and the distribution of food safety patents by application year. This distribution over time is rather uneven. The fluctuations may indicate the dependence of this technology sector on policies and market trends.

About 80 percent of assignees are U.S. and foreign firms. The remaining organizations are universities, institutions, governments, hospitals, and individuals. Most of these entities are concentrated in traditional innovation centers around New York and Boston, but many are scattered across the country, particularly in the Midwestern region, where agriculture accounts for a major share of the local economy.

The overwhelming majority of the U.S. companies' patents are within the WIPO food chemistry technology field. Broader technology sectors covering food safety patents include chemistry, mechanical engineering, instruments, and electrical engineering. Patents across most of these categories are concentrated around New York, Minneapolis–St. Paul, and Cincinnati. However, patents related to electronic engineering and consumer electronics, such as microwaves and food refrigeration, are not as closely clustered and include places as far afield as Greeley, CO (15 patents); Kennesaw, GA (10); Wayzata, MN (4); New Port Richey, FL (4); and Wichita, KS (4).

Only a fraction of identified patents is associated with the federal government: 21 patents are assigned to the U.S.

Department of Agriculture (USDA), two are assigned to the Army, and one is assigned to the National Aeronautics and Space Administration (NASA). Additionally, 37 patents have the so-called government interest statement that assigns full or partial interest in the given patent to the U.S. government. Some of these patents are co-funded by several government agencies. The USDA and affiliated institutions account for the bulk of these patents. The National Science Foundation (NSF) and National Institutes of Health have an interest in four and nine food safety patents, respectively.

References

1. Sampat BN. The impact of publicly funded biomedical and health research: a review. 2011.

2. Azoulay P, GraffZivin JS, Li D, Sampat BN. Public R&D investments and private-sector patenting: evidence from NIH funding rules [Internet]. 2015. (Working Paper 20889). Available from: http://www.nber.org/papers/w20889

3. Li G-C, Lai R, D'Amour A, Doolin DM, Sun Y, Torvik VI, et al. Disambiguation and co-authorship networks of the U.S. patent inventor database (1975–2010). Res Policy [Internet]. 2014 Jul [cited 2015 Apr 29];43(6):941–55. Available from: http://www.sciencedirect.com/science/article/pii/S0048733314000225

4. King JL, Schimmelpfennig D. Mergers, acquisitions, and stocks of agricultural biotechnology intellectual property. AgBioForum. 2005;8(2–3):83–8.

5. Krestel R, Smyth P. Recommending patents based on latent topics. Proc 7th ACM Conf Recomm Syst - RecSys '13 [Internet]. 2013;395–8. Available from: http://dl.acm.org/citation.cfm?doid=2507157.2507232

Koen Jonkers, Peter Fako, Thomas Zacharewicz, Lorenzo Isella, Ulf Sandstrom and Peter van den Besselaar

Excellence or widening: an analysis of the publication and collaboration behaviour of the EU's Marie Sklodowska Curie Action (MSCA) fellowship

Session 7D

This is a draft: please do not make public before approved. We shall extend the abstract and include the literature review upon receiving decision on acceptance/rejection.

The Marie Sklodowska Curie Action (MSCA) fellowship scheme aims, as a part of the European framework programmes, to promote scientific excellence, mobility and research collaboration in the European Research Area. As most elements on the EU Framework Programmes, it also aims to widen capacity development throughout the EU in Member States with different levels of scientific development. This report analyses the mobility, publication and international co-publication behaviour of a group of European researchers that have taken part in the Marie Sklodowska Curie Action (MSCA) Fellowship schemes. It compares researchers from two groups of countries before and after being granted the fellowship.

The first group of countries (FPIC) receives a relatively large share of their research funding budget from the European Framework Programmes and a relatively low share from the European Structural and Investment Funds. The second group of countries (ESIFIC) presents a lower Framework Programme funding intensity but the Funding intensity of the European Structural and Investment funds is higher. The funding intensity levels associated with these broad programmes are taken as an indication of the level of scientific development: roughly ESIFIC corresponds with Central Eastern and Southern European Countries, whereas FPIC corresponds to North Western European countries. It strongly correlates with the average impact of the publications made by researchers in these countries.

The analysis finds that successful applicants from the ESIFIC countries perform significantly below the applicants from FPIC countries at the time of selection on the impact of their research, measured as the sum of the citation impact of their publications per year. The hypothesised rationale behind this aspect is that researchers coming from lower quality research environments (measured as the average field weighted citation impact of their home organisation) stand to gain more from mobility to a high impact research environment and will thus converge in their performance with peers that received their training in higher impact research organisations. On average the performance of both groups of authors increases over time. However, while we do observe a degree of convergence between researchers from ESIFIC and FPIC countries, a significant difference remains in terms of their citation impact. Post grant publication performance is correlated especially to pre-grant performance.

In terms of international co-publication behaviour one observes a general increase across the board. There is no significant difference between the improvement in international co-publication behaviour between researchers from ESIFIC or FPIC countries. Post grant international co-publication behaviour is most strongly associated with pre-grant international co-publications. It is thus the "internationally well connected" researchers who continue being the most active collaborators also after the grant.

The potential for robust evaluations, either in the form of counterfactual analyses or randomised controlled experiments should be taken into account at the planning and implementation phase of the Framework Programmes.

Gretchen Jordan and Rachel Parker

Assessing Effects of a Canadian Research Institute on International Cross-disciplinary Teams

Session 7B

There is a trend toward more research teams that are both inter-disciplinary and multi-country. It is time that more attention be paid to assessing how these international teams are formed and led and if the expected outcomes of this new approach to research are as expected –an acceleration of knowledge advances that inform solutions to global problems. This presentation will describe a recently revised performance measurement and evaluation system for the Canadian Institute for Advanced Research (CIFAR) which has a 34-year history of forming and leading research teams that cross boundaries of discipline and national borders.

Jiwon Jung and Monica Gaughan

Educational Mismatch and Labor Mobility Across Fields: Consequences of Working Outside of One's STEM Degree

Session 5E

The push for STEM (Science, Technology, Engineering, and Mathematics) education and efforts to increase the workforce in STEM fields appear to have grown from a concern for the low number of future professionals to fill STEM jobs and economic and educational competitiveness along with an increased attention to improving health and environment and safeguarding national security (NSB, 2010; NSTC, 2013). Consequently, retaining STEM-educated graduates for STEM workforce becomes an important policy objective as a part of the human capital development and national competitiveness. However, individuals' career field choices often do not match with their field of study in STEM. They sometimes reflect limited labor market opportunities at the time of graduation or many workers voluntarily enter a mismatch for career or personal reasons (Stenard & Sauermann, 2016) causing a drain in the STEM-educated human capital. In order to understand such disciplinary divergence among the graduates of STEM fields and to better attract and retain skilled human capital in STEM fields, it is essential to examine multiple factors simultaneously influencing individuals' education-occupation mismatch. Furthermore, this paper examines the 'objective' measure and subjective assessment of STEM field divergence in addressing the competing factors motivating field mismatch.

Known as a vertical mismatch, prior education-occupation mismatch studies have compared the years of schooling to the job requirements resulting in over- or under-education (Allen & Van der Velden, 2001; Bauer, 2002; Bender & Heywood, 2011; Stenard & Sauermann, 2016). Horizontal mismatch is a less explored perspective. It focuses on education-job mismatch when the field of study is inadequately matched with a job (García-Espejo & Ibáñez, 2006; Robst, 2007a; Wolbers, 2003), which will be explored further in this study. College graduates involuntarily enter a different field in the labor market from their field of study due to labor market frictions (Åstebro, Chen, & Thompson, 2011) which is particularly found to be true in poor economy with high unemployment (Bowlus, 1995; Kahn, 2010; Oreopoulos, Von Wachter, & Heisz, 2012; Wolbers, 2003). Internal motivation such as unsatisfied level of financial and nonfinancial benefits, loss of interest in the original field of study, and family issue is also found to be influencing the choice of field divergence (Robst, 2007a, 2007b; Stenard & Sauermann, 2016). Organizational studies on person-job or person-organization match have also found that employees' job and field experiences determine the subjective assessment of field mismatch (Cable & Judge, 1996). However, these studies examined each factor individually while these factors are, in fact, simultaneously influencing the choice of field divergence.

Furthermore, in each instance, these studies rely on workers' subjective assessment of whether their education level matches or their degree discipline relates to their job. Although subjective assessment may provide relevant information of mismatch between education and job, the perceived relevancy between the degree field and the job field is likely to be influenced not only by the actual field divergence but also other educational and job experiences, including job satisfaction, the level of salary or work benefits, and level of education. That is, the subjective assessment of relatedness may be an imprecise measure that combines the effect of educational background and that of current work experience. In fact, the objective of increasing STEM workforce focuses on the number of STEM workforce generated by the number of graduates in STEM fields, not on individuals' subjective assessment whether they think they are working in a relevant field or not. Therefore, to better capture the ties between STEM higher education and the labor market aligned with the policy aim, this paper considers an observational measure that systematically compares the actual field of the highest degree to the job field.

Using a longitudinal study of 2010 and 2013 National Survey of College Graduates (NSCG), this paper uses the nested model to examine the simultaneous effect of work experiences, external labor market conditions, and internal motivation on individuals' choice of field divergence. It aims to examine on a subjective assessment of field mismatch in expectation of its correlation to current job experiences. Further, objective field divergence measure is examined to find influencing factors in the choice of job field outside one's STEM discipline. The effects of multiple influencing factors are likely to be greater for objective field divergence than for subjectively assessed mismatch. In particular, educational background such as types of the highest degree and degree discipline is expected to explain the choice of field divergence particularly well for the objective measure of divergence relative to subjective measure.

This paper serves several contributions by examining the actual STEM field divergence and factors simultaneously influencing the divergence. First, the paper extends the discussion of 'subjective' and 'objective' measurement of education-occupation mismatch studies postulating the underlying significance of each perspective. Second, proper measurement that is aligned with the policy objective (i.e. STEM-educated graduates as an input and the number of workforce in STEM fields as an output) provides a better understanding of the field choice graduates of postsecondary institutions make and, thus, help society to address the education-labor market ties in STEM fields.

This study is supported by the NSF grant 1537879 and we appreciate NSF for the support and the valuable data.

In Keon Lee and So Young Kim

Technological Innovation and Employment in South Korea: An Analysis of the Effects of R&D on Employment in Manufacturing and Service Sector

Session 1

While much has been written on the Schumpeterian distinction between product and process innovation, relatively little is done on the empirical assessment of various consequences of such different types of innovation in the not-formally-developed country. A majority of literature is focused on European countries showing diverse employment effects of types of innovation. Further, some of the studies are related with "paradox" of R&D, which is represented by concerns on outcomes of R&D investment and other innovation activities, and long-term economic downturn.

This paper examines the effects of product and process innovation on the labor demand with the panel regression analysis of South Korean manufacturing industry (1996-2015). It has been a few decades ago after the Korean system of innovation was discussed to have been changed from "imitation to innovation" (Kim 1997), which was led by the government and large firms (Chaebols). Korean firms had made success in "reverse engineering" for developing advanced products until late 90's.

After recovering economic crisis in 1997, South Korea is standing between developed and developing state with the dramatic expansion of the R&D budget since 2002. Ranking the top in Bloomberg Index straight from 2014 to 2017 and in terms of the share of GDP spent on R&D (4.15%) yet suffering from high youth unemployment rates, innovation disparity between small and medium entrepreneurs (SME) and large firms, and so-called "Korean Paradox", South Korea provides a great example of how innovation activities lead to more or less demand for labor and discussing the changing role of government in innovation system of developing country.

Our empirical analysis, which is based on annual R&D Activity Survey on manufacturing sector composed with 20 sub-industries reveals that entire manufacturing industry has invested almost 70% of total expenditure on process innovation. Process oriented R&D increases the profits of the manufacturing firms, which are in turn inversely correlated with labor demands. In addition, investment in product innovation shows a similar effect, contrary to some of the previous studies finding the opposite effect of product and process innovation.

We also examine the innovation activities and labor demand by firm size, finding that SMEs tending to invest more on process innovation have increased their demand for labor, while labor demand has declined in large firms generally turning to increase product innovation share since 2011. In detail, the SMEs' average working time and wage have been increased; however, the growth rates of time and wage are smaller than large firms' respectively, and the majority of increased labor in SMEs are in irregular labor.

Lastly, this research considers the employment effect with an economic condition, foreign investment. Large firms have increased foreign direct investments (FDI) until 2013; however, SMEs have decreased the FDI since 2008 and not concentrated on it. The FDI of two groups have increased each of profits, and large firms gain more than SMEs, which is inversely correlated with labor demand.

One of the critical implications of this study is concerned with the roles of government in mediating the effects of technological innovation. The developmental-state thinking pervasive in the South Korean R&D has long dictated the government to play a role of a "system administrator," but now with rapid technological innovation and the proliferation of innovation agents, it is increasingly called upon to become a "system coordinator.

Davit Khachatryan and Brigitte Muehlmann

Measuring Technological Depth and Breadth of Patent Documents

Session 10D

Please find the extended abstract attached as a PDF file. The copy is pasted below.

Measuring Technological Depth and Breadth of Patent Documents

Davit Khachatryan, PhD

Assistant Professor of Statistics and Analytics

Babson College; Division of Mathematics and Science

Email: dkhachatryan@babson.edu; Phone: (781) 239 – 6475

Abstract

In this work, we develop measures for technological depth and breadth of patent documents. We conceptually compare and contrast several measures that have been used in existing literature, illustrating some of their main limitations. Motivated by the drawbacks of the existing measures we demonstrate how Rao's Quadratic Entropy, an effective measure used in ecology for measuring biodiversity, can be applied to measure both technological depth and breadth of patent documents. Specifically, we take advantage of the structure of International Patent Classification (IPC) and apply Rao's Quadratic Entropy in a way that effectively captures the depth and breadth of inventions classified with IPC. Subsequently, the properties of the proposed measures are investigated. In particular, based on patent documents in business data processing (business methods) arena, the relationship between depth/breadth and the time at pendency, as well as with the likelihood of patent granting are explored. As part of that investigation, four hypotheses are postulated and subsequently tested to illustrate these relationships. The hypotheses include the existence of a functional relationship between the developed measures and the time at pendency, as well as with the likelihood of granting, followed by conjectures regarding the forms of those relationships. We hypothesize that both technological depth and breadth are statistically related to the time at pendency and to the odds of patent granting. In addition, we conjecture that those relationships have inverted u-shaped forms.

For the illustration of the developed measures and the investigation of their properties, we use all non-provisional patent documents applied to the United States Patent and Trademark Office (USPTO) on or after November 29, 2000, which have United States Patent Classification (USPC) class 705 as their main class. These data were extracted from Thomson Reuters' Thomson Innovation (currently Clarivate Analytics) patent database. Using these data, we show evidence for support of postulated hypotheses. In particular, using generalized linear mixed models and survival analysis, we demonstrate the existence of functional relationships between depth/breadth and the aforementioned variables, and provide empirical evidence that those relationships have inverted u-shaped structures.

The implications of the proposed measures are discussed in the context of entrepreneurship and competitor identification. We illustrate how the landscape of companies with recent innovations in network security for business methods can be partitioned in terms of breadth and depth, and how that partitioning can help an entrepreneur identify competitors and strategically position the planned venture. Further, familiarity of technological breadth and depth of (potential) competitors can help an entrepreneur determine what technological capabilities would be pertinent to hire in a venture to be able to innovate and effectively compete with the existing innovative players in the respective field.

Biography

Dr. Davit Khachatryan is an applied statistician with research interests in analyzing intellectual property data to study the formation and diffusion of knowledge in emerging industries. Davit's current and former research has produced publications in academic, peer-reviewed journals such as Scientometrics, IEEE Transactions on Engineering Management, Journal of the Royal Statistical Society (Series C), The American Statistician, and Journal of Statistics

Education. Prior to joining Babson College, Davit was a Senior Associate at the National Economics and Statistics practice of PricewaterhouseCoopers (PwC). In the latter role he consulted in the area of predictive modeling and advanced data analytics, helping clients from financial, healthcare, and government sectors with building automatic predictive models and enhancing business intelligence solutions. Davit has earned his B.S. in Applied Mathematics and Informatics from Yerevan State University, M.S. in Statistics and Ph.D. in Management Science from the University of Massachusetts, Amherst.

Firdous Khan

Combining policy and innovation in Science to impact Global Health

Session 1

In developing countries such as South Africa the maternal and under-five infant mortality is increasing at an alarming rate. Goal four described in The Millennium Development Goals (MDGs) focuses on increasing both maternal and under-five survival rates. Further to this goal 2 in the Sustainable development goals (SDG) is aimed at ending hunger, achieving food security, improved nutrition and promoting sustainable agriculture.

The poor, particularly in rural areas, tend to subsist on a diet of staple crops such as rice, wheat and maize, which are low in these micronutrients. Most of the rural poor, cannot afford or efficiently cultivate enough fruits, vegetables or meat products that are necessary to obtain healthy levels of these nutrients. As such, increasing the micronutrient levels in staple crops can help prevent and reduce the micronutrient deficiencies. This could be achieved by the process of biofortification in staple crops to ensure elevated levels micronutrients specifically Vitamin A (VA). Biofortification is the process by which the nutritional quality of food crops is improved during plant growth rather than through manual means of the crops by agricultural processes, conventional plant breeding, or modern biotechnology. Biofortification may have advantages over other health interventions and may therefore present a way to provide nutrients to the rural poor with limited or no access to commercially fortified foods. Specifically targeted communities may utilize products from biofortification as an alternative to instances where supplementation and conventional fortification activities may be difficult to implement. As such, biofortification is seen as an upcoming strategy for dealing with deficiencies of micronutrients such as VA which affects millions worldwide.

Insufficient amounts of VA in the body results in a Vitamin A deficiency (VAD) which can lead to, a higher incidence of blindness, a weaker immune system, stunted growth and impaired cognitive development. VAD is the leading cause of preventable childhood blindness and plays critical role in child mortality and morbidity often increased by secondary infections. It is estimated that approximately 250 million children under the age of 5 globally and 63 % of children in early childhood development stages are affected in South Africa making it a global health problem. Approximately 250,000 to 500,000 malnourished children in the developing world go blind each year from a deficiency of vitamin A, approximately half of whom die within a year of becoming blind. It is further stated that it is likely that in vitamin A deficient areas a substantial proportion of pregnant women is VA deficient. These statistics are prevalent for children under the age of 5 and pregnant mothers in developing countries.

Studies in maize biofortification have shown a 10X increase in the amount of pro Vitamin A production in the crops that have been biofortified, which could favourably impact the state of the global health problem in maize dependent communities in the developing world. Similarly a trial in Mozambique, showed that eating sweet potatoes biofortified with beta-carotene reduced the incidence of vitamin A deficiency in children by 24%.

Further to this our study attempted to identify putative markers that play a key role in the regulation pathway of carotenoid biosynthetic genes to be used as key targets for biofortification in crops.

Methods

This study investigated the carotenoid biosynthetic pathway responsible for carotenoid production in the plant Arabisopsis thaliana which is used as a model for plant research. A literature review identified all known genes with a direct involvement in β carotene production as well as the abiotic stress factors such as drought and cold, affecting the genes. A co-expression analysis of genes was done to determine the relationship between existing genes and to identify new genes in the pathway. A correlation analysis of the genes against and abiotic stresses was performed to determine which abiotic stresses negatively affect the production of Vitamin A. Furthermore a systems biological approach was used to identify key environmental conditions under which pro vitamin A production in crops were affected.

Results

Findings from the study identified 32 genes responsible for vitamin A production in plants. The co-expression analysis identified a number of new genes implicated directly in the production of Vitamin A. Expression profiling revealed that vitamin A producing genes were negatively affected in the plant when exposed to two abiotic factors drought and cold. These two factors showed a 7-9 fold decrease in the plants ability to produce Vitamin A in comparison to normal growth conditions.

Future prospects and recommendations

This approach may have advantages over other health interventions such as providing foods fortified after processing, or providing supplements. Although these approaches have proven successful when dealing with the urban poor, they tend to require access to effective markets and healthcare systems which often just do not exist in rural areas. Biofortification is also fairly cost effective after an initial large research investment. By implementing the finding of this study the development of seeds encompassing the alterations could be produced and distributed at a fraction of the cost of fortifying foods after growth. This will in turn decrease processing charges and will decrease the necessity for oral supplementation of Vitamin A which is comparatively much more expensive and requires continued financing over time, which may be jeopardized by fluctuating political interest.

In Future findings from our study could be implemented using biotechnology and plant breeding programs in other crops specifically maize and sorghum in Africa. By doing this, production and conversion of vitamins will increase and therefore the global problem of vitamin deficiencies such as VAD may be addressed. This will also directly contribute to achieving both the MDG 4 and SDG 2.

Hassan Khan, David Hounshell and Erica Fuchs

Scaling Moore's Wall: A Public-Private Partnership in Search of a Technological Revolution

Session 5A

The decline of corporate research and vertical disintegration of supply chains in many industries has led to an innovation ecosystem increasingly reliant on linkages between institutions. These shifts present new challenges for long-term technology development. Pre-commercial public-private research consortia offer one policy response, and yet the majority of past research has focused on public-private consortia created for short-term (1- to 3-years out) technology development and technology catch-up. Based on unprecedented access to archives of the Semiconductor Research Corporation (SRC), publicly available data, 50 semi-structured interviews, and participant observation, we examine how one public-private partnership, the Nanoelectronics Research Initiative (NRI), emerged in response to arguably the most significant presumptive anomaly of our time: the end of Moore's Law. NRI aimed to bridge the semiconductor industry's past 40 years of unprecedented technology development—captured by Moore's Law—with a radically new (and, as of this writing, not-yet-discovered) technology that will maintain this development indefinitely. We describe and analyze the processes by which NRI emerged. Building on a long history of collaborative university-industry research programs managed by the Semiconductor Research Corporation (SRC), we suggest the NRI played a coordinating role within the scientific community. Specifically, we show how NRI incorporated industry expertise in manufacturing and design to inform and shape academic research aimed at inventing a successor to CMOS technology. We conclude by questioning the extent to which the effort was appropriately suited to the nature and importance of the end-of-Moore's Law challenge and the extent to which lessons from NRI may be generalized to a broader set of industrial contexts requiring coordination to overcome major technological discontinuities. Given that the NRI program was ongoing as of the terminal date of our study, we make no normative judgment about NRI's success or failure in meeting its objectives.

Richard Klavans and Kevin Boyack

Predicting Grant Funding at the Topic Level

Session 8A

In this study, we use grant data along with a detailed model of the scientific literature to predict funding at the topic level. Over 300,000 grants from the StarMetrics database were assigned to a paper-level model (or taxonomy) of knowledge that is comprised of nearly 60 million documents partitioned into over 90,000 topics (Klavans & Boyack, 2017). These grants totaled $161.9 Billion over the six-year period from 2008-2013, representing approximately $34,200/year for each U.S. author with a Scopus publication profile. A log normal model was able to predict funding by topic (for 2011-2013) based on information available before 2011 with an R-square of .66. An index of prominence (Grandjean [2011]) was found to be particularly useful in predicting future grant funding. Examples of funding forecasts are provided for topics associated with Metagenomics and Graphene. Implications for research planning are stressed.

Sergey Kolesnikov, Seokkyun Woo, Jan Youtie and Philip Shapira

International University Research Ventures: The Global Emergence and Significance of Trans-Border Academic Research Institutions

Session 1

Research universities around the world are increasingly establishing long-term institutional research footprints overseas through the creation of research centres, facilities and partnerships outside of their home countries. Examples include research centres opened by the Massachusetts Institute of Technology (MIT), the University of Cambridge, and the Technical University of Munich at the CREATE campus in Singapore; Georgia Tech's R&D facilities in Metz, France; and the Fudan-Yale Biomedical Research Center in China. We argue that such international university research ventures (IURV) are a distinct kind of formal institutional knowledge-producing arrangements which have emerged recently at the intersection of two trends: expanding international research collaborations (Katz and Martin 1997, Wagner and Leydesdorff 2005) and the globalization of higher education (Altbach and Knight 2007), each responding to the growing complexity of science and institutional pressures from funders and policymakers (Youtie et al. 2006). IURVs vary in form and function, while their scope often includes not only research but also an expanding mix of knowledge exchange and developmental objectives, suggesting growing IURV impact not only on global knowledge production but also on human capital, innovation, economic competitiveness, security, and international development.

Previous studies of institutionalized forms of international research collaboration have focused either on multinational firm R&D (Kuemmerle 1999; Von Zedtwitz and Gassmann 2002), public research institutions (Jonkers and Cruz-Castro 2010), or research activities at international branch campuses (Kinser and Lane 2016; Guimon 2016). With the exception of some notable IURV case studies (Pfotenhauer et al., 2016, Hird and Pfotenhauer 2016), there has been limited comprehensive analysis of IURVs and their roles in global cross-border knowledge flows. To fill this gap in knowledge, we have undertaken an exploratory study of the scale and scope of global IURV activity. Data on IURV locations, years of operation, partnerships, research areas, missions, activities, and organizational forms was collected by mining the websites of participating universities, their partners, and IURVs themselves. Additional information was gained from government reports and news sources.

The study consisted of two phases. The initial effort targeted IURV activities of the 108 top U.S. research universities as defined by the "Carnegie Doctoral/Research Universities – Very High Research Activity" classification, 2010 edition. The second phase surveyed the 40 top non-U.S. research universities based on Times Higher Education World University Rankings 2016, plus an additional 40 top non-US and non-European research universities from the same rankings stratified by region to ensure broader regional coverage. The resulting combined and stratified sample includes 111 North American universities, 33 Asian universities (including a Middle Eastern subsample of 8), 24 European, 8 Latin American, 8 African universities, and 4 universities from Oceania (all located in Australia). The full scale of IURV phenomenon in the world is not fully captured by our combined sample: in the process of data collection, we found evidence of at least 120 additional universities that established IURVs. Our study focuses primarily on IURVs created by top global and regional research universities, not all IURVs ever created.

Our results confirm that IURVs are, indeed, a worldwide phenomenon. We found 392 IURVs set up in 84 countries by 99 universities. While many IURVs are located in emerging economies, with China (125 IURVs), India (24) and Singapore (22) as clear leaders, the full geographical distribution is more dispersed: we found IURVs established in some of the most and the least developed and research-active countries in the world. On a regional level, Asia is the biggest receiver of IURVs (264 IURVs – more than two-thirds of the total worldwide amount). It is followed by Africa (48 IURVs), Europe (40), Latin America (27), North America (U.S. and Canada combined, with 9 total), and Oceania (4).

Top European research universities show relatively strong engagement with IURVs, with 87% of the European part of the sample establishing at least one, compared to roughly 50% of North American and Asian peers in the sample. Top IURV-creating institutions are the University of Oxford with 30 IURVs, MIT (24), and the Chinese University of Hong Kong (21). Top IURV sending countries (apart from the U.S. which is overrepresented in the combined sample and produced 183 IURVs in total) are the United Kingdom with 8 sampled universities creating 72 IURVs, followed by Hong Kong with 40 IURVs established by 4 universities. Other countries exporting a significant number of IURVs are Japan, Netherlands, Canada, Germany, Russia, and Australia.

Regarding cross-regional IURV circulation, North America exports IURVs to Asia (117 IURVs), Africa, Europe (28 each),

and Latin America (22). European universities send IURVs to Asia (75 out of the total of 114 IURVs) and Africa (20), with smaller representation in other regions. Asia focuses on within-region IURV collaboration: 67 out of the total of 75 IURVs established by Asian universities are hosted by other Asian countries. Most Australian IURVs are also hosted in Asia. In contrast, universities in Africa and Latin America tend to be on the receiving end of joint research ventures, exporting little to none.

IURVs are a relatively recent phenomenon. While the earliest IURV in the sample has been in operation since 1954, a significant growth in IURV entry started at the turn of the current century and continues to the present, with a peak of 39 new entries in 2012. IURV expansion seems to slow down after this peak, suggesting either an exhaustion of resources or interest for IURV creation from host countries or saturation of organizational capacity of top research universities to manage IURV activities abroad. Nevertheless, most of the recorded IURVs are still currently active; only 22 of them ceased operations or became independent.

Based on the analysis of the geographical distribution of IURVs, their partnerships, activities, and research specialization, we identified three primary motivations behind IURV location decisions made by universities: 1) opportunities for high-quality research; 2) host country policies for capacity building in science and technology; and 3) international development programs. Profit-seeking motivations and path dependency in previous relationships between countries may also play a role in these decisions. The relatively high relevance of the second and the third motivation may explain some of the regional and country-level differences in characteristics of IURVs, reflecting different approaches of the hosting countries to national science and technology priorities and strategy, as well as the role IURVs play in it. In particular, in China a majority of IURVs are created in partnerships with universities, reflecting government efforts to improve the research capacity of domestic universities (Zhang et al. 2013). For Hong Kong, IURVs are a response to institutional pressure to formalize collaborations with mainland China and expand to Chinese market. In Singapore, Qatar, United Arab Emirates, and Malaysia IURVs are part of their strategies in building global education hubs (Knight 2014). Finally, in Pakistan and most of the African countries including Kenya, Ethiopia, and Tanzania, IURVs predominantly work in the international development context.

Drawing on the mapping of the global landscape of IURVs and our detailed probing of IURV characteristics, partnerships, objectives, and operational arrangements, the paper concludes by considering the significance of IURVs and potential trajectories and emerging regional locations for future development.

Acknowledgements

The research reported here is based upon work supported by the U.S. Army Research Laboratory and the U.S. Army Research Office through the Department of Defense Minerva Research Initiative under grant #W911-NF-15-1-0322. Additional research assistance in data collection was performed by Yin Li, Jon Schmid, and Olufunke Adebola.

References

Altbach, P. G., & Knight, J. (2007). The internationalization of higher education: Motivations and realities. Journal of studies in international education, 11(3-4), 290-305.

Guimon, J. (2016). Universities as multinational enterprises? The multinational university analyzed through the eclectic paradigm. Multinational Business Review, 24(3), 216–228. https://doi.org/10.1108/MBR-07-2016-0025

Hird, Mackenzie D., and Sebastian M. Pfotenhauer. (2016) How complex international partnerships shape domestic research clusters: Difference-in-difference network formation and research re-orientation in the MIT Portugal Program. Research Policy. DOI: http://dx.doi.org/10.1016/j.respol.2016.10.008

Jonkers, K. and L. Cruz-Castro (2010), The Internationalisation of Public Sector Research through International Joint Laboratories, Science and Public Policy, 37 (8), 559–70.

Katz, J.S. and B.R. Martin (1997), What is research collaboration, Research Policy 26(1), 1–18.

Kinser, K., & Lane, J. E. (2016). International Branch Campuses: Evolution of a Phenomenon. International Higher Education, (85), 3-5.

Knight, J. (2014). International education hubs: Collaboration for competitiveness and sustainability. New Directions for Higher Education, 2014(168), 83-96.

Kuemmerle, W. (1999). The drivers of foreign direct investment into research and development: an empirical investigation. Journal of international business studies, 30(1), 1-24.

Pfotenhauer, S. M., Wood, D., Roos, D., & Newman, D. (2016). Architecting complex international science, technology and innovation partnerships (CISTIPs): A study of four global MIT collaborations. Technological Forecasting and Social Change, 104, 38-56.

Wagner, C.S., Leydesdorff, L. (2005). Network structure, self-organization, and the growth of international collaboration in science, Research Policy, 34, 1608–1618.

Von Zedtwitz, M., & Gassmann, O. (2002). Market versus technology drive in R&D internationalization: four different patterns of managing research and development. Research policy, 31(4), 569-588.

Youtie, Jan, Libaers, Dirk, Bozeman, Barry. (2006). Institutionalization of university research centers: the case of the National Cooperative Program in Infertility Research. Technovation, 26(9), 1055-1063.

Zhang, H., Patton, D., & Kenney, M. (2013). Building global-class universities: Assessing the impact of the 985 Project. Research Policy, 42(3), 765-775.

Stefan Kuhlmann, Jakob Edler, Ralf Lindner, Gonzalo Ordonez, Sally Randles and Bart Walhout

Transformative Research and Innovation Policy – Towards a Meta-governance Frame

Session 3A

The paper will develop a meta-governance framework facilitating transformative policy-making, with a particular focus on the meso-level of research and innovation systems (RIS). In our concept “governance” includes all related actors, their resources, interests and power, fora for debate and arenas for negotiation between actors, rules of the game, and policy instruments applied helping to achieve legitimate agreements (Kuhlmann 2001; Benz 2006). “Meta-governance” is about “organising the conditions of governance” (Jessop 2002, 242).

Why is this perspective relevant? The contexts and conditions for RIS are changing, placing more, new and multiple kinds of pressures, demands and requirements on science, technology and innovation (STI). These demands can be understood as increased legitimacy pressures on STI actors and RIS (e.g. Schot & Steinmueller 2016; Mulgan 2017). Since about 15 years STI policies have become geared towards addressing objectives reaching beyond an immediate economic focus on growth and competitiveness (Lindner et al. 2016). This "normative turn" is expressed in the strategic reorientation of national and supranational STI policies to address the “Grand Societal Challenges” such as health, demographic change, wellbeing and sustainability (Foray et al. 2012; Kallerud et al. 2013; Kuhlmann & Rip 2014). Well known examples for this ongoing paradigm shift are the European Union's Europe 2020 strategy, the US Strategy for American Innovation or Germany's Hightech Strategy. This is complemented and propelled forward by the recent discourse on “responsibility” in research and innovation.

Against this background the paper will address the following questions:

- What is needed to establish, ensure or regain legitimacy for STI policy? Can legitimacy be constructed pro-actively (c.f. Suchman 1995)? How and towards which ends do RIS and their meta-governance have to be transformed to achieve this?

- Which meta-governance frame (at the meso-level) can help to address the transformations called for, and eventually contribute to establishing legitimacy of STI?

The paper does not intend to deliver a “grand concept” to transform RIS, covering all levels and systems dimensions. Rather, the focus is on transformation of organisations and institutions at the meso-level (such as funding organisations; ministries; boards of universities and of companies; civil society organisations). This level is often forgotten, as analysis and prescription either target “the system”, policy or individuals, and if they target the meso-level, it is often very specificly tailored towards a certain category. However, our premise is that while there is a variety of different organisations in RIS, there are core structures and processes influencing responsiveness to external demands across all of them that need to be understood and addressed. Successful changes at the meso-level have a potential to contribute, in a legitimate way, to system-wide transformations.

A recent prominent attempt to (re-)establish legitimacy and provide normative orientation for STI policy and RIS is the above mentioned quest for “Responsible Research and Innovation (RRI)” (e.g. von Schomberg 2013). In essence, “RRI” aims at improving the alignment of the impacts of technology and innovation with societal demands and values as far as possible. The concept is inherently characterised by a high degree of normativity in order to provide necessary guidance as to what constitutes desired or “responsible” research and innovation (Randles et al. 2014; Lindner and Kuhlmann 2016). The prominent position of “RRI” in the European Union's research and innovation programme Horizon 2020 and the endorsement of the "Rome Declaration on RRI in Europe" by the European Council in 2014 indicate that “RRI” has been used as a legitimacy resource for policy, research funding and scientific communities. The quest for “RRI” can be interpreted as one of the current responses to the challenges raised by the broader changes and dynamics conditioning and structuring STI. The related “RRI discourse” is an attempt to question, revise and strategically re-stabilise the legitimacy of public investments in STI policies.

But such claims to increase the “responsibility” and “responsiveness” in RIS should not be equalled with a meta-governance frame. Therefore, in contrast to attempts to define what “RRI” should mean in substance (e.g. Stilgoe et al.

2013), in our paper we apply a genuine governance perspective. The intended meta-governance framework facilitating transformative, responsive and legitimate policy-making in RIS will have to cope with two basic challenges:

- "Responsibility" has always been subject to changing value choices (Arnaldi & Gorgoni 2017). Also the recent claim for "RRI" is an inherently normative concept. The concrete realization of these normative claims will be contested in the context of pluralistic societies. Instead of downplaying these tensions and potential conflicts, we acknowledge the need to identify conditions and viable mechanisms that facilitate the capacities and capabilities of relevant actors to engage in constructive and productive negotiations.

- Any effective governance approach needs to take into account the manifold, multi-layered incumbent governance arrangements in RIS and STI policy, and draw on them constructively.

These various, often well-established arrangements and mechanisms, as well as normative priorities of actors, represent what we consider as "RRI in the making" or the de facto governance (Rip 2010) of evolving "divisions of moral labour" (Rip 2017) between actors.

Consequently the paper builds on a research approach aiming to learn from "RRI in the making", understood as a historically unfolding process, co-evolving with understandings of what it means to be responsible in any particular context. Here we are interested in those practices in which the participating actors work towards legitimate normative objectives and outcomes.

In order to identify "building blocks" for a meta-governance framework and given the heterogeneity and complexity of present research and innovation governance landscapes, a case study approach was chosen to study "RRI in the making", aiming to generate deep insights into established arrangements, mechanisms and practices of governance across a range of different research and innovation situations and contexts. Consequently, an explorative rather than a representative approach was applied to select and conduct 26 very diverse empirical cases (Randles et al. 2016). A tailored model was developed to guide the empirical research (Walhout et al. 2016). The case study programme was be complemented by a continuous monitoring process of "RRI" trends and developments in 16 European countries (Mejlgaard & Griessler 2016). The empirical material was analysed in a 3-stage deductive-inductive research process, and we identified 13 transversal lessons for the governance of RRI, along procedural and substantive dimensions (Randles et al. 2016).

Against this background we developed in an abductive manner the rationale and ambitions of a meta-governance framework ("Responsibility Navigator", Kuhlmann et al. 2015). This orientating framework is meant to facilitate responsibility-related debates, strategic reflection and decision-making processes in meso-level RIS organisations. The framework builds on ten principles organised along the three dimensions of (1) Ensuring Quality of Interaction, (2) Positioning and Orchestration, and (3) Developing Supportive Environments. We claim a high degree of robustness of the suggested principles given a strong empirical foundation plus the fine-tuning and testing in an elaborated "co-construction process" with key meso-level stakeholders from RIS in Europe and beyond (Bryndum et al. 2016).

References:

Arnaldi, S. & Gorgoni, G. (2016): Turning the tide or surfing the wave? Responsible Research and Innovation, fundamental rights and neoliberal virtues, Life Sciences, Society and Policy 6,

DOI: 10.1186/s40504-016-0038-2.

Benz, A. (2006): Governance in connected arenas – political science analysis of coordination and control in complex control systems. In Jansen, D. (ed.): New Forms of Governance in Research Organizations. From Disciplinary Theories towards Interfaces and Integration, Heidelberg/New York: Springer, 3-22.

Bryndum, N.; Alexander Lang, A.; Mandl, C.; Velsing Nielsen, M.; Bedsted, B. (2016): The Res-AGorA Co-construction Method. In: Lindner, R., Kuhlmann, S., Randles, S., Bedsted, B., Gorgoni, G., Griessler, E., Loconto, A., Mejlgaard, N. (eds.): Navigating Towards Shared Responsibility in Research and Innovation. Approach, Process and Results of the Res-

AGorA Project. Karlsruhe/Germany (Fraunhofer ISI), 46-53 (ISBN: 9-783000-517099; https://indd.adobe.com/view/eaeb695e-a212-4a34-aeba-b3d8a7a58acc).

Foray, D.; Mowery, D.C.; Nelson, R.R. (2012): Public R&D and social challenges: What lessons from mission R&D programs? Research Policy 41, 10, 1697-1702, ISSN 0048-7333, http://dx.doi.org/10.1016/j.respol.2012.07.011.

Jessop, B. (2002): The Future of the Capitalist State, Ox¬ford.

Kallerud, E., et al. (2013): Dimensions of research and innovation policies to address grand and global challenges; Eu-SPRI Forum Position Paper of the project "The emergence of challenge-driven priorities in research and innovation policy (CPRI)" (http://www.euspri-forum.eu/key_missions/CPRI_Position_paper.pdf).

Kuhlmann, S. (2001): Governance of Innovation Policy in Europe – Three Scenarios. Research Policy,. 30, 6, 953-976 (DOI: 10.1016/S0048-7333(00)00167-0).

Kuhlmann, S., Rip, A. (2014): The challenge of addressing Grand Challenges. A think piece on how innovation can be driven towards the "Grand Challenges" as defined under the European Union Framework Programme Horizon 2020, Report to ERIAB; DOI: 10.13140/2.1.4757.184

Kuhlmann, S., Edler, J., Ordóñez-Matamoros, G., Randles, S., Walhout, B., Gough, C., Lindner, R. (2015): Responsibility Navigator, Karlsruhe/Germany (Fraunhofer ISI), www.responsibility-navigator.eu. Published also in: Lindner, R. et al. (eds.): Navigating Towards Shared Responsibility in Research and Innovation. Approach, Process and Results of the Res-AGorA Project. Karlsruhe/Germany (Fraunhofer ISI), 132-155 (ISBN: 9-783000-517099; https://indd.adobe.com/view/eaeb695e-a212-4a34-aeba-b3d8a7a58acc)

Lindner, R. et al. (2016): Addressing directionality: Orientation failure and the systems of innovation heuristic. Towards reflexive governance. Karlsruhe (Fraunhofer ISI Discussion Papers Innovation Systems and Policy Analysis No. 52) ISSN 1612-1430.

Lindner, R.; Kuhlmann, S. (2016): Responsible Research and Innovation und die Governance von Forschung & Innovation: Herausforderungen und Prinzipien. In: Forschung: Politik - Strategie – Management, Fo 1/2016, 9. Jg., S. 22-27.

Mejlgaard, N.; Griessler, E. (2016). Monitoring RRI in Europe: approach and key observations. In: Lindner, R. et al. (eds.): Navigating Towards Shared Responsibility in Research and Innovation. Approach, Process and Results of the Res-AGorA Project. Karlsruhe/Germany (Fraunhofer ISI), 114-118 (ISBN: 9-783000-517099; https://indd.adobe.com/view/eaeb695e-a212-4a34-aeba-b3d8a7a58acc).

Mulgan, G. (2017): Thesis, antithesis and synthesis: A constructive direction for politics and policy after Brexit and Trump. NESTA Blog, http://www.nesta.org.uk/blog/thesis-antithesis-and-synthesis-constructive-direction-politics-and-policy-after-brexit-and-trump.

Randles, S./Dorbeck-Jung, B./Lindner, R./Rip, A. (2014): Report of the Roundtable at S.NET Boston 2013: ‚Where to Next for Responsible Innovation'?, In: Coenen, C.; Dijkstra, A.; Fautz, C.; Guivant, J.; Konrad, K.; Milburn, C.; van Lente, H. (eds.): Innovation and Responsibility: Engaging with New and Emerging Technologies, Berlin, 19-38.

Randles, S.; Edler, J.; Gee, S.; Gough, C. (2016): Res-AGorA case studies: drawing transversal lessons. Lindner, R. et al. (eds.): Navigating Towards Shared Responsibility in Research and Innovation. Approach, Process and Results of the Res-AGorA Project. Karlsruhe/Germany (Fraunhofer ISI), 64-72 (ISBN: 9-783000-517099; https://indd.adobe.com/view/eaeb695e-a212-4a34-aeba-b3d8a7a58acc)

Rip, A. (2017): Division of Moral Labour as an Element in the Governance of Emerging Technologies. In: Bowman, D.M.; Stokes, E.; Rip, A. (eds): Embedding New Technologies into Society, 113-127.

Schot, J., Steinmueller, W.E. (2016): Framing Innovation Policy for Transformative Change: Innovation Policy 3.0. Brighton (SPRU working paper series).

Stilgoe, J.; Owen, R.; Macnaghten, P. (2013): Developing a framework for responsible innovation, Research Policy, 42, 9, 1568-1580, ISSN 0048-7333, http://dx.doi.org/10.1016/j.respol.2013.05.008.

Suchman, M. C. (1995): Managing legitimacy: Strategic and institutional approaches. Academy of management review, 20(3), 571-610.

Von Schomberg, Rene (2013): A vision of responsible innovation. In: R. Owen, M. Heintz and J. Bessant (eds.) Responsible Innovation. London: John Wiley.

Walhout, B., Kuhlmann, S., Ordonez-Matamoros, G., Edler, J. (2016): Res-AGorA concepts and approach. In: Lindner, R. et al. (eds.): Navigating Towards Shared Responsibility in Research and Innovation. Approach, Process and Results of the Res-AGorA Project. Karlsruhe/Germany (Fraunhofer ISI), 46-53 (ISBN: 9-783000-517099; https://indd.adobe.com/view/eaeb695e-a212-4a34-aeba-b3d8a7a58acc).

Seokbeom Kwon

Impact of Patents Purchase on Ex-Post Patent Holdup and R&D of Firms

Session 10D

Firms used to purchase patents to use the patents for strategic purpose (Figueroa & Serrano, 2013; Galasso et al., 2013; Kelley, 2011; Monk, 2009; Morton & Shapiro, 2014), which can aggravate ex-post patent holdup (Galasso et al., 2013; Lemley & Shapiro, 2006).

The literature on strategic patenting explains how patent ownership change configures the involved parties' ex-post patent holdup and how these parties can benefit from it. Firms often acquire patents for defensive purposes (Hall & Ziedonis, 2001; Thumm, 2004; Ziedonis, 2004) so that their operations are not hindered by patent assertions made by their rivals. At the same time, firms use patents to deter market entry of would-be competitors (Cohen et al., 2000; Gallini, 1984; Hall & Ziedonis, 2001; Motohashi, 2008; Ziedonis, 2004). Such strategic use of patents is particularly visible in the complex technology field (Noel & Schankerman, 2013; Reitzig, 2004). The implication of this literature is that firms will face increased ex-post patent holdup risk if patents are obtained by rivals who have strategic stakes in the use of patents. In contrast, firms able to secure patents before they fall into rivals' hands can prevent the patents' strategic utilization by rivals. Hence, the relationship between patent holdup and patent ownership change on innovation will depend on who becomes owner of the patents and whether the owner is willing to use the patents strategically.

Although the reasoning outlined above appears to offer a straightforward path towards understanding how patent markets will affect innovation, few studies have investigated this reasoning empirically. The literature on patent holdup largely focuses on finding empirical evidences of whether patent holdup causes a detrimental impact on innovation (Cockburn & MacGarvie, 2009; Elhauge, 2008; Galetovic et al., 2015; Walsh et al., 2003). Meanwhile, studies on the market for patents examine firms' patent trading patterns (Serrano, 2005, 2010), enforcement of purchased patents (Galasso et al., 2013), or the patent transaction flow between small and large firms (Figueroa & Serrano, 2013). This literature gap suggests the following question: how does firms' R&D activity respond to the changed level of ex-post patent holdup risk associated with patent ownership change?

The present study aims to find theoretical and empirical answers to this question. First, using a micro economic model a firm's R&D allocation decision, I describe how firms' R&D activity is affected by decreased or increased ex-post patent holdup risk. Second, I derive hypotheses about how the firms' R&D is affected by the changed level of ex-post patent holdup risk by patents ownership transfer. Finally, the derived hypotheses from the model are tested using the case of auction of Nortel patents following the firm's bankruptcy.

Seokbeom Kwon and Seokkyun Woo

Does strong IPR regime improve innovation in developing countries? Evidence from the 1986 South Korean IPR Reform

Session 1

The Intellectual Property Right (IPR) system is one of the key institutions to incentivize innovation. However, it is not obvious whether a strong IPR regime always encourages innovation. This is because the relationship between strength of IPR regime and innovation depends on interaction of a variety of factors as well as the accompanying complex dynamics. Indeed, studies emphasizes different factors and conditions that define the relationship between the IPR regime and innovation. The consequence of the strong IPR regime depends on innovative firms' organizational structure that governs the interaction between R&D division and IPR managing division (Sakakibara & Branstetter, 2001). The impact of IPR regime on innovation activity differs by industry (Moser, 2003) as the importance of IPR is heterogeneous across different industry (Cohen, Nelson, & Walsh, 2000). The weak IPR may drive innovation by promoting technological competitions and R&D investment accordingly (Qian, 2008) while firms strategically protect their intellectual property through knowledge internalization when they face with the weak IPR regime (Zhao, 2006).

The complex dynamics and various factors that needs to be considered in understanding the relationship between IPR regime and innovation impose more difficulties particularly to the innovation policymakers in designing the proper IPR policy in the context of developing country. Since the developing countries often suffer from the limited infrastructure and resources for innovation activity, it become crucial for the policymakers to find the best mode of institutions to effectively promote innovation in their context. When it comes to the IPR system, it is critical issue to find how the strength of IPR regime will affect the innovation capability of indigenous innovators across different industrial sectors because the strong IPR regime can be disastrous for those who are in infant industries whereas it could be advantageous for innovators who are capable of catching the new opportunities generated from the strong IPR regime.

Although the prior studies have put extensive effort to discuss how the organizational or strategic characteristics of innovators and general industrial characteristics relate to the impact of IPR regime on innovation in developed countries' context, they are less informative in understanding how the strength of IPR regime influence on the innovation capability of the innovators in developing countries across different industries that have different level of absorptive capacity of innovators. Does the strong IPR regime differently affects the innovation capability of innovators by the industry level absorptive capacity in the developing country context?

The present study aims at addressing this question by using the case of IPR reform in Korea in 1986. This IPR reform becomes a unique case to address the research question of the present study for the following reasons. First, the reform was particularly for strengthening IPR regime. By the reform, the patent length increased from 12 to 15 years. Also, patenting new substances such as pharmaceutical products and the protecting computer software through copy right were newly allowed. Second, the pharmaceutical industry was under developing stage whereas computer software related industry was in rapid growth in Korea from 1970s. Hence, the innovators in the two industries may have built different level of absorptive capacity. Third, this reform also took place when Korea was still a developing economy.

For empirical analysis, we proxy for the innovation capability by the quality of produced patents. We analyze whether the quality of the patents improved differently for pharmaceuticals and computer-software related patents after the reform. We have obtained patents filed to US, Germany and UK patent office by Korean applicants during 1982-1991 period.

Our analysis finds no empirical evidences that the Korean IPR reform enhanced the technological significance of the both of pharmaceutical and computer-software related patents. Instead, the reform seems to affect the patenting behavior of inventors in the two sectors, differently. Our findings contribute to the broad literature on the relationship between the IPR regime and innovation with implications for innovation policymakers in developing countries.

Reference:

Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2000). Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not). Retrieved from

Moser, P. (2003). How do patent laws influence innovation? Evidence from nineteenth-century world fairs. Retrieved from

Qian, Y. (2008). Impacts of Entry by Counterfeiters. The Quarterly Journal of Economics, 123(4), 1577-1609.

Sakakibara, M., & Branstetter, L. (2001). Do Stronger Patents Induce More Innovation? Evidence from the 1988 Japanese Patent Law Reforms. RAND journal of economics, 77-100.

Zhao, M. (2006). Conducting R&D in countries with weak intellectual property rights protection. Management Science, 52(8), 1185-1199.

Bitna Lee and So Young Kim

Expert-Expert Gap? A Study of Heterogeneity in Risk Perceptions among Nuclear Experts and Its Implications for Risk Governance

Session 5C

One of the most complex questions in science policy emerges when one looks at how society and its various actors handle risks. Notably, nuclear technologies have brought controversies that are fueled by several ambiguities due to different perceptions of risk. To deal with these debates, a risk governance framework provides the interpretation of the content and core principles of risk governance as well as of risk-related decision-making processes. More than simply assessing and managing risk, it requires consideration of the socio-economic context in which actors and stakeholders are linked interacting with one another. It is thus necessary to understand the complex relationships of actors and the ways in which they engage in communication and decision-making. (Renn 2008)One thing that needs to be considered closely is the subjective perceptions of individuals and groups about risk. Risk perceptions affect how risks are treated in different domains and socio-political cultures. (IRGC 2005)

Much of the existing research and policy discourse on highly technical issues has concentrated on the expert-lay gap in risk perceptions (Sjöberg 1980; Slovic 1987), in which experts with technical knowledge and resources are portrayed as more or less a homogeneous community confronting citizens of lesser expertise. Empirical studies as well as discourse analyses in the fields of psychometrics (Fischhoff, et al. 1978) and science and technology studies (STS) (Cho, & Kang 2016; Min 2016) have thus been keen on identifying and measuring the gaps in risk perceptions between experts and lay citizens with each assumed as monolithic groups.

In this study, we challenge such an assumption by exploring heterogeneity in risk perceptions among nuclear experts in South Korea. With the catastrophic nuclear accidents of the last few decades – Three Mile Island (1979), Chernobyl (1986), and Fukushima (2011), risk management and governance have become perhaps the biggest focal point in nuclear policymaking.

The South Korean nuclear expert community provides a strategic research site in many ways. As a major world, nuclear energy country with the geopolitical concerns with the fuel cycle issue, South Korean nuclear engineers and scientists have long grappled with various issues of nuclear risk communication. In this course of handling multiple risk issues such as nuclear safety, security, and even nonproliferation, South Korean nuclear experts have developed nuanced positions on specific policy decisions rather than making a unified pro-nuclear voice.

Based on the in-depth interviews of nuclear experts in government research institutes, universities, the nuclear industry, and the relevant ministries and the analysis of the archive of key policy documents, we uncover the diversity of nuclear experts in their views of the degree and significance of nuclear risks as well as the political and technical feasibility of managing nuclear risks. Through the literature survey, we have collected a large amount of legal, administrative, and policy data related to the nuclear risk and safety issues in South Korea. Yet while these data are publicly available and official, it is difficult to detect the motives behind informal activities undocumented in those data. Therefore, we supplement our analysis with in-depth interviews.

This research provides a complementary approach to the existing risk governance discourse that has highlighted the democratic participation of citizens, by looking closely into perceptions and decision-making of experts who generally provide mainstream voices in risk management and governance. One of the central contributions of this study is to appreciate the tensions within the expert community and thereby help to design a better interface – whether institutions or policies – for the governance of knowledge as well as for knowledge in governance.

REFERENCES

Beck, U. (1992) Risk Society: Towards a New Modernity. New Delhi: Sage. (Translated from the German Risikogesellschaft)

Cho, A-R., & Kang, Y-J. (2016). A Study on the Shift from Risk Governance to Uncertainty Governance. Journal of Social

Thoughts and Culture, 19(2), 93-127.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. (1978) How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. Policy Sciences, 9, 127–152.

IRGC (International Risk Governance Council) (2005). Risk governance: Toward an integrative approach. White paper No.1, Renn, O. with an annex by P. Graham. Geneva, Switzerland.

Min, E. (2016). Exploring Governance as a Nuclear Risk Management System: Focusing on the Wolsong No.1 in Gyeongju. ECO, 20(2), 7-49.

Renn, O. (2008). Risk Governance: Coping with Uncertainty in a Complex World. Earthscan.

Sjoberg, L. (1999). Risk perception by the public and by experts: A dilemma in risk management. Human Ecology Review, 6 (2), 1-9.

Slovic, P. (1987). Perception of Risk. Science, 236, 280-285.

Keun Lee, Marina Szapiro and Zhuqing Mao

From Global Value Chains (GVC) to Innovation Systems for Local Value Chains and Knowledge

Session 8E

There is an emerging call for a need to integrate the two approaches, Global Value Chains(GVC) and IS(innovation systems), with the recent initiatives by Lundvall (Lundvall, 2015, 2016). He has raised this fundamental issue of the integration by asking the following questions: 1) should less developed countries let comparative advantage rule and make attempts to upgrade through GVC; 2) or should they engage in active trade and industrial policy to promote specific sectors with bigger learning opportunities. The current study can also be considered as an attempt to seek a linkage between the two approaches or integrating the two. The integration of the two approaches is important since if an economy decides to pursue the latter (industrial policy), it should arrange access to learning (foreign knowledge), which in turn means some degree of openness to the GVC (or global knowledge flow). On the other hand, just joining the GVC does not guarantee upgrading, and an economy might be stuck in low value activities, without functional upgrading.

This paper thus proposes the N-shaped curve hypothesis that while at the initial stage of growth more GVC is desirable for learning from outside, functional upgrading requires some effort or stage of seeking separation and independence from the existing foreign-dominated GVC, and that the latecomer firms and economies might have to seek again for an opening to integrate back into the GVC after building up their own local value chains. This paper has tried to verify this 'N-shaped, In-Out-In again' hypothesis first by looking into cases of 'upgrading and independence' in Korea and Brazil, and second by checking the national level data of the share of foreign value-added (FVA). It is shown that the trends of FVA in successful catching-up economies, like Korea, Taiwan, and recently China, is consistent with this N-shaped or In-Out-In again pattern. The paper has also presented some regression results that confirms some correlations between the degree of local creation and diffusion of knowledge and the values of FVA. This can be regarded as an important contribution because it illustrates the linkage between the innovation system variables (knowledge localization) to the GVC variable of the FVA. This finding implies that building local innovation systems is the key to make upgrading and local value creation possible while being integrated in the GVC.

This work was supported by the BK21Plus Program(Future-oriented innovative brain raising type, 21B20130000013) funded by the Ministry of Education(MOE, Korea) and National Research Foundation of Korea(NRF)

Min Leng and Yu Tao

Academic Entrepreneurship at Public Research Institutes in China: Scientists' Role Conflict and Choice

Session 7E

Academic entrepreneurship, including patenting, licensing, startup creation, and university-industry partnership, has been increasing importance in many countries. The Bayh-Dole Act of 1980 in the U.S. and its European counterparts in the early 1990s have led to the growth of academic entrepreneurship in the U.S. and Europe. Literature on academic entrepreneurship reveals that commercialization of academic knowledge in U.S. and European universities is affected by different levels of factors. They include new regulations and government actions (e.g., the Bayh-Dole Act and IP laws), support from regional and local organizations (e.g., university-industry ties, strong local support networks), university-level structure and support (e.g., an entrepreneurial culture, incubators, university venture funds, Technology Transfer Office, intensity and funding source of faculty research), institutional culture (e.g., the scientific reward system), external factors (e.g., access to venture capital), and scientists' characteristics (e.g., willingness to change their identity from scientist to entrepreneur, tenure and research skills) (O'Shea et al., 2004; Grimaldi et al., 2011). Also, these factors may have different effects at different stages of commercialization.

In China, a recent national policy allows scientists to keep their academic and research positions for up to 3 years while starting their own companies. However, unlike what follows the Bayh-Dole Act or its European counterparts, there have been heated discussions and debates on this policy. A world-renowned scientist and vice president of Tsinghua University, Yigong Shi, believes that to encourage scientists to start their own companies will divert scientists' focus from basic research to business- and finance-related issues (Shi, 2017). On the other hand, other scientists believe that scientists participating in entrepreneurial activity do not forgo their scientific research but provide scientific advice to the startup, and academic entrepreneurship does not necessarily conflict with conducting basic or state-of-the-art research (Zhang, 2017).

In this context, this paper examines sources of conflict—for instance, the conflict between different levels of mechanisms (e.g., national policy vs. institutional evaluation systems)—and how scientists behave when they experience these conflicts. Overall, Chinese scientists are more responsive to national policies than those in Western countries, but with the new policy encouraging academic startups, Chinese scientists are not so actively responding. While this policy encourages startups, the scientific reward system still values publication the most.

In order to examine this research question, we will collect data by interviewing scientists and engineers working in the Chinese Academy of Sciences (CAS), a public research institute in China. Research institutes in China are similar to research universities in the U.S. in terms of intensity of research. Some research institutes also have a teaching component (mostly graduate students). As an elite public research institute, CAS produces a large proportion of China's research publications as well as commercialization output. In addition to the effects of different levels of mechanisms, we will explore the effects of some other factors identified in literature, such as personal characteristics, including willingness to change identity as well as gender, which is understudied in academic entrepreneurship literature.

Olena Leonchuk and Denis Gray

Exploring mechanisms of graduate training of the science and engineering students. Mix method approach.

Session 3B

Evaluation scholars are always in pursuit of the best ways to capture complexities of science, technology and innovation (STI) programs and projects, but for the large part, they remain focused on long-term outputs (e.g. co-publishing) and outcomes (e.g. IP) and microeconomic analysis. Nevertheless, these metrics are limited in their ability to capture the human aspect of science and processes that make collaborative research successful. Continuously growing number of academic journals, development of GIS mapping and text analytics helped to revive interests in bibliometric-based studies, but they are disproportionally limited to established researchers working in academia. As a result, existing metrics tend to omit early career scientists during their graduate or post-graduate training, what factors are important to their careers and what role they play in STI initiatives.

In this paper, we aim to meet two goals. First, we want to provide more understanding about graduate students in the context of STI investments, their training and outcomes. Second, we aim to contribute to the STI evaluation community as a whole by testing the Scientific and Technical Human Capital (S&T human capital) framework developed by Bozeman, Dietz and Gaughan (2001).

S&E graduate students are unique for several reasons. In comparison with students in other disciplines, S&E graduate students have a greatest proportion of international students; are widely employed by industry in numbers exceeded only by business graduates. Because S&E disciplines contribute the most to the US innovation capacity, S&E graduate training has significant industry involvement and collaboration opportunities across sectors and institutions. Students who are involved with one type of these initiatives, cooperative research centers, are believed to benefit more from their training, especially, in formation of social and human capital.

At its core, the S&T human capital framework looks beyond simple economic and publication metrics and instead focuses on scientists' social capital. The premise of the framework is that science does not happen in vacuum and that resources embedded in scientists' social networks are important and enduring outcomes of the scientific process that were not being captured by traditional metrics.

This paper employs a multidimensional measure of social capital based on the network theory of social capital proposed by Nan Lin (1999). According to Lin, social capital consists of three components: availability of resources and social embeddedness in one's network and mobilization of these resources. In order to address these elements, the paper employs two studies. Study 1 looks at accessibility of resources in students' social networks and whether students would be likely to mobilize them by using a proxy measure of norms and values about collaborations. The study also addresses the effect of social capital on students' experiences and outcomes, specifically, on their satisfaction and perceived career preparedness. Study 1 investigates the mechanisms that explain students' outcomes by employing data from a matched sample of S&E doctoral students trained at the Industry-University Cooperative Research Centers, IUCRCs (N=173), and doctoral students from the same universities and disciplines who were trained more traditionally (N=87). Two exploratory path models demonstrate the important role of availability of network resources and proxy for mobilizing them on students' perceived career preparedness and satisfaction with their training. Study 2 is a case study of one IUCRC's whole social network. We attempt to provide a better understanding of the embeddedness components of students' social capital in their IUCRC network.

We discuss the results of both studies and how they help to better understanding of graduate students and the role of graduate training in their careers. For example, the results of Study 1 show that IUCRC training has a large positive effect on all students' outcomes. Social capital and industry experience represent some of the mechanisms that explain why students differ in their career preparedness. Study 2, on the other hand, provides visual representation of social processes happening in one of the IUCRCs and social embeddedness of students within this IUCRC. At the end, we discuss the lessons learned about applying the S&T human capital framework on graduate students in the context of STI programs and projects.

Benedetto Lepori and Aldo Geuna

Money matters, but why? Scaling properties of US and European universities

Session 8A

Introduction

An extensive literature has documented scaling properties of the science system, for what concerns the distribution of scientific citations (1), the structure of scientific networks (2), the relationships between scientific production and impact at the level of countries, scientific communities (3) and cities (4). These relationships have been frequently approximated with power-law distributions (5); (6). A power-law relationship between the volume of publications and the citations has been observed for the 500 largest universities worldwide in terms of scientific production (7). Supra-linear scaling implies that the average number of citations per paper, a widely-used indicator of scientific excellence, increases with the volume of scientific production and, therefore, more productive universities will also show up at the top of international research rankings, which are heavily correlated with bibliometric measures.

Unlike the parallel literature on cities, where scaling is measured against city population or volume of economic production (8), the literature on science scaling did not rely until now on a consistent measure of resources, despite economics of science suggesting that the volume and distribution of resources within scientific systems strongly impact scientific production (9). For what concerns specifically universities, it has been suggested that the dominance of US universities in international rankings over their European counterparts is largely due to a more competitive funding systems (10), (11). Understanding whether scaling holds also for the relationships between resources and output is highly relevant for policy purposes, as supra-linear scaling implies that policies concentrating resources increase the system's level of output, respectively of scientific visibility and, therefore, might explain the so-called 'European paradox', i.e. European science being more productive, while US showing at the top of scientific excellence and international rankings (12) (13).

Empirical findings

By using a comprehensive dataset comprising 3287 HEIs in the US and 2264 HEIs in Europe, this paper demonstrates a supra-linear scaling between the total budget of universities and the volume of publications and citations. Furthermore, we show that this relationship is similar both for US and European universities, therefore suggesting some general mechanisms underlying the relationship between resources and scientific production. While European universities tend to be more productive than their US counterparts, a group of US universities have a much larger volume of resourcing and, therefore, of scientific outputs. Supra-linear-scaling of scientific production translates into a strong association between resourcing and the position in international rankings: 15 out of the top-25 universities in the Shanghai ranking are among the top-25 universities in our database in terms of the total budget.

We show that concentration of resources is related to three differences between the two systems.

First, US higher education is endowed with a higher level of resources. When normalized by the number of students, the difference can be estimated from our data to be around 40%, a figure compatible with data from international statistics (14).

Unlike European universities, which mostly rely on core governmental allocation (63% of the total resources) and complementarily on project funds (18%) and on tuition fees (18%), funding of US HEIs comprises four major streams, i.e. States core allocation (17%), private donations and endowments (22%), project funds (21%) and tuition fees (37%). We highlight the central role of private endowments and donations in the US, which are concentrated in the top-research universities and largely account for their exceptional level of resourcing. On the contrary, while introducing some performance elements (15), recent changes in funding of universities in Europe did not significantly change the composition by streams and resources (16).

Second, we observe a clear difference in the extent of institutional differentiation between the two systems. The European system comprises a large number of colleges and focused HEIs, but research universities account for nearly 70% of the academic staff and of the enrolments at the diploma, bachelor and master level. On the contrary, research universities account in the US for 55% of staff, but only for 45% of the enrolments; the difference would be even larger

when including US associated colleges.

Third, there are clear differences between US and Europe in the distribution of resources, education and research. The level of concentration of educational activities (as measured by enrolments) is similar in both systems and is closely followed by the distribution of academic staff. In Europe resources display the same distribution as students and staff, while in the US they are more concentrated, the difference being larger for the top-20% of the HEIs. European HEIs tend therefore to “scale up” with students’ enrolments, while US research universities have more resources as compared with their enrolments.

Discussion

The observed scaling relationships hold across a large range of HEI dimensions and profiles and across different systems, suggesting that some fundamental mechanisms generate these regularities. Our findings also move beyond previous results on preferential attachment in scientific networks (1), as they demonstrate that scaling applied both to publications and to citations in respect to resources. Therefore, bibliometric indicators, included those normalized by the volume of scientific production, largely reflect the level of resourcing of HEIs; their interpretation as a measure of excellence must be questioned and they should never be used for comparing HEIs without considering differences in resourcing (17).

In a comparative perspective, our results show that the supremacy of US universities in terms of research excellence is generated by a distinctive combination of factors: a significantly higher level of resources, thanks to differentiation of funding streams; a more diverse set of types of HEIS, which dates back to the XIX and the early XX centuries; the concentration of research activities also for what concerns research universities. When taken together, these factors imply that a group of US universities have budgets which are a multiple of the best-funded European universities. In turn, higher concentration of resources and supra-linear scaling of research output and citations with budget explain the (apparent) paradox of European universities being more productive, while their US counterparts having more citations and showing at the top of international rankings.

References

1. G. J. Peterson, S. Presse, K. A. Dill, Nonuniversal power law scaling in the probability distribution of scientific citations. Proc. Natl. Acad. Sci. U. S. A. 107, 16023-16027 (2010).

2. A. L. Barabasi, R. Albert, Emergence of scaling in random networks. Science. 286, 509-512 (1999).

3. J. S. Katz, The self-similar science system. Research Policy. 28, 501-517 (1999).

4. Ö. Nomaler, K. Frenken, G. Heimeriks, On scaling of scientific knowledge production in US metropolitan areas. PloS One. 9, e110805 (2014).

5. M. E. Newman, Power laws, Pareto distributions and Zipf's law. Contemporary Physics. 46, 323-351 (2005).

6. J. Leitao, J. Miotto, M. Gerlach, E. Altmann, Is this scaling nonlinear? ArXiv Preprint arXiv:1604.02872.(2016).

7. A. F. van Raan, Universities scale like cities. PloS One. 8, e59384 (2013).

8. L. M. Bettencourt, The origins of scaling in cities. Science. 340, 1438-1441 (2013).

9. P. Dasgupta, P. A. David, Toward a new economics of science. Research Policy. 23, 487-521 (1994).

10. P. Aghion, M. Dewatripont, C. Hoxby, A. Mas-Colell, A. Sapir, The governance and performance of universities: evidence from Europe and the US. Economic Policy. 25, 7-59 (2010).

11. A. Bonaccorsi, Better policies vs better institutions in European science. Science and Public Policy. 34, 303-316 (2007).

12. P. Albarrán, J. A. Crespo, I. Ortuno, J. Ruiz-Castillo, A comparison of the scientific performance of the US and the European Union at the turn of the 21st century. Scientometrics. 85, 329-344 (2010).

13. A. Bonaccorsi, T. Cicero, P. Haddawy, S. Hassan, Explaining the transatlantic gap in research excellence. Scientometrics., 1-25 (2016).

14. OECD, Education at a Glance (OECD, Paris, 2016).

15. D. Hicks, Performance-based university research funding systems. Research Policy. 41, 251-261 (2012).

16. B. Jongbloed, H. Vossensteyn, University funding and student funding: international comparisons. Oxford Review of Economic Policy. 32, 576-595 (2016).

17. G. Abramo, C. A. D'Angelo, A farewell to the MNCS and like size-independent indicators. Journal of Informetrics. 10, 646-651 (2016).

Loet Leydesdorff, Dieter Franz Kogler, Bowen Yan and Jordan A. Comins

Portfolio Mapping and Statistical Analysis of US Patents, the Comparison of Strengths and Weaknesses,

Session 5B

Alongside the longer-term program of journal mapping, we develop a set of tools for patent mapping and analysis (Rotolo *et al*., 2017). The (online) tools enable users to (i) map the portfolios of organizations, (ii) overlay and compare portfolios, (iii) retrieve landmark patents using Patent Citation Spectroscopy (PCS), (iv) perform statistical analysis using network statistics (e.g. centrality).

1. Mapping

The new maps are based on aggregated citation relations among Cooperative Patent Classifications (CPC). CPC is jointly developed by the European and US Patent Offices. New categories were added to the International Patent Classification (IPC; Kogler *et al*., in preparation; Newman *et al*., 2015) under "Y" indicating new technological developments such as nanotechnology and technologies for the mitigation of climate change (Leydesdorff, Kogler, & Yan, 2017).

We use the matrix of more than five million USPTO patents (cited) *versus* citing patents aggregated into the 654 CPC classes at the 4-digit level for generating the base map (Yan & Luo, 2017). VOSviewer is used for both the decomposition (colors) and visualization. In addition to diversity scores, the analyst is able to compare the portfolios of two competing firms (Figure 1). See for the routine and instruction at http://www.leydesdorff.net/cpc_cos/portfolio/index.htm.

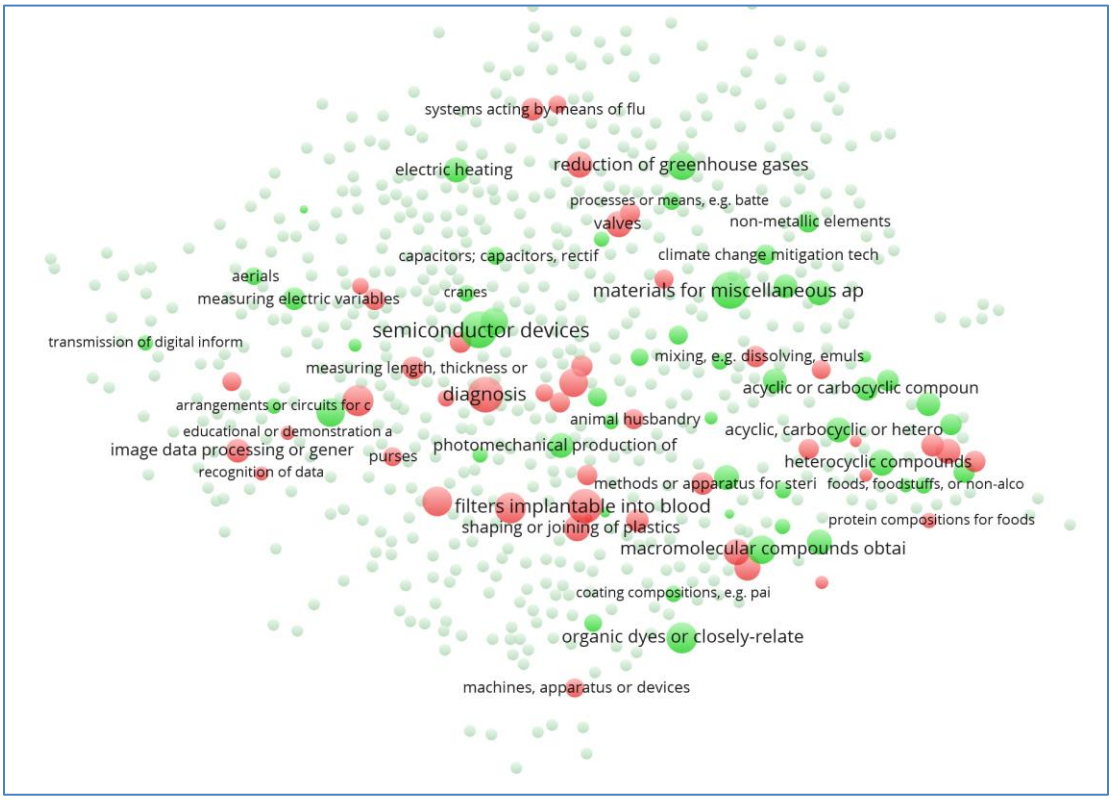


Figure 1: Comparison of portfolios between 276 patents granted to Novartis (colored red) *vs*. 350 patents granted to Merck Sharpe and Dome (colored green) in 2016.

2. Patent Citation Spectroscopy and Landmark Patents

In analogy to Referenced Publication Year Spectroscopy (RPYS; Thor *et al*., 2016)); we develop Patent Citation Spectroscopy (PCS; Comins & Leydesdorff, 2017). The online tool at http://www.leydesdorff.net/pcs integrates PCS with the indication of Landmark Patents in analogy to milestones in RPYS (Figure 2; Comins, Carmack, & Leydesdorff, in preparation).

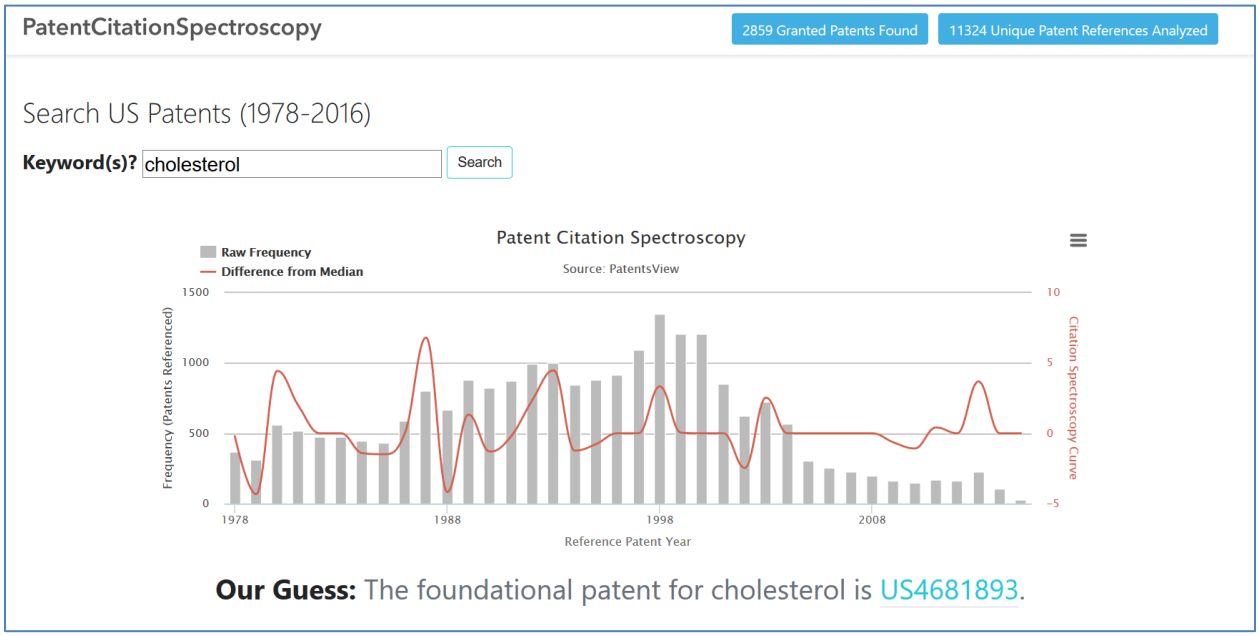


Figure 2. PCS plot for cholesterol. The patent identified as most seminal in this area was US4681893 by Bruce Roth granted in 1987. This represents the patent underlying the medication Atorvastatin (i.e., Lipitor).

References:

Comins, J. A., & Leydesdorff, L. (2017). Citation algorithms for identifying research milestones driving biomedical innovation. *Scientometrics*, *110*(3), 1495-1504.

Comins, J. A., Carmack, S. A., & Leydesdorff, L. (in preparation). Patent Citation Spectroscopy (PCS): Algorithmic retrieval of landmark patents.

Kay, L., Newman, N., Youtie, J., Porter, A. L., & Rafols, I. (2014). Patent overlay mapping: Visualizing technological distance. *Journal of the Association for Information Science and Technology*, *65*(12), 2432-2443.

Kogler, D. F., Heimeriks, G., & Leydesdorff, L. (2016). Patent Portfolio Analysis of Cities: Statistics and Maps of Technological Inventiveness. *arXiv preprint arXiv:1612.05810*.

Leydesdorff, L., Kogler, D. F., & Yan, B. (2017). Mapping Patent Classifications: Portfolio and Statistical Analysis, and the Comparison of Strengths and Weaknesses. *Scientometrics*, *112*(3), 1573-1591.

Rotolo, D., Rafols, I., Hopkins, M. M., & Leydesdorff, L. (2017). Strategic intelligence on emerging technologies: Scientometric overlay mapping. *Journal of the Association for Information Science and Technology*, *68*(1), 214-233.

Thor, A., Marx, W., Leydesdorff, L., & Bornmann, L. (2016). Introducing CitedReferencesExplorer (CRExplorer): A program for reference publication year spectroscopy with cited references standardization. [Article]. *Journal of Informetrics*, *10*(2), 503-515.

Yan, B., & Luo, J. (2017). Measuring technological distance for patent mapping. *Journal of the Association for Information Science and Technology*, *68*(2), 423-437.

Chao Li, Philip Shapira, Mercedes Bleda and Fumi Kitagawa

From Innovative SMEs to Innovative China: Innovation Strategies, Dynamics and Networks among SMEs in Chinese Manufacturing Sectors

Session 8E

Research Background

Having been extremely proactive in making policies and initiating investments on national-wide innovation development in recent years, the Chinese government endeavors to upgrade its national position in the global production system from a low value-added manufacturer to a global leading designer and innovator. Significant efforts have been made by both central and local governments through thousands of tailored initiatives and programs, aiming to facilitate innovative development throughout the whole innovation system, from universities, research centers, to large and small businesses. As a result of the tremendous input, achievements could be identified in terms of the increasing number of academic publications, patents, and the growing amount of high-tech entrepreneurs. Despite the above identified changes based on figures, the underlying transition of innovative power in China's industries and markets is still unclear. Questions like whether the policy schemes could successfully stimulate the innovative development of Chinese companies, and whether the diffusion of advanced technologies from universities towards firms and between firms could be facilitated, are mysterious to academics and policy makers worldwide, since the changes of innovative capacity in Chinese firms would largely affect the structure of global production system.

Research Design

This research is designed to explore the fundamental changes among Chinese firms during the transitional period of institutional and innovation systems in recent years, by looking into the statues and dynamics of firm strategies and connections. In particular, the research targets on small and medium-sized enterprises (SMEs) in manufacturing sectors in Shanghai. Representing the majority of Chinese companies and the main force of global manufacturing base, SMEs, which are historically considered as low-tech and resource-intensive manufacturers (Liu, 2007), have been targets of multiple supportive policy schemes (Liu et al., 2011). The investigation on SMEs could reflect the fundamental changes in Chinese manufacturing sectors. Shanghai, as one of the pioneer cities in China in terms of institutional and innovative development, could provide the perfect location to explore the underlying and emerging changes taken place in China.

In order to achieve an in-depth understanding of innovation development among SMEs in Chinese manufacturing sectors, the research adopts the case study method. Semi-structured interviews are conducted with 34 SMEs managers, which are randomly approached in four manufacturing sectors in Shanghai, including intelligent hardware, medical device, equipment and auto-parts industries. Another 11 interviews were done with industrial experts and government officers. Two research questions are examined: 1) What are the innovation strategies among SMEs in Chinese manufacturing sectors? 2) How do SMEs with different strategies develop and reflect on the transition of innovation system? Research protocols are developed based on the theories of innovation strategies (Fagerberg and Srholec, 2008), ambidexterity (March, 1991, Baum et al., 2000, Smith and Tushman, 2005), and networking strategies (Lee et al., 2010), including questions covering the topics of firm innovation activities (technology and market dimensions), external relationships

throughout the product life cycle, identification of market dynamics and government support, as well as firm competitiveness and performance.

Research Findings

According to the theoretical understanding of organizational learning and innovation strategies and based on the case analysis, five original types of strategies are identified among SMEs interviewed across the four manufacturing sectors. The fundamental difference to categorize the strategies is the nature of firm innovation and knowledge creation process, referring to the dynamic of knowledge boundaries and the development of firm innovative capabilities. As shown in Fig. 1 (omitted, see attached file), the five types of strategies are labeled as "Exist", "Enhance", "Integrate", "Edge" and "Switch" respectively.

The Exist strategy features the pursuit to sophisticate existing knowledge, identified in SMEs focusing on the proficiency of production and service. The Enhance strategy refers to continuously expansion of knowledge boundary through intensive investments on R&D projects, identified in firms pursuing the advantage of innovative capability. The Integrate strategy represents the efforts on combining multi-disciplinary knowledge from different areas, by firms aiming to lead the dynamic of customer demands and the transition of conventional markets. The Edge strategy describes the absolute advantage of obtaining edge-cutting technologies, with which firms keep a close eye on the development and application of world-leading emerging technologies. The last type, the “Switch” strategy, indicates the shift of business focus from the existing one to a new one, which enables firms to enter into brand-new markets with new products developed.

In addition, the research identified that connections with various external resources are closely related to the adoption and dynamics of different innovation strategies. The adoption of “Exist” strategy results in close interaction with customers, and the “Enhance” SMEs proactively seek collaboration with universities. Endeavoring to collaborative innovation, the “Edge” firms are more independently competent, while the “Integrate” and “Switch” SMEs reply more on their partners. Through the collaborations with customers, universities and other business partners, technologies could be effectively diffused, which facilitates the transition and restructure of innovation systems.

In summary, despite of the traditional image of less innovative SMEs in Chinese manufacturing sectors, this research shows the emerging phenomenon of growing innovative capability of these firms, in particular, via five distinct types of innovation strategies. Furthermore, the research indicates the connections between SMEs and external networks could facilitate the diffusion of technologies and sheds light on the transition of innovation systems in China. The implications for business owners and policy makers are also discussed in the paper.

Feng Li and Li Tang

Does Transnational Capital Matter in China's Academic Recognition System?

Session 6B

Recruiting and retaining the global highly skilled is an integral part of China's national academic recognition system. In spite of a growing number of studies investigating overseas returnees, little attention has been paid to the catalyst role, if any, of transnational capital on their career advancement. Built upon a novel data set of Chang Jiang Scholars (CJS), this study examines if overseas experiences accelerate the speed of obtaining prestigious academic titles. We find that, all else being equal, returnee professors not only tend to obtain the CJS title within a shorter time period than locals after receiving PhDs, but they also do so at a younger age. The difference gap has not been enlarged over time. Our research also reveals that the types of overseas experiences matter: the disadvantage of domestic PhD degree holders winning the CJS title is not diluted if they pursue only post-doctoral training abroad. In addition, the premium of professors working at their alma maters suggests that strong intramural networks benefit scholars in their career development.

Meng-Hao Li

Linking Network Structures with Dyad Relations: Examination of the CTSA Program and Knowledge Transfer in Scholarly Collaboration Networks

Session 7D

In 2006, the National Institutes of Health launched the Clinical and Translational Science Awards (CTSA) program that aims to bridge the gap between basic science and clinical research. The University of Illinois at Chicago (UIC) is one of awarded medical research institutions that received the CTSA funding in July, 2008. With the funding, UIC established the Center for Clinical and Translational Science (CCTS) to facilitate translational process. This goal of article is to explore how the CCTS intervention affects knowledge transfer among scientists at UIC. Specifically, this article framed two levels of analysis to understand how the CCTS intervention (individual level), network properties (individual level; i.e. network size) and the nature of ties (dyad level; i.e. strength of ties, spatial proximity, and homophily of disciplines) affect knowledge transfer (dyad level) between two scientists. Knowledge transfer is categorized as three dependent variables, "provided clinical expertise", "provided methodological or theoretical expertise", and "integrated diverse methods or approaches." The hypotheses of this study are proposed below.

• H1: Scientists having a high degree of network connections are more likely to obtain knowledge.

• H2: A strong tie has a high likelihood of carrying knowledge in comparison with a weak tie.

• H3: Knowledge transfer is likely to occur between two scientists with different knowledge domains.

• H4a: Scientists who have a high level of absorptive capacity are more likely to increase knowledge transfer.

• H4b: Scientists who have a high level of absorptive capacity are more likely to increase a positive effect of the strong tie on knowledge transfer in comparison with scientists who have a low level of absorptive capacity.

• H5: Scientists connected within spatial proximity are more likely to increase knowledge transfer.

• H6a: CCTS participants are more likely to gain knowledge from their collaborators.

• H6b: CCTS participants are more likely to increase a positive effect of the strong tie on knowledge transfer in comparison with non-CCTS participants.

This study used data from the 2010 CCTS Annual Scientific Collaboration Survey to examine the hypotheses. The survey employed egocentric network research design with name generator and name interpreter questions to establish scientific collaboration networks. Name generator questions asked respondents to name five types of collaborators, UIC faculty collaborators, non-UIC faculty collaborators, postdoctoral collaborators, PhD student collaborators, and non-academic collaborators, with whom respondents have worked on a team to produce intellectual products in the past academic year. Name interpreter asked respondents to answer a set of questions for each collaborator such as their friendships, gender, age, disciplines, race, and types of collaborative activities.

The population of this survey include CCTS participants (n=938) and a random sample of non-CCTS faculty (n=499). The survey successfully interviewed 406 respondents and the response rate is 27.5%. As only school faculty is considered as non-CCTS users, students and staff were excluded from the analysis. One of the key research questions in this study is to understand the effect of spatial proximity on knowledge transfer. In order to identify respondents and their collaborators' locations, the respondents need to be faculty members affiliated with UIC for the comparison purpose. Non-UIC respondents thus were excluded from the analysis (n=308). In addition, this research attempts to know how network factors influence knowledge transfer between two scientists. The respondents who did not have collaborators were excluded from the analysis (n=230). Because of some missing values in the analytic variables, the final sample in the analysis includes 169 respondents and 1056 collaborative relationships. The Hierarchical Linear Modeling (HLM) is utilized to estimate the multi-level models.

The results indicate that those three types of knowledge are significantly different from each other. Their predictors exhibit inconsistent patterns across the estimated models. CCTS does not play an explicit role in facilitating knowledge

transfer among scientists. Because of dissimilar features of knowledge, the possible explanations of incoherent patterns of three types of knowledge transfer are addressed respectively.

First, a scientist's source of clinical expertise is likely provided by a collaborator who has a close relationship with the scientist, has a different discipline from the scientist, and is a faculty member from another school. As knowledge transfer theory stated, the strong tie benefits tacit knowledge transfer more than the weak tie does (Cowan, David & Foray, 2000; Krackhardt, 1992; Ruef, 2002). Collaboration is likely to occur when two scientists need to complement each other with heterogeneous knowledge domains (Casciaro & Lobo, 2008). However, the finding does not support the hypothesis H4a, showing that a scientist who has a high level of absorptive capacity is negatively associated with obtaining clinical knowledge. Absorptive capacity represents a scientist's capacity to assimilate and identify knowledge and is measured by the number of publications. It is likely that those scientists with high number of publications are less interested in clinical research but are more interested in basic research.

Second, in terms of "provided methodological or theoretical expertise", a scientist who has high degree of absorptive capacity is more likely to obtain methodological or theoretical expertise. The superior inherent knowledge and experiences will help the scientist to identify and assimilate knowledge from the collaboration (Cohen and Levinthal, 1990; Zahra and George, 2002; Van Wijk et al., 2008). Also, a scientist's methodological or theoretical knowledge is possible to be provided by a collaborator who is a UIC faculty and has a similar discipline as the scientist has. The spatial proximity hypothesis is supported in the model, suggesting that frequent in-person interaction at UIC can reduce communication costs and accelerate distribution of knowledge in collaboration (Hoekman, Frenken, and Van Oort, 2009; Ponds, Van Oort, and Frenken, 2007).

Finally, "integrated knowledge of diverse methods or approaches" seems to perform a more complex form of knowledge than "providing methodological or theoretical expertise". Because most scientists are trained with highly specific expertise, it may be difficult for them to find collaborators who can integrate diverse methods or approaches. Hence, only a few predictors can explain the outcome variable. A scientist's strong tie is more likely to transfer integrated knowledge of diverse methods or approaches. A scientist's UIC faculty collaborators are more likely to provide integrated knowledge of diverse methods or approaches in comparison with non-academic collaborators. Both findings support the strong tie and spatial proximity hypotheses (Cowan, David & Foray, 2000; Hoekman, Frenken, and Van Oort, 2009; Ponds, Krackhardt, 1992; Ruef, 2002; Van Oort, and Frenken, 2007).

Ning Li

Disciplinary Structure of China's National Research System: Evolution, Path Dependence, and Science Policy

Session 3E

An in-depth understanding of a nation's disciplinary profiles (such as areas of strength and weakness) is key to science policy-making, especially regarding strategic planning for resource allocation in research. Bibliometric studies have confirmed a general trend of convergence in the disciplinary profiles across nations (i.e, in Li, 2017). Meanwhile, an overall pattern of persistence in disciplinary structures is found in specific nations (Glänzel and Schlemmer, 2007) and regions (Radosevic and Yoruk, 2014).

The question remains as to how China's research system has evolved in its disciplinary profiles in the medium and long terms. China's significance lies in its position as a transition country into both the world's second largest economy and producer of academic publications. While literature in China's science policy is abundant (i.e., most recently, Cao and Suttmeier, 2017), most studies of the nation's research system have been focused on its efficiency and effectiveness rather than disciplinary structure. Thus, a holistic overview and analysis across disciplines in China is much needed.

The present study follows the tradition in bibliometric studies to trace and analyze the evolutionary patterns of China's national research system. Furthermore, this paper aims to advance the understanding of such evolutionary patterns through a historically oriented approach (see Fagerbery, Mower, and Verspagen, 2008) by taking into consideration social, institutional, economic, and policy changes over the history.

Our dataset is extracted from the Scopus database covering 4 main areas (physical, life, health, and social sciences) and 27 major disciplines for the period from 1996 to 2015. A nation's disciplinary structure is measured by the distribution of scientific publications across disciplines. The Finger-Kreinin Similarity Index (FKSI) is used as an indicator of the structural similarity between China's academic publications as compared to the global distribution of publications. The level of specialization for each discipline is measured by the Relative Specialization Index (RSI) and the level of dispersion among disciplinary specializations is calculated as the standard deviation of RSIs. Significance of the structural changes is tested through regression models.

Our bibliometric analysis confirms a clear and continuous process of convergence in China's disciplinary structure towards the world research profiles. The regression results reveal that this converging process has led to significant structural changes in China's research profiles. However, the rankings of China's disciplinary specializations have been fairly stable, demonstrating consistency in its peculiarities and preferences. For example, China has constantly been comparatively strong in all major fields of physical sciences but weak in areas of life, health, and social sciences.

We argue that the persistency in China's disciplinary structure can be mainly explained by path dependence in the evolution of the nation's research profile. First, much of China's R&D resources (best-trained personnel and ample funding) have historically been channeled into fields related to national security and defense. Second, a significant portion of research has been devoted to the national survey of natural resources. Third, research in life sciences and social sciences were largely damaged through political events, such as the dominance of Lysenkoism on China's genetics and the discontinuation of sociology programs in universities. Fourth, the imbalance between physical sciences and life sciences has been reinforced by China's institutional arrangements, i.e. the composition of the members of CAS and the disciplinary distribution of government research institutes. Fifth, China has broadly been following the so-called Asian catching-up model characterized by a strong concentration in physical sciences.

The converging process in China's research profile is largely related to changes in China's science policy and to the improvement of socio-economic environments. There has been a gradual and steady shift in the guiding principles of China's science policy, from concentration on prioritized fields to an overall enhancement in the nation's sustainable innovative capacity. Thanks to its rapid economic growth, China has been able to maintain a steep growth of investment in research and has launched a series of funding programs. We find that there exists a strong positive relationship between national funding in research and the level of structural similarity to the global research profiles.

References

Cao, C. & Suttmeier, R. P. (2017). Challenges of S&T system reform in China. Science, 355(6329), 1019-1021

Fagerberg, J., Mowery, D. & Verspagen, B. (2008), Innovation systems, path dependency and policy: The Co-evolution of science, technology and innovation policy and industrial structure in a small, resource-based economy, DIME Working Paper 2008.1, June 2008.

Glänzel, W. & Schlemmer, B. (2007) National research profiles in a changing Europe (1983–2003) An exploratory study of sectoral characteristics in the Triple Helix. Scientometrics, 70(2): 267-275

Li, N. (2017). Evolutionary patterns of national disciplinary profiles in research: 1996–2015. Scientometrics. doi:10.1007/s11192-017-2259-4

Radosevic, S. & Yoruk, E. (2014). Are there global shifts in the world science base? Analysing the catching up and falling behind of world regions. Scientometrics, 101(3), 1897-1924

Weichen Liu

How important is China location for young scientists?

Session 3B

This paper asks whether being located in China lowers research productivity in a data set of foreign-born, U.S. educated young scientists. China's great lead forward is intriguing. In light with the increasing share of Chinese PhD graduates, as well as the inflow of China-born, foreign-educated young scientists, many observers have questioned whether China's location is favorable for young scientists. Using coarsened exact matching, we investigate 1119 U.S. educated, China-born scientists funded by the Chinese Thousand Youth Talents Project in terms of their scientific output (measured by the number of publications), and scientific impact (measured by the number of citations), as well as the scientific direction (measured by novelty of keywords for published research).

The Chinese Thousand Youth Talents Project was launched in 2010 and primarily sponsored by the Organization Department of the Central Committee of the CPC. The program launches as a milestone in Chinese scientific funding system, aiming to bring in around 2000 STEM scientists back within five years. In particular, scientists funded by the project must return with full-time positions. Since its inception, it has successfully attracted around 2900 overseas scientists in eight waves during last five years. With a formal evaluation on policy effectiveness and a particular focus on the China case, this paper provides a great understanding on the career paths of mobile scientists and further opens the black box of policy incentives on knowledge creation.

However, a naive comparison of scientific productivity of funded scientists both before and after return is plagued by unobserved heterogeneity and endogeneity. The improvement performance of funded scientists might because of their inherent advantages when being exceptional selected. We try to separate the incentive results from the selection effects by constructing a matching group of 1119 China-born doctoral holders who received their PhD in the same University, field, gradation period and the same advisor (if possible), but without the Thousand Youth Talents Project funding and stay overseas. Our data contributes significantly to the data set that tracks the career paths of China-born, U.S. educated doctoral holders.

To summarize our results, we first find young scientists who remain in the United States are at an advantage in terms of publications, citations and research novelty compared with their compatriots funded by Thousand Youth Talents Project. This implies a negative self-selection of funded scientists. We also find that, on average, scientists funded by the Thousand Youth Talents Project leads to an improvement in publications and citations, but a downward in novelty. However, such a positive impact is not significant in the first two years after the return but start to be significant after this adjustment period. These results suggest that Chinese policy makers should not disregard the problem of current brain circulation strategies and critically reconsider the inflow of China born, U.S. educated scientists. More broadly, these findings have implications on the furtherance of mutual understanding on foreign related policies and make contributions on the future path of geographical dispersion in science. In particular, the China case offers a unique lens as the largest source country in international scientific mobility.

One caveat to the conclusions in this paper is that the social network with U.S. research environment of those foreign-born, U.S. educated young scientists, as well as the alumni contact of those funded returnees might influence their productivity. In our future research, we will consider the network effect. Much more could be done to explore the impacts of incentives on scientific productivity in this setting. For example, does the inflow of China-born, U.S. educated scientists foster the scientific productivity of their native counterparts or has a crowd-out effect to the Chinese scientific system? It is important to continue expanding the research agenda on researcher mobility, and particularly on the effects of mobility, to support a more evidence-based policy design of incentive mechanisms to stimulate and attract researchers from abroad.

Susan Losh and Fang Yang

No More Monkey Business or Horoscopes: Factors related to General Public Adult Perceptions of Agreement among Environmental Scientists on Global Warming

Session 5C

NOTE: Selected references and tables are in the pdf attachment

Vaccination, evolution, and climate change "skeptics" share some common ground: through anecdotes, scripture, or even fraud, they deny systematic science methods and findings. All three also have dangers. Lower vaccination rates contribute to restricted epidemics, e.g., measles in 2015 California. By encouraging adherents to "find their destinies in the stars," astrology can promote passivity. Those experiencing blizzards or coastal flooding know the first-hand effects of global warming. American perceptions of climate scientists as divided on whether global warming exists, its extent, its causes, or possible solutions can justify poor international cooperation, homeostasis or even increases in fossil fuel consumption, and delays in necessary ameliorative actions.

This study examines factors related to 2006 and 2010 general public adult perceptions of environmental scientist consensus on global warming using the National Science Foundation Surveys of Public Understanding of Science and Technology ("the NSF Surveys") collected by the General Social Survey (GSS, Smith, Marsden, & Hout, 2015). While climatologists became virtually unanimous on anthropogenic global warming (e.g., Powell, 2015), adult general public estimates on agreement among such scientists fell. Those seeing considerable science agreement dropped from 42 (2006) to 36% (2010), while those perceiving little or no agreement rose from 15 to 21% over that time .

We compare relationships between perceived climatologist agreement and educational variables with more cultural factors, such as religion, pseudoscience beliefs, or politics. Considerable data illustrate disproportionate male and Asian representation in physical science and engineering (National Science Board, 2016). After the Kitzmiller, et al. v. Dover Area School District decision (e.g., Goodstein, 2005), at least some reports link presenting classroom alternatives to evolution to also challenging research on climate change (e.g., Plutzer et al, 2016) thereby avoiding separation of church and state issues.

Most of these factors were similar in 2006 and 2010; however primary sources of science and information technology (S&T) information changed. GSS respondents with home Internet rose from 64% to 74% over that time and estimates of adults referencing the Web for S&T information rose from 23 to 40 percent ($X2(1) = 53.5$ $p < 0.001$). It has also been argued that "social identity politics" in recent years have rendered science beliefs more politicized (e.g., Iyengar, Sood, & Lelkes, 2012). Indeed, Hamilton et al. (2015) find that a political partisan gap in trust about science widens with education.

Methods

Participants and Measures: The 1403 total respondents were from the 2006 (n=928) and 2010 (n=475) NSF Surveys, face to face interviews through the GSS. We analyze the SCIAG ("AGREE") item, which explicitly addressed perceived agreement on global warming among climatologists with a five point scale anchored by "nearly complete agreement" to "no agreement at all" (see Appendix A for science questions used.)

We examine study year, gender, ethnicity, degree level (less than high school through graduate school), the number of high school science courses (0 to 3) , and whether adults rated human evolution as true or false. Possible cultural correlates included whether the person considered themselves a born again Christian, if they rated astrology as very or somewhat scientific (coded 0) or not scientific at all ("1"), whether they gleaned S&T information from the Internet, and general political party (coded 0 for Strong Democrat to 6 for Strong Republican). Case losses on some items (e.g., 2.6% on party identification; 1.0% on perceived agreement) make the maximum possible total cases 1385 combined for both years and 1017 for multivariate analyses with listwise deletion.

Results

Table 1 shows the drop in perceived climatologist agreement on global warming from 2006 to 2010. Drops occurred in both the "4" and "5" high categories. Table 2 presents multiple regression results of study year, gender, Asian ethnicity,

being “born again”, degree level, high school science exposure, evolution belief, astrology rejection, accessing Internet S&T, and political party on perceived agreement. Even after entering potential mediators, 2010 respondents still perceived lower climatology agreement than those in 2006. The better educated, Asian-Americans and evolution supporters—as well as born-again Christians—attributed more agreement to climatologists. Republicans, respondents who rejected astrology and those obtaining S&T information off the Internet perceived less scientist agreement. Political party identification and degree level were the strongest predictors, although the overall explained variance was relatively low.

Discussion and Implications

Somewhat to our surprise, educational variables, excepting degree level, had limited utility. We did not expect that astrology rejecters, whom we had expected to be more knowledgeable, would also reject climatologist agreement. Perhaps these adults are generally more skeptical. Conversely “born again” adults may be generally more optimistic, including perceiving greater scientist agreement on global warming. We plan to analyze these variables further, e.g., with some of the GSS trust variables.

One reason for the drop in perceived scientist agreement over a relatively short period may lie in the mixed climate change messages Americans receive. Classroom teachers (Plutzer, et al., 2016) and television weathercasters (Wilson, 2009) often underestimate the near unanimity among environmental scientists on global warming (Powell, 2015). Unfortunately the Web compounds the problem; some sites among the vast number where “news” is available obfuscate science with opinion (Del Vicario, et al., 2016.) The rise in “social identity politics” also may polarize science comprehension and undermine trust in science (e.g., Hamilton et al., 2015; Leiserowitz, et al., 2013) in ways that Hunter (1991) suggested for “culture wars.” When weathercasters, pundits and politicians declare climate change a hoax or analogous to endorsing a “flat [not to mention 5500 year old] earth” (e.g., Lewandowsky, et al., 2013; Shuham, 2016; Wilson, 2009), rejecting science findings has portentous implications for national policy that researchers—and citizens—ignore at their peril. The results here remind us that the nature of public understanding of science can be multidimensional and complex, as are its possible contributions to public policy. Implications for science education and communication are discussed.

Mariano Macedo

The Demand-side Innovation Policies in Brazil

Session 7A

Traditionally, innovation policies have been more closely associated with supply-side instruments (credit lines and financing in favorable conditions, economic subvention, tax incentives for research and development, funds for the infrastructure of scientific and technological institutions, incubators and technological parks, etc.). However, both in Brazil and overseas, demand-side innovation policies have been increasingly adopted.

These policies rely on instruments that encourage increased expenditure on R&D, the diffusion of innovations and

the abandonment of obsolete technologies by (i) steering government procurement towards innovative products

and services, with a view to achieving strategic goals of public policies (social, environmental, industrial, regional development, foreign trade, etc.); (ii) defining new requirements for products and services (e.g., standardization, energy efficiency levels and local content requirements in terms of RD&I); and (iii) promoting interaction between users and producers of innovation, in addition to other objectives.

Several relatively recent initiatives of the Federal Government of Brazil can be classified as demand-side innovation policies. The purpose of this article is to put the theme of demand-side innovation policies on the agenda for discussion on ST&I policy in Brazil and emphasize the importance of systematizing information regarding the use of this type of policy.

This systematization has been conducted in accordance with the different types of instruments that characterize each of these policies (government procurement, standardization, regulation, systemic or cluster policies, and others).

The following federal government initiatives deserve to be highlighted:

- Government procurement based on an additional margin for manufactured products and national services resulting from the development and technological innovation achieved in the country. For example, domestic medicines that include in their formulation drugs wholly produced in Brazil, domestic hi-tech medical products, domestic information and communication technology equipment, domestic executive aircraft and licensing for the use of computer programs and services developed in the country;

- Government procurement and incentives for technological innovation by micro and small companies;

- Employing goods, services and undertaking public administration works in compliance with sustainability criteria and practices, such as using innovations that reduce pressure on natural resources;

- Government procurement of foodstuff for the National School Meals Program (PNAE) directly from family farms (especially land reform settlements, traditional indigenous communities and quilombos or former slave communities), with pre-set quality requirements and priority for organic and/or agroecological food production;

- Use of procurement power in the Economic and Industrial Health Complex: support for public laboratories and Product Development Partnerships (PDP). PDPs are partnerships between public institutions and private firms to enable access to priority technologies and make the public health system less vulnerable, with a commitment to internalizing and developing new technologies for strategic healthcare products;

- Government procurement of local content, technological development and innovation associated with the Defense Industrial Base (DIB);

- Regulation of local content, R&D expenditure and expenditure on engineering, basic industrial technology and training for suppliers through the Program for Incentives for Technological Innovation and Consolidation of the Motor

Vehicle Production Chain;

- Incentives provided by the Law of Computer Technology and Automation regarding R&D and local content requirements;

- Requirements for local content and R&D in the Oil and Gas Chain; and

- Purchase of technology to resolve specific technical problems or obtaining innovative products and processes through the structuring of Knowledge Platforms.

As can be seen, Brazil demand-side innovation policies, in the context of a late industrialization process, are characterized not only as specifically R&D-based innovations but also as instruments for providing incentives for strategic segments to catch up their production structures. This refers particularly to local content strategies and the emergence of economic segments with high degrees of technology (strategic healthcare products, information technology and communication, the industrial defines base, motor vehicle production chain, pre-salt layer oil and gas chain, and others).

Pauline Mattsson, Stephanie M Wood and Katarina Nordqvist

Organizational practices around technology transfer - perceived barriers and enhancers

Session 7E

Relevance and aim of the study

The utilization of university discoveries through commercialization or diffusion of knowledge benefits society and drives economic growth. As a response to their increasing importance in the regional and national innovation system universities have set up specific infrastructure around technology transfer units, often under the name of technology transfer offices (TTOs). Much literature on TTOs has focused on productivity using indicators such as disclosures, licenses, patents, spin-offs and industry collaborations and to identify factors that influence these outputs (see Rothaermel et al., 2007 for an overview). Since universities vary in size, resources, scientific focus, location and human resources it is difficult to make direct comparisons between universities, and many researchers view technology transfer and the role of the TTO as a complex process. Individual university TTOs may focus on different aspects of the process which could explain some of the variations in TTO output across universities. Earlier literature has often been limited to study TTO strategies when it comes to the legal aspects and overlooked other organizational routines along the commercial pathway (for an exception see for example Siegel et al., 2003). To further understand the role of TTOs within the innovation eco-system this study will therefore investigate current technology transfer strategies employed by TTOs and routines in place to implement these strategies.

The extent to which a TTO develops entrepreneurial competence is influenced by the willingness of academics to commercialize their results (Pries and Guild, 2011) and to utilize the TTO to do so. A stream of literature has identified that a share of academic entrepreneurship is carried out outside the formal university IP system (Balconi et al., 2004; Fini et al., 2010; Meyer, 2003; Saragossi, 2003; Thursby and Thursby, 2007). In addition (Siegel et al., 2004, 2003) find that TTOs provide little incentive for faculty involvement and that researchers have difficulties in negotiation and transacting with the TTO (Link and Siegel, 2005). These findings suggest that a number of barriers exist along the technology transfer pathway.

Previous studies have interrogated the motivations and opinions of researchers or TTOs (Abrams et al., 2009; Aldridge and Audretsch, 2011; Di Gregorio and Shane, 2003; Fini et al., 2010), but have not directly compared the two groups of actors, whose interactions are critical for successful technology transfer from universities. Hence, the second aim of this paper is to identify perceived enhancers and barriers (researchers and TTOs) when it comes to technology transfer. This will provide insights into the human factors that are inseparable from the innovation process.

To shed light on the effects that institutional differences might have on different strategies but also perceived enhancers and barriers, we study TTOs and researchers in two highly innovative countries, namely Sweden and USA. These two countries differ in the regulations governing inventor ownership at universities. US universities own the rights to inventions made by researchers, who have to disclose inventions to the university technology office according to the Bayh-Dole Act. In contrast, Sweden is in favor of inventor patent ownership (Professors privilege or Teachers' exemption), meaning that publicly funded research is owned by the individual researcher and not the institution where the research is carried out. These differences are expected to provide different incentives to universities and inventors (Freeman and Lundvall, OECD report).

The results from this study will provide further insights how universities can improve existing routines when it comes to translation and enhance the process of commercialization of ideas originating from academic research.

Previous research

Earlier studies have suggested that TTOs are not necessarily driven by profit making. Feldman and Desrochers (2003) studied John Hopkins University and explained the limited visible economic benefit by the fact that it was never one of the university's objectives. In a 2009 survey, only 11.5% of TTO managers ranked revenue maximization as their most important driving factor (Abrams et al., 2009). Thus, TTOs are involved in other activities not covered by output metrics generating profits such as patents, spin-offs and licenses. Also organizational differences exist resulting in TTOs

engaging in different activities. Bercovitz et al. (2001) found that universities that have high interactions with industry often apply a decentralized model of technology transfer where responsibilities for transfer activities are located close to research groups. Other strategies identified to increase industry engagement include the offering of incentives (Debackere and Veugelers, 2005; Derrick, 2015; Friedman and Silberman, 2003); education programs (Hatakenaka 2006); active participation of university inventors (Markman et al., 2005); visibility and flexibility to adapt to researchers need (Derrick, 2015).

According to contingency theory there is no best way of structuring and organizing since the optimal organization depends on various internal and external constraints (Lawrence et al. 1967, Burns and Stalker 1969). In this study we investigate how environmental and institutional differences may affect TTO strategies and the routines around the technology transfer process. In the context of university technology transfer, there has been little research on the possible contingency effects of particular institutional structures or organizational processes. Using contingency theory we will illustrate how both external and internal factors influence TTO strategies and organizational practices and how these in turn affect the output of TTOs.

Material and methodology

We combine quantitative data and interviews with star scientists and senior staff of technology transfer organizations in both Sweden and USA. Semi-structured interviews were carried out in the field of biomedicine. Open-ended and targeted questions were asked, covering the development of the innovation system/TTO, major activities, interactions with industry and university inventors, and perceived blockers and enhancers of the commercialization pathway. The focus on star scientists can be justified by the fact that they differ from ordinary scientists in several ways: they publish more articles, are cited more often, apply for more patents, and obtain greater funding (Azoulay et al., 2014; Cole and Cole, 1972; de Solla Price, 1963; Zucker et al., 2001; Zuckerman, 1977, 1967). The quantitative data included information regarding number of disclosures, patents, licenses, spin-offs, R&D investments from both private and public sources. The US data was mainly compiled from the Association of University Technology Managers (AUTM) database and annual reports but also from the interviews, as for the Swedish data the main sources were annual reports, UBI Global and data from interviews.

Outcomes

We found that structural differences exist between TTOs in US and Sweden. These differences can mainly be explained by regulatory differences due to the Bay-Dohle Act in the US and the teacher's exemptions in Sweden. In the latter the innovations system is scattered with many actors involved in the translational process. Support mechanisms such as outreach to researchers, innovation advice and corporate alliances were mainly taking place within the university system while activities and support related to start-ups and licensing were mainly taking place within external organizations in the form of holding companies. The US system was less scattered with TTOs carrying out activities also related to commercialization.

Based on our interviews and earlier literature we identified seven mechanisms/activities that TTOs can be involved in during the translational process and on which they build their business model and activities around. Our qualitative data showed that the intensity to which TTOs are involved in the different mechanisms can rather be explained by contingent factors such as resources, entrepreneurial culture, and the external entrepreneurial environment than by regulatory factors that are unique for a specific national innovation system. With one exception, in accordance with earlier literature we find that US TTOs favor licensing to established firms rather than startups, whilst in Sweden there is rather a focus on university startups while licensing activities are limited. Further, we link identified strategies with quantitative output data and find that there is not always a direct linkage between organizational practices/business models/strategies and the number of disclosures, licenses, patents, spin-offs and industry collaborations.

Lastly in our preliminary results we find that the perceived barriers and enhancers when it comes to the translational process differ between actors within the university system. Researchers consider good science an important factor when it comes to enhancing the innovation performance while TTO personnel point out that "successful" innovations do not necessary have to be based on great science. While researchers in US consider the TTOs an enhancer Swedish sees the teachers' exemption as an enhancer to the translational process.

We can conclude that the organizational practices and the outcomes from TTOs is thus contingent on a complex set of

organizational, cultural and environmental factors that should be taken into account when comparing and evaluating the performance of universities involvement in commercialization. In addition, TTOs are involved in other activities not covered by output metrics generating profits such as patents, spin-offs and licenses.

Jon Mikel Zabala-Iturriagagoitia, Charles Edquist, Javier Barbero and Jose Luis Zofio

Assessing the performance of national innovation systems in Europe

Session 3E

To support the establishment of the European Innovation Union, the European Commission is using the Innovation Union Scoreboard (IUS) as a tool to monitor the implementation and to examine the innovation performance of European member states and evaluate (and rank) their research and innovation systems. To assess the innovation performance of the member states, a Summary Innovation Index (SII) is provided by the IUS. The SII includes 25 indicators, which are equally weighted. According to this single synthetic composite indicator Denmark, Finland, Germany and Sweden are the innovation leaders (i.e. more than 20% above EU average) within the EU. The SII is formed by calculating the average of all 25 indicators.

We argue that synthetic or composite innovation measures such as the one provided by the IUS (i.e. SII) are highly misleading. In this paper, the performance of EU28 national innovation systems are analyzed from an efficiency perspective by using exactly the same data as those provided by the IUS for year 2015. The innovation performance in efficiency terms is measured as the relation between the inputs and the outputs. This efficiency analysis is carried out using Data Envelopment Analysis (DEA) following the contribution by Chen (2012),[1] who corrects for rank reversal problems through the use of ideal and anti-ideal decision making units. From this point of view, innovation systems are depicted as technically more or less efficient transformers of inputs into outputs.

Following Edquist and Zabala-Iturriagagoitia (2015),[2] and using the data provided by the IUS for year 2015, we depart from a standard model with 4 inputs[3] and 8 outputs.[4] The overall mean of the calculated technical efficiency for the EU28 countries studied for year 2015 was 0.702 (std. 0.265 and typical error 0.05). Our results reveal that eight countries had highly efficient innovation systems: France, Cyprus, Luxembourg, Spain, Greece, Romania, Malta and Bulgaria. We show that many countries which devote fewer resources than the innovation leaders, achieve outstanding levels of efficiency and, contrary to what the IUS predicts, countries with consolidated innovation systems, do not show efficiency levels commensurate with their expected competitiveness.

In order to avoid any potential flaws that may derive from the selection of the 25 indicators included in the IUS, we have completed all possible DEA models considering the 25 IUS indicators. As a result, we

[1] Jin-Xiao Chen (2012) A comment on DEA efficiency assessment using ideal and anti-ideal decision making units. Applied Mathematics and Computation 219: 583–591.

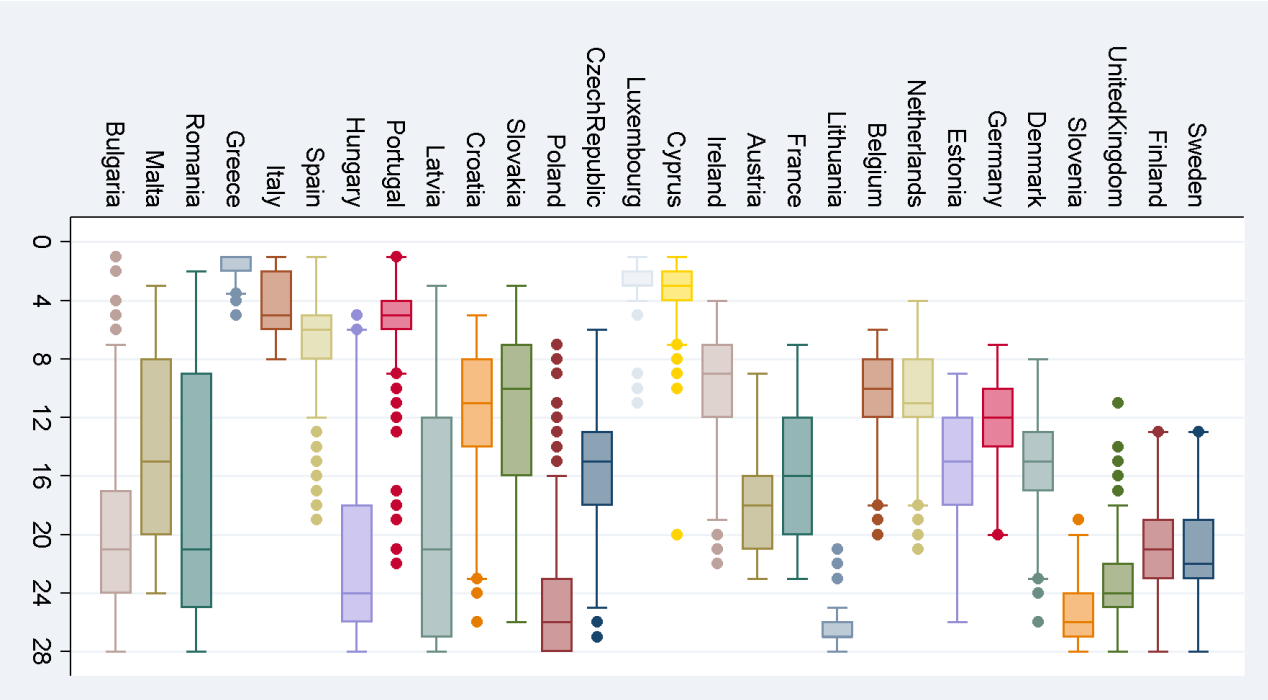
[2] Charles Edquist and Jon Mikel Zabala-Iturriagagoitia (2015) The Innovation Union Scoreboard is flawed: The case of Sweden – not being the innovation leader of the EU. Papers in Innovation Studies - Paper no. 2015/16. Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University, Sweden.

[3] The four input indicators considered are: Public R&D expenditures, Venture capital investments, Business R&D expenditures, Non-R&D innovation expenditures.

[4] The eight output indicators considered are: SMEs innovating in-house, Community trademarks, Community designs, SMEs introducing product or process innovations, SMEs introducing marketing or organizational innovations, Contribution of medium and high-tech product exports to trade balance, Knowledge-intensive services exports, Sales of new to market and new to firm innovations.

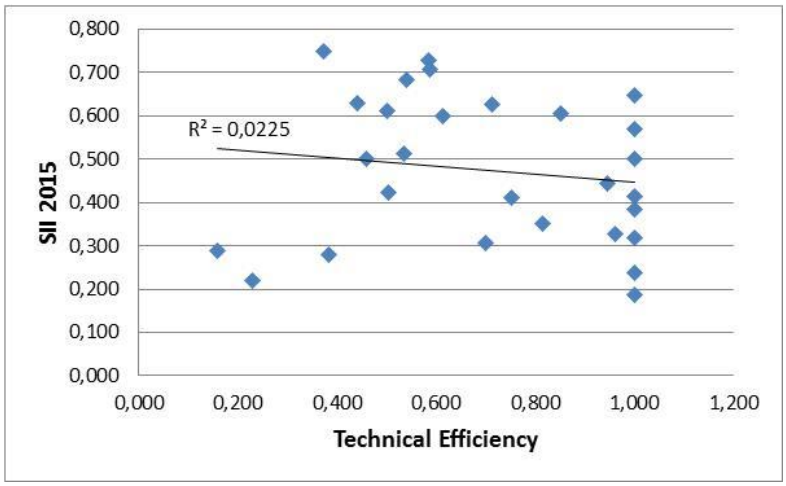
consider that the minimum model that can help characterize an innovation system with the IUS indicators should have 2 inputs and 3 outputs, while the model with the maximum amount of indicators would be that with 7 inputs and 12 outputs. This gives us the possibility of generating combinations with 7-2 = 5 inputs and 12-3 = 9 outputs. This implies that we have 32 possible combinations of inputs and 512 possible combinations of outputs. This gives us a total of 16,384 combinations to be solved. The figure below provides a summary of the distributions achieved in the rankings (from 1 to 28) of the EU28 Member States after computing all these models. These results are coherent with the standard model suggested by Edquist and Zabala-Iturriagagoitia (2015) of 4 inputs and 8 outputs.

Figure 1.- Ranking in innovation performance of EU28 Member States



If the technical efficiency is compared with that provided by the SII, which according to the IUS, measures innovation competitiveness of European countries, we should expect a 45º line, since, if the two performance indicators coincided, the majority of points (i.e. Member States) would be located along the 45º line. However, the relationship between the two indices points to a negative relationship between the two, in such a way that the rankings with both approaches seem to be reversed. The negative relation of these indices must result from their different conceptual settings, since the measures employed in both cases are the same. While the SII is created as a measure mainly oriented to the inputs in the system in the sense of 'the more the better', the efficiency measure refers to the how these resources are used relative to a particular output.

Figure 2.- Relationship between technical efficiency and SII[5]



Even if the "innovation leaders" of the EU may be regarded as comprehensive in many aspects, the results indicate that their efficiency levels are far from being adequate. The innovation leaders, generally speaking, invest vast resources and still do not manage to produce as much outputs as other countries. The results we obtained might perhaps be explained by the complexity of innovation processes and thus the need to coordinate the activities promoted by innovation policies. Those countries with higher R&D expenditure levels, and which have a long tradition in the implementation of science, technology and innovation policies, tend to support new growth industries which imply higher risks in their innovation policy proposals. As a result, the innovation systems in these countries devote more inputs, which despite render the systems very dynamic, the high levels of coordination required and the uncertainties involved reduce their levels of efficiency. Similarly, those territories with lower absorptive capacity and fewer resources, adopt the embodied knowledge and the innovations of others, which involve lower levels of development and at the same time produce more efficient behaviors since risk is avoided and the 'new' knowledge is rapidly adopted. It also to note that the countries with fewer resources to invest have to pay much more attention to how they are used. They cannot afford to squander the scarce resources dedicated to innovation activities. Their more cautious behavior produces unexpected and unforeseen efficiencies.

From a quantitative perspective, the approach followed by the IUS seems to offer a partial view of the actual state of innovation systems. We have shown that the use of these indicators within different methodological frameworks yields differing, but not necessarily contradictory results. Thus, they provide a partial picture of the phenomenon being examined; different approaches should be seen as being complementary. Therefore, policy makers will need to consider the results of different and complementary analyses to obtain a comprehensive picture of their respective innovation system. From our point of view, the sum of each partial view will provide a clearer picture than that provided by each in isolation.

[5] The values reported in Figure 2 for the technical efficiency represent the average value of all 16,384 combinations for each country.

Torger Möller

From Government Research to Higher Education Research – The International Shift in Public Research Funding

Session 3E

Introduction and research questions

National public research systems can be generally divided in two sectors. On the one hand, there are higher education institutions and on the other hand are government research institutions. Both sectors conduct a wide range of blue sky or applied research but have also other tasks. The higher education institutions are dedicated to tertiary education and provide qualified human resources to the business sector and the broader society. In addition, the higher education institutions reproduce the science and research system. The government research institutions can have other special objectives. They provide mayor scientific research infrastructures, which could not be run by a single university. They support public authorities and bridge the gap between academic and business research and development.

Over the last decades an international and substantial change in national public research systems took place. In the 1980s the overall expenditures on research and development (R&D) of the OECD countries have been considerably larger in the government sector than in the higher education sector. Since the beginning of the 1990s the overall R&D expenditures for the higher education sector exceed those for the government sector and the gap between both is constantly growing. Today, in almost every OECD country the shift in public research funding from government research to higher education research is observable.

The overall trend raises several questions: What are the reasons for the shift in public research? What are the underlying changes in national science policies? How can this trend and the differences between the OECD countries be explained? Are there performance differences between those countries, which concentrate their funding in the higher education sector and those which focus also on the government sector? What effects can be observed on an institutional level?

Methods

For answering these questions different data were inquired. First we focus on 19 OECD countries which have valid data reporting since 1981. Second, we investigated OECD data and EUROSTAT data on R&D expenditure, funding sources, research personnel and other information. Third, the performance was analyzed by a bibliometric study on an in-house database of the Web of the Science (WoS) and Scopus that is hosted by the German Competence Center for Bibliometrics. Beside a publication and citation analysis on a country level we also explored partly self-cleaned institutional data and secondary institutional bibliometric data from the Scimago Institutional and the Leiden Ranking. Forth, the changing process of the national science policies and their measures over time were inquired by some case studies. In the end we connect both data sources and findings in a comparative analysis.

Some preliminary results

95% of the OECD countries have increased their R&D expenditures in the higher education sector in proportion to the R&D expenditures in government sector. Only in Germany is a slightly decrease observable. In 1981 Germany belonged to those countries with a relative high share of public R&D expenditures in the higher education system. Today Germany is amongst the countries with the highest share in R&D expenditures in the government research sector. In contrast, Denmark shows a remarkable shift towards the higher education system over the last decades and today more than 94% of the public R&D expenditures concerned the higher education sector.

By comparing the countries three basal and interconnected drivers towards a growing importance of higher education research can be pointed out. (1) In some cases the reform of the public funding systems was caused by broader policy concepts. For instance, the policy of privatization in Great Britain affected also the public research system and reduced the government research sector since the 1980s in several waves. In Denmark mergers were a broad policy instrument not only in science policy. The government research institutions were included step by step into the higher education system.

(2) The government research institutions have to legitimate themselves via complementary tasks compared to those of the higher education system (e.g. running great research infrastructures). If the productivity and efficiency of research as well as the complementarity are questioned, the government research institutions become easily an object of science policy restructuring measures. Great Britain and Denmark provide various examples.

(3) Over the decades the national and international competition between the higher education institutions has risen steadily and national and international higher education rankings made the performance of public research visible for the science policy makers and a broader audience. The low performance of French and German universities was discussed in both countries under the term “Shanghai-Shock”. In contrast to the government research sector the essential role of the higher education institutions is providing tertiary education and preserve them from cut-backs. Two ways of strengthening the research in the higher education system were observable in our case studies. (a) One way is to strengthen the higher education institutions by setting up different science policy measures (e.g. performance based funding systems, Excellence Initiatives). (b) Countries with high performing government research institutions attempt to improve the performance of higher education research by fostering stronger collaborations with good performing government research institutions (France, Germany). A bibliometric co-publication analysis for German institutions shows a growing amount of collaborations between both sectors that helps to improve the higher education performance.

Cheryl Moses

How does eco-innovation in the manufacturing sector contribute to environmental sustainability? Findings from the South African National Business Survey

Session 1

Emissions of carbon dioxide and other greenhouse gases are changing the earth's climate, potentially imposing a significant global cost that will fall disproportionately on the poor. South Africa is a contributor to greenhouse gas emission and is particularly vulnerable to the effects of climate change to health, livelihoods, water and food, with disproportionate impact on the poor, especially women and children. The impact that climate change exerts on South Africa is already evident in the marked temperature and rainfall variations and rising sea levels. Industry and households need to adapt to these changes by reducing their negative impact on the environment.

The country suffers from a number of developmental challenges that should be addressed in a manner that ensures environmental sustainability and builds resilience to the effects of climate change, particularly in poorer communities. In order to support the development of a more sustainable society and the transition to a low-carbon economy, investments have to be made in skills, technology and institutional capacity. The key to reconciling the continued development of mineral endowments, with the goal of building a low-carbon economy, is a reduction in scope 2 emissions. The South African National Development Plan 2013 proposes a number of manners in which most industrial sectors would be able to achieve this:

- Introducing more energy-efficient and less carbon-intensive industrial processes within the sector.

- Increasing the contribution of renewable energy to electricity generation.

- Reducing the carbon footprint of existing and planned coal-powered power stations through retrofitting, clean coal technologies and investigating the financial and environmental feasibility of carbon capture and storage technologies.

Manufacturing industries have responded to the ever growing environmental concerns by showing greater interest in sustainable production and adoption corporate social responsibility initiatives. The results presented here examine how innovative manufacturing enterprises have embarked on eco-innovative initiatives and how they contribute to sustainable manufacturing.

The results represented in this study were obtained from data extracted from the data set of the South African Business Innovation Survey 2010- 2012 (BIS2010-2012). The BIS2010-2012 was based on the guidelines of the OECD OSLO Manual (OECD, 2005) and more specifically, the methodological specifications for round four of the Community Innovation Survey (CIS 4). The survey design was also informed by the structure of the Business Register of Statistics South Africa, from which a random stratified sample was drawn. The results presented here are not intended to represent the entire population, but only the realized sample of 328 manufacturing enterprises that responded to the survey. The generated statistics are thus purely descriptive. Firms were asked about their contribution to environmental sustainability through questions on their eco-innovation contribution.

About 43.9% of innovation active enterprises reported reducing energy use per unit output, of which 20.4% were enterprises in the Food Products, Beverages and Tobacco sector. Almost 40% of innovation active enterprises reported a reduction in the CO2 footprint due to innovative products. The Food Products, Beverages and Tobacco sector again shows the highest number of enterprises reporting this (20.7%) followed by 17.2% of innovative enterprises in the Refined Petroleum sector and 14.9% in the Basic metals, fabricated metal products, machinery and equipment sector. The Basic metals, fabricated metal products, machinery and equipment sector had the highest percentage of innovation active enterprises (17.5%) reporting on material gains through innovative products. A reduction in soil, water, noise and air pollution was also reported by 26.3% of innovation active enterprises in this sector and 22.1% reported recycling of waste, water or materials as a direct result of innovation implementation.

The aftersales benefits of innovation implementation are also important for environmental sustainability. Energy saving innovations affecting the customer/end user was reported by 32.3% of manufacturing enterprises. This was most prominent in the Basic metals, fabricated metal products, machinery and equipment sector (23.6%). Improved recycling of products after use, was reported by 27.8% on innovation active enterprises of which the Food Products,

Beverages and Tobacco sector enterprises was most prominent (24.1%).

Manufacturing enterprises also introduced some of their innovations as a response to voluntary codes or agreements for environmental good practice in the various sectors (29.6%), existing environmental regulations or taxes on pollution (19.7%) or regulations or taxes to be introduces in future (16.6%). The availability of government grants, subsidies or other financial incentives also play a role in the decision to introduce eco- innovations, but only 8% of innovation active enterprises reported this. The market demand from customers is also a driver of the implementation of eco-innovations (26%).

The results show that most innovative manufacturing enterprises did not report eco-innovation. The Food Products, Beverages and Tobacco sector, the Refined Petroleum sector and the Basic metals, fabricated metal products, machinery and equipment sector have the highest share of enterprises indicating involvement in eco-innovation activities. There is a definite eco-innovation gap that suggests a lot of untapped potential to improve eco-innovation performance in the South African manufacturing sector. The policies and strategies that the South African government has put in place is an indication of the efforts to contribute towards sustainable development.

Kazuyuki Motohashi, Kenta Ikeuchi, Ryuichi Tamura and Naotoshi Tsukada

Measuring science intensity of industry by using linked dataset of science, technology and industry

Session 7E

This paper presents new indicators measuring science intensity of industry, by linking scientific paper database (Science), patent information (Technology) and economic census data (Industry) in Japan. The new indicators reflect interaction between science and industry, via academic patenting activities, which cannot be measured by an existing indicator of science linkage, non patent literature (NPL) citations by patents. As an academic sector gets involved with patenting activities more, its scientific knowledge becomes to be used by industries, which were not categorized as science based ones. In addition, it is found that more scientific knowledge is used for industrial innovation over 10 years, across all academic discipline. Our study reconfirms that public support to science is an important policy to promote industrial innovation.

Molly Nadolski, Tom McDermott, Sara Farley, Kathryn Bowman and Jill Carter

Aligning Stakeholder Incentives for More Systematic Solutions

Session 10A

The most pressing challenges we face today – from climate change to economic inequality – are complicated: they involve numerous actors, relationships, and contexts. Addressing these challenges requires not only discrete innovations, but also a stronger understanding of how the impact of these innovations will play out in the world around them. Systems analyses have the power to unpack these numerous actors and their relationships, allowing for more sustainable solutions with the potential for greater impact on the challenge at hand.

Recognizing the strength of these approaches, in 2015 The Rockefeller Foundation asked the Global Knowledge Initiative and the Georgia Tech Research Institute to develop a method to help the foundation apply systems analysis to complex social challenges. Our answer to this call was a two-year research effort to assemble the Assessing Innovation Impact Potential (AIIP) toolset. The toolset is a collection of 9 tools that enables decision makers to better understand the challenges in which they work and to uncover those solutions best poised for impact. The AIIP toolset measures the potential for impact of an innovation on a specific problem by examining the intersection and interactions between three systems: (1) the problem space of focus, (2) the system from which innovation is sourced (the innovation system), and (3) the context in which challenges and innovations intersect (the context). Furthermore, the toolset incorporates Futures Foresight to enable decision makers to find signals of the future in the present to consider how these three systems may change over time. More than 20 social sector organizations including Harvest Plus, USAID, Ashoka, R4D and others participated as reviewers and thought partners during the production and refinement of the toolset.

Since its completion, GKI and GTRI have piloted the toolset on a number of cases and with a range of organizations seeking to assess innovation impact potential in complex systems. Two of these pilots will be explored and contrasted in the presentation, one on economic exclusion in OECD cities and the other on urban food insecurity in and around Atlanta.

One of the first pilots conducted by GKI following the creation of the AIIP toolset was on the topic of economic exclusion in OECD cities. This urban economic exclusion occurs when segments of the population experience disadvantage and have little prospect for overcoming their situation. For example, because OECD cities generally attract jobs aimed at high-skilled labor and that exclude low-skilled labor, 8% of the labor force living in these cities experiences unemployment. Our analysis examined how the scope of these structural constraints, such as segregation and municipal fiscal crises, serve to exclude entire population groups (e.g., ethnic minorities, youth, low-income families, women, etc.) from economic opportunity. The application of this toolset identified 14 areas for innovation on the challenge of economic exclusion in OECD cities, ranging from low-infrastructure approaches to transportation to new models of community ownership, and more. We then assessed the relative impact potential of these innovation areas by examining the system drivers that may enable or thwart innovation. These findings thus supported institutional decision making with regards to investing in innovations aimed at addressing economic exclusion.

In a second instance of application of the AIIP toolset, the GTRI team applied AIIP's systems approaches to challenges facing urban food systems in Atlanta. Currently, Atlanta's food system is characterized by inequitable food access and food insecurity, inequalities between farmers, food waste, and the high cost of urban-grown, fresh food. In their analysis, the team applied the toolset's Three Horizons method to identify an ideal future in which Atlanta's urban agriculture is characterized by a diversity of crops grown through a sustainable and diverse supply chain. Among the conclusions drawn from the pilot, the team found that as is the case with many social issues, addressing food security and urban agriculture cannot be tackled by one agency or organization alone. Rather, coordination between the local government in Atlanta, urban farmers, industrial actors, consumers, and other key stakeholders is essential.

Analysis and comparison of these two cases studies offers a number of insights about the utility of the toolset and the usability of it by various groups attempting to optimize decision making. First, the toolset offers a number of facilitated tools that gather together diverse actors from within a system to construct a shared depiction of systems under different conditions. Participants bring with them different backgrounds, objectives, perspectives on innovation, and values. For example, while consumers may desire strict regulations on food quality for protection, these same regulations may hurt the ability of smallholder farmers to survive the industry. How these viewpoints collide

constructively is shaped by the nature of the tools themselves and the decision of the facilitator in terms of how much depth to pursue. Second, through the application of our toolset on various challenges and innovation opportunities within different institutional settings, the team uncovered an important finding: collaboration and coordination between key stakeholders seeking to address the challenge is essential to produce a robust systems analysis. For example, the relative impact of various systems enablers and barriers on innovation can be judged to have greater or lesser meaning depending upon one's position in the system. The toolset's explicit method to organize and align these perceptions helps to create an analysis that best matches with shared organizational values. Third, determining the degree to which co-created systems insights shape organizational processes poses a number of questions regarding how best to remove bias, avoid too much complexity, and right size analysis to the organizational capacity to use it effectively for innovation decision making.

Maria Nedeva and Duncan Thomas

Assessing the Impact of Complex Policy on the Science System: the Research Excellence Framework and the British Universities

Session 3C

Much has been written on issues of the impact of science on economy and society ((Kostoff 1995; Donovan and Butler 2007; Orozco et al. 2007; Kelley et al. 2008; Meagher et al. 2008). While this literature has its merits, it tends to ignore a very important part of the relationships involving science, namely this between policy and science. In other words, the impact of policy on science, or the science system, is relatively under-investigated although there is some work on it.

In this paper we take a step towards unpacking the relationship between policy and the science by focusing on the impact that complex policy could have on the science system and the ways in which these policies are (could be) assessed through that. More specifically, we investigate the impact of the Research Excellence Framework (REF) in the United Kingdom on the British universities.

For the purposes of this paper we define the impact of a policy or governance tools as the change it produces in an object, i.e. as the change in an object that can be causally attributed to that policy or governance tool (Nedeva et al, 2013). This definition emphasises: 1) the notion of impact as attributable change; 2) the necessity to outline the changing object(s); and 3) the necessity to attribute change causally. Our definition is in accordance with other general definitions, e.g. the one by Becker (2001) who defines impact assessment as the process of identifying future consequences of current actions at individual, organisational or system level.

Complex policies, such as the REF for instance, can be reasonable expected to produce a complex set of impact. To be able to cope with these multiple and diverse effects (impact) we propose to use a typology that uses as points of reference the stated intentions for impact as read in the objectives of policy and funding schemes and whether this impact can be reasonably expected (from the point of view of the policy actor introducing the policy). These two dimensions outline four types of effects, namely 'straight runs', long shots', 'collateral' and 'accidentals' (Nedeva et al, 2013).

Expectations regarding intended and expected impact ('straight runs') and intended and unexpected impact ('long shots') can be identified through the stated objectives of policy and research funding scheme. Whether or not these intentions are realised depends on whether they are supported by the core practices and communicated clearly, on the one hand, and on how these are interpreted and used by the potential beneficiaries, on the other. Whilst 'straight runs' are intended and anticipated, the 'long shots' are effects that are intended but cannot be expected to occur with any level of certainty within a set time frame.

Unintended and expected impact ('collateral') is the 'collateral damage' that actors anticipate but cannot avoid because there are many social influences at play that the policy or funding scheme cannot control. Finally, unintended and unexpected impact ('accidentals') is very interesting as a possibility but difficult to measure. It can, however, be captured if an empirical object is studied exhaustively.

In this paper, we will identify a set of reported effects of the REF on British universities by analysing the findings reported by previous studies. For this, we will use a database of close to 400 research articles, reports and other research outputs. We will also conduct a longitudinal analysis of the REF rules starting in 1996 (this is the cut-off year when the rules of the REF, or the Research Assessment Exercise (RAE) as it was known then, started to become more elaborate). Following that the reported impact on British universities will be traced back to the core – and/or peripheral – objectives and instruments of the REF and attributed to a particular type of impact.

We posit that the overall impact of a complex policy that has multiple and varied effects would be 'positive' when, and only when, the 'straight run' and 'long shot' effects outweigh the effects that can be considered to be 'collateral' and 'accidental'.

We believe that this approach contributed to already existing approaches for assessing the impact of complex policy in the following important ways: 1) it deals with the research question directly rather than transferring it to the research object; 2) it shifts attention from the 'efficiency' question is assessing policy, namely whether the policy has achieved its objectives, to effects that go beyond these; and 3) it opens the objectives of policy to questioning.

Peter Neuhäusler and Rainer Frietsch

Patenting Computer-Implemented Inventions – Current Legal Situation and Economic Implications

Session 10D

Patents and other intellectual property rights are one of the pillars of every innovation system and provide substantial support for technology development and economic growth of national economies (Grupp 1998). When issuing a patent, the state grants the patent holder a temporary monopoly on the rights to utilize and commercialize a technological solution. In return, the patent applicant needs to publish all the information about the underlying invention. Proponents of the patent system emphasize the planning security, the clarity of the rules and the resulting incentives for innovation. Opponents of the system (or parts of it), on the other hand, state that the creation of temporary monopolies might slow down innovative activities and prevent competition of the best technological solutions (see for example Bessen, Meurer 2005, 2007, 2008; Hahn 2005; Heller, Eisenberg 1998; Shapiro 2001).

This dispute between proponents and opponents of the patent system has been especially visible with regard to the patenting of computer programs. Computer programs are patentable to a certain extent, although critical voices suggest that algorithms implemented in software are not inventions in the basic sense but rather discoveries - like mathematical arguments - that are fundamentally excluded from patenting. Others argue that computer programs do not have a technological content (or a technological orientation) and thus want to exclude software from patenting, stating that the copyright of the written form of the algorithm or the software as a whole is sufficient.

Especially between the European and the U.S. patent system there are large differences with regard to patenting of computer programs. While software “as such” can be patented at the USPTO, the EPO prohibits patenting pure computer programs. The distinguishing feature for the EPO is the “technical character” of an invention (European Patent Office 2007). A computer program is only patentable if it is of "technical nature" or has a "technical effect" that goes beyond the “normal” physical interactions between a program (software) and a computer (hardware). Such inventions can be described as "computer-implemented inventions" (CII), as opposed to software "as such". Consequently, a “grey zone” between technology and software emerges with regard to patenting CII.

In this paper, we investigate the differences between the European and American patent system with regard to patenting computer programs by also addressing the historical developments that have resulted in the national differences. Based on these considerations, first of all a definition of CII is derived, which will be operationalized to enable us to carry our empirical analyses. A number of approaches have been suggested to identify software patents in the whole universe of patent filings. However, most of these definitions were generated with regard to the USPTO (compare Allison, Tiller 2003; Bessen, Hunt 2004, 2007; Chabchoub, Niosi 2005; Graham, Mowery 2003, 2005; Layne-Farrar 2005).

For the European context, however, adopting one of these approaches is not appropriate as the patent regimes are rather different with regard to patenting computer programs. Therefore, we apply a combination of keywords and IPC classes to generate a search strategy for CII that can serve as a lower-bound estimate for the number of CII filings (Frietsch et al. 2015; Xie, Miyazaki 2013) for the EPO and the USPTO. We then compare these figures at both offices alongside different dimensions based on data from the EPO Worldwide Patent Statistical Database (PATSTAT) matched with the ORBIS firm database by Bureau van Dijk.

By applying a conservative estimate, our results show that the share of CII filings at the EPO lies at around 25% at present, while at the USPTO a current margin of approximately 33% can be reached. It can therefore be concluded that at least every fourth patent at the EPO and every third patent at the USPTO is in fact a CII filing, i.e. we are indeed talking about a large share of filings at the respective offices.

Based on these figures and further trends over time, we aim to look deeper into the structural differences in CII filings at the two offices. In particular, we aim to find out about the spread of CII filings across economic sectors and how this differs across the EPO and the USPTO. Since ICT is often seen as a general purpose technology, first results show that CII patents are filed by firms across the whole range of industry sectors, i.e. they are not only used, but also produced by firms from other sectors, mostly within the machinery industry, although the sectoral spread seems to be larger for the EPO.

In addition, we pose the question about structural differences with regard to firm size. Are SMEs more or less involved in CII patenting? First results show that, in comparison to total patents, CII shares are overrepresented in the portfolios of large firms; a trend that seems to be more pronounced for the EPO than for the USPTO.

In sum, these trends provide first evidence that clarification is needed with regard to the definition and demarcation of the “technical character” or “technical effect” of an invention at the EPO, in order to take account of the factual (technological and economical) relevance of computer-implemented inventions. Clear rules are essential to reduce uncertainties and provide the relevant incentives for innovation. The absence of such rules weakens the patent system and leaves an open space for the emergence of patent thickets (Shapiro 2001), which might block (further) technological developments, especially for new and complex technologies. This may also be a reason why especially small companies, which tend to lack the relevant resources, file relatively fewer CII patents.

References

Allison, J.R.; Tiller, E.H. (2003): Internet Business Method Patents. In: Cohen, W.M.; Merrill, S.A. (eds.): Patents in the Knowledge-Based Economy. Washington, D.C.: National Academies Press.

Bessen, J.; Hunt, R.M. (2004): An Empirical Look at Software Patents.

Bessen, J.; Hunt, R.M. (2007): An empirical look at software patents. In: Journal of Economics and Management Strategy, 16 (1), pp. 157-189.

Bessen, J.; Meurer, M.J. (2005): The Patent Litigation Explosion, Working Paper No. 05, Boston: Boston University School of Law.

Bessen, J.; Meurer, M.J. (2007): What's Wrong with the Patent System? Fuzzy Boundaries and the Patent Tax. First Monday. Online: http://www.firstmonday.org/issues/issue12_6/bessen/index.html (accessed: 23.06.2008).

Bessen, J.; Meurer, M.J. (2008): Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk, Princeton, NJ: Princeton University Press.

Chabchoub, N.; Niosi, J. (2005): Explaining the propensity to patent computer software. In: Technovation, 25 (9), pp. 971-978.

European Patent Office (2007): Examination of computer-implemented inventions at the European Patent Office with particular attention to computer-implemented business methods. In: Official Journal EPO, 11/2007, pp. 594-600.

Frietsch, R.; Neuhäusler, P.; Melullis, K.-J.; Rothengatter, O.; Conchi, S. (2015): The economic impacts of computer-implemented inventions at the European Patent Office: 4IP Council, Fraunhofer ISI.

Graham, S.J.H.; Mowery, D.C. (2003): Intellectual Property Protection in the U.S. Software Industry. In: Cohen, W.M.; Merrill, S.A. (eds.): Patents in the Knowledge-based Economy. Washington, D.C.: National Academies Press.

Graham, S.J.H.; Mowery, D.C. (2005): Software Patents: Good News or Bad News? In: Hahn, R.W. (ed.): Intellectual Property Rights in Frontier Industries: Software and Biotechnology. Washington, D.C.: AEI-Brookings Joint Center for Regulatory Studies, pp. 45-80.

Grupp, H. (1998): Foundations of the Economics of Innovation - Theory, Measurement and Practice, Cheltenham: Edward Elgar.

Hahn, R.W. (2005): An Overview of the Economics of Intellectual Property Protection. In: Hahn, R.W. (ed.): Intellectual Property Rights in Frontier Industries: Software and Biotechnology. Washington D.C.: AEI-Brookings Joint Center for Regulatory Studies, pp. 11-44.

Heller, M.A.; Eisenberg, R.S. (1998): Can Patents Deter Innovation? The Anticommons in Biomedical Research. In: Science, 280 (5364), pp. 698-701.

Layne-Farrar, A. (2005): Defining Software Patents: A Research Field Guide, AEI Working Paper No. 05-14.

Shapiro, C. (2001): Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting. In: Jaffe, B.A.; Lerner, J.; Stern, S. (eds.): Innovation Policy and the Economy, Volume 1. NBER Book Series Innovation Policy and the Economy, MIT Press, pp. 119-150.

Xie, Z.; Miyazaki, K. (2013): Evaluating the effectiveness of keyword search strategy for patent identification. In: World Patent Information, 35 (1), pp. 20-30.

Koichiro Okamura

Determinants of research performance: An analysis of RoboCup

Session 7B

Introduction

The innovation inducement contest has become increasingly popular among governments, companies and various organizations in recent years. In essence, it is an ex ante R&D prize system where the sponsor of the prize defines the terms of the contest as well as a challenge (i.e., a problem to be solved) and a reward for solving it, which is often a one-time large cash award or a future purchase of a qualified product (e.g., government procurement)(Davis & Davis, 2004). The contest aims to accelerate the commercialization or development of specific technologies or products. In contrast to its popularity, there exists only a limited number of studies that have analyzed innovation inducement contests empirically; a common finding among these studies is that the contests promote the commercialization of new technologies (Brunt, Lerner, & Nicholas, 2012; Nicholas, 2013).

Research context and questions

Academic researchers have also begun initiating the R&D contests, which follow a framework similar to innovation inducement contests but are held in the basic and applied research domain rather than in commercialization. Some contests are quite successful and have been held on a regular basis, among which this study empirically analyzes the RoboCup Soccer Competition (hereafter termed “RoboCup”), an R&D contest in robotics. It is a soccer competition played by robots. RoboCup was initiated in 1997 and has been annually organized by robotics researchers to date. RoboCup challenges participants to develop a team of robot soccer players that can beat a human World Cup champion team by 2050 (Kitano et al., 1998).

In the RoboCup, participating teams who build and/or programmed original robots compete with one another in several leagues, each of which focuses on specific research challenges and thus differs from others in several aspects such as technological characteristics, resources and skills required for the entry, the competitive environment shaped by the number of participating teams. The study examines the research performance of participants and the knowledge flow among them in the light of the organizational ambidexterity (Tushman and O’Reilly, 1996). The theory implies that the advantageous modes for innovative activities are determined by the level of the technological maturity (Hoppmann, Peters, Schneider, and Hoffman, 2013). When technology is in its infancy, the exploratory mode such as searching for new technologies is preferable (Hoppmann, Choi, and Mauter, 2014). As technology becomes mature, a technological paradigm is formed (Dosi, 1982) and therefore the exploitative mode to utilize the current technological knowledge rather than pursue radical innovation is preferable (Lumpkin and Dess, 2001; Malerba, 2009). The study analyzes the factors that determine the direction and size of the contest’s impact on research performance, including, for example, the participants’ participation history and the characteristics of the technological fields where the contests are held.

Data

In RoboCup, each participating team is obliged to submit a short team description paper (TDP) to disseminate technical information about their robots or programs. In addition to the soccer games, an academic symposium is also held. This study uses the TDP information and symposium papers between 1999 and 2011. The number of participants is approximately 5,000, which accounts for about 9,900 authorships in total.

The study uses Scopus to measure the research performance of RoboCup participants and compares with other robotics researchers who do not participate in the contests. The bibliometric information is collected for major nineteen major academic journals in robotics published from 1996 to 2012.

Analysis and results

The study uses two dependent variables to measure research performance. Research productivity is assessed as the number of papers published, and research quality is assessed as the number of citations received from subsequent papers. (Kostoff, 2002; Narin & Hamilton, 1996). Fractional count is used to capture each researcher's contribution (Moed, 2005).

The explanatory variables addressing the research questions include contest experience (measured by year), first participation or not (dummy), and the seven dummies, each of which represents a corresponding league (technology field). The control variables are included in the analysis: the number of papers published in the previous year and year dummies to control for the individual-specific effects and year-specific effects, respectively. The data is a panel-data, with researcher in one dimension and year in the other. There may still exist individual-specific effects that are not fully controlled by control variables. Therefore, the fixed-effect panel-data regression model is used for regression.

The analysis finds that the contests have positive effects in research performance overall. The impact is clearer on research productivity than on quality. The first participation shows the largest impact; the impact of the subsequent participation, which is measured by contest experience, is positive for research productivity but negative for research quality; however, the size of the impacts is small. Next, there is a performance variation among the leagues. Matured leagues (the description about the maturity is omitted in this summary due to word limitation) have negative impacts, though they are small and statistically insignificant, and vice versa. The findings seem to be encouraging for researchers as well as policymakers who are interested in the contests to promote R&D activities.

Gonzalo Ordonez-Matamoros and Stefan Kuhlmann

Author Meets Critic: Challenges and ways forward in innovation governance in emerging economies

Session 9B

Focusing on innovation governance and public policies in emerging countries, this paper aims at provoking discussions related with theoretical, governance and social capital failures and options for implementing alternative, more efficient approaches to effectively allow science, technology and innovation activities make sound contributions to development in such countries.

In particular, the authors reflect on basic/fundamental questions such as - Why in many cases knowledge, science, technology and innovation activities are not satisfactorily contributing to the expected progress at the desired pace in emerging countries?, - What can be attributed to theoretical failures, governance failures and social capital failures? And - How can emerging developments, opportunities and options taking place both in terms of innovation theory, policy and practice in emerging countries be understood?

In so doing, the authors bring a new perspective on innovation policy debates, focusing on governance issues resulting from the 'dance' (Kuhlmann, Shapira, & Smits, 2010), i.e. the interplay between innovation policy, theory and practice in emerging countries.

Hence, following an interpretative approach, substantiated by discussions in several workshops with policy scholars, in this paper the authors assess the rationales and relevance of current/dominant innovation theories and policies and assess their consequences, while exploring options based on new developments found in the arena.

More specifically, to understand failures, the authors analysed:

a) The underlining assumptions supporting innovation policies implemented in emerging economies

b) Key features of innovation policymaking processes

c) Typical innovation governance challenges in the framework of poverty and globalization

d) Contextual determinants of innovation policy change, failure or effectiveness by examining the role of cultural, historical or political drivers, barriers, policies and governance issues

e) The role indigenous knowledge play in development policies implemented

f) The role of international aid, cooperation, funding organizations, NGOs, multinational corporations, universities, networks and/or media

g) The role of local management, leadership and entrepreneurial capabilities

h) The role of organizations, institutions, norms and values

i) The role of corruption

j) The role of ideology

To understand current options and opportunities, the authors analysed:

a) The conceptualization of 'innovation', involving grassroots innovation, social innovation, social technologies, innovation for inclusion and innovation for the 'bottom-of-the- pyramid', the role of new.

b) The role of 'new' actors

c) New ways of governance

After applying the innovation policy dance metaphor, this process helped the authors to identify ‘bumpy dancing’ and stories of systemic failures expressed in terms of:

a) Theoretical failures when theory is the leading dancing partner,

b) Governance failures when policy is the leading dancing partner, and

c) Social capital failures when practice is the leading dancing partner.

The process also helped the authors to identify creative dancing and stories of success of making knowledge and innovation an engine for development resulting from the emergence of:

a) New and/or more relevant theories and concepts,

b) New and more relevant policies and programmes, and

c) New and more relevant innovation practices.

This paper extents from discussions proposed at the introductory chapter ‘Governance of innovation in emerging countries: understanding failures and exploring options’ of the recently published book “Research Handbook on Innovation Governance for Emerging Economies: Towards Better Models”, edited by Stefan Kuhlmann and Gonzalo Ordonez (Stefan Kuhlmann & H.G. Ordonez-Matamoros, 2017).

In so doing, the authors identified a set of key governance challenges developing countries would have to face to embrace a new paradigm of innovation policy if they are serious in their intent of making STI an engine for development in a more effective way.

References:

Kuhlmann, Stefan and Ordonez-Matamoros, Gonzalo. (2017). Introduction: Governance of innovation in emerging countries: understanding failures and exploring options. In Kuhlmann, Stefan, & Ordonez-Matamoros, H.G. (Eds.). Research Handbook on Innovation Governance for Emerging Economies: Towards Better Models. Cheltenham, U.K. and Northampton, MA. USA.: Edward Elgar.

Kuhlmann, Stefan, & Ordonez-Matamoros, H.G. (Eds.). (2017). Research Handbook on Innovation Governance for Emerging Economies: Towards Better Models. Cheltenham, U.K. and Northampton, MA. USA.: Edward Elgar.

Kuhlmann, Stefan, Shapira, Philip, & Smits, Ruud E. (2010). Introduction. A Systemic Perspective: The Innovation Policy Dance. In R. E. Smits, S. Kuhlmann & P. Shapira (Eds.), The Theory and Practice of Innovation Policy - An International Research Handbook. Cheltenham, U.K. and Northampton, MA. USA.: Edward Elgar Publishing.

Shin-Ren Pan and Lan Xue

Can a sustainability transition be designed? The congruence in path creation of the high-tech industry in Taiwan

Session 1

Twenty years ago, the “Asian Tigers” achieved exceptional economic growth and radically changed their technological regime. In the research into transition and innovation, the cases in which Asian latecomer economies presented in the late 20th century were used to demonstrate the pathway of an aggregation where the government policy networked with other actors for innovation development. However, many industrial cases, especially in so-called high-tech industries, did not perform similarly as the path developed by such aggregation over the same decades. For example, the pharmaceuticals industry was less efficient than the integrated circuits (IC) industry in Taiwan. This gap triggered the question, are the pathways in Asian latecomer economies a “guaranteed” transition? Did the path of the Asian Tigers shape their amazing performance or was it a kind of negative path dependence?

In order to explore this theoretical void, the emerging field of innovation study, called sustainability transition, expressed as the lens of strategic niche management (SNM), which is defined as a form of governance executed by various actors that aims to change existing socio-technical regimes through niche innovation for the long-term (Geels & Schot, 2007; Schot & Geels, 2008), is introduced. Different from the past Taiwan studies that focused on government’s role and the institutional setting driving the R&D power, entrepreneurship and public policy, SNM provides a perspective that how the niche, conceptualized as a protective space that converges powers from actors and lever radical innovation, shape or constrain a path via the formation of key resource (Farla et al., 2012; Smith & Raven, 2012; Markard et al., 2012; Binz et al., 2016; Boschma et al., 2017). However, the key resources formed in the IC and the pharmaceuticals sectors did not express the theoretical development in the same period. Engaging in the theory of institutional entrepreneur, we frame a theoretical framework to quest how does the attribute of an interaction of actors affect the formation of sustainability transition for high-tech industries in Taiwan?

Based on 16 times semi-structure interviews and second-hand data, we compare the mechanism of the formation of the key resources with the two cases and find that the new determinant to empower the niche-innovation in Taiwan’s matters is the congruence of interaction. This theoretical generic resource form the pathway of sustainability transition with the following propositions:

Proposition 1: The interaction of actors in developing a path is formed not only by the dynamics of transactions by the incumbent and entrant, but also by the dynamics of conforming between their interactions.

Proposition 2: The key resource formed by the interaction of actors continues to influence the development of the path and enables the niche innovation change in the technological regime.

Proposition 3: The key resource presents as the congruence formed by an interaction where the incumbent and the entrant recognize the strategies and take actions to coordinate with one another.

Proposition 4a: The homogeneous cognitions of developmental strategy between the actors conducts the formation of congruence.

Proposition 4b: The heterogeneous cognitions of developmental strategy between the actors enervates the formation of congruence.

This article contributes to two theories. First, we framed the framework toward the actor’s interaction within the lens of SNM and found that the theoretical resource, congruence, is the attribute of the interaction of the actor and influences the path creation of sustainability transitions. Second, we extended the vision of path creation of Asian developmental economies with the aspect of actors, who were divided into incumbent and entrant and who own the distinct agencies and enable or constrain the path development via their interplay. Also, this paper suggests that the government should not only create incentives, including financial grants, institutional arrangements, and so on, but it should also be concerned with the congruence of the developmental strategies that are interacted between itself and the actors who may be initiated later. Toward the Taiwan’s matter, the government-initiated development is not a guarantee of the efficient pathway of niche innovation (sustainability transition), but it may work with a particular

situation.

Keston Perry

Networks of power, technology development and short-lived successes in a small developing country

Session 6A

Introduction

For emerging economies, generating competitive products and utilizing technologies that can enhance productivity are imperative for economic success and societal transformation. Many developing country firms encounter significant challenges, including access to long-term financing, human resource shortages, unsophisticated managerial capabilities, and poorly performing institutions. All of these concerns require institutional responses in conditions of underdeveloped capital markets, a weak private sector, and fierce global competition. Oftentimes, the experiences of small developing countries have been under the radar, and not well understood in these debates. As a result, the theoretical and empirical literature is often silent on the less successful small economies.

This paper seeks to fill this lacuna by shedding light on the institutional dynamics and effects of technological development in Trinidad and Tobago. Such small developing state are not well analysed, and thus policy implications drawn from larger states have been inappropriately applied to these countries (G. Marcelle 2009, 2016). In response, the paper advances a conceptual tool, i.e. 'networks of power' that describes the asymmetric and dynamic social relations among heterogeneous domestic and international actors across organisations. The paper addresses the following concerns:

1. What has been the historical experience of a small developing country, in particular Trinidad and Tobago, in the governance of science and technology (S&T)?

2. How have the relations among business groups, university researchers, the state, and international actors affected institutional performance?

3. What are the institutional and political factors in Trinidad and Tobago that affect technological outcomes?

This analysis is there important for the innovation scholars, the development community, and policy makers to help highlight the specific experience of small developing countries, and the role of their institutional and political contexts that shape innovation outcomes during different periods.

Literature Review

For three decades, the evolutionary theory of the firm has been critical in shifting understanding of the importance of learning routines and internal capabilities of firms. This point of departure for studies of innovation in developing contexts has elucidated insights on the historical evolution of technological capabilities within firms (Bell and Pavitt 1997; Bell and Figueiredo 2012). This work also highlights that innovation capabilities in developing countries go beyond Research and Development (R&D) activities. They comprise a host of capability building, technological, design, search activities, namely technological adaptation, modification, and imitation (Kim and Nelson 2000; Marcelle 2016). Coupled with this, to give greater emphasis to the institutional context and factors that shape innovation processes provoked by interaction among several actors and institutions, the innovation systems concept has been quite influential (Edquist 1997; Lundvall 2010). Notwithstanding these important contributions, the literature has for a long time neglected the political context, the structure of power and interests that shape innovation processes and capability-building efforts (Bell 2009; Watkins et al. 2015).

In a small developing country, interactions among agencies and agents in the innovation system are particularly driven intense lobbying, personalistic politics, and informal arrangements that have consequences for technological progress (Khan 2010; Veenendaal 2015; Hadjimanolis and Dickson 2001). The small number of organisations also utilize a number of clientilist strategies to acquire subsidies and favors from political elites (Ngo 2016). These efforts depends on whether these resources are invested in technological activities (Gray and Whitfield 2014). The diversity of interests and differential power among myriad organisations in business, the state, university, and international institutions within the S&T system and political economy thus create the conditions for policy implementation, and collective action in the innovation ecosystem. Their degree of effectiveness depends on the existing stock of capabilities in firms

and the nature of political contestation among organisations.

Research design

This research is based on a qualitative research design. It traces a historical process of evolution of networks of actors and agencies, institutional changes, and their effects on technological and economic outcomes over different periods. Forty-seven interviews were conducted with business, state officials, university community, and the international development agencies. Data were also collected from archival and secondary reports and documentation which were used to cross-check the interview responses.

Findings

Over the course of history, these exchanges have either produced or undermined technological outcomes, in the process impinging upon institutional performance in resource-dependent Trinidad and Tobago. Provoked by mass mobilizations and discontent in the first decade of independence from 1960s, the state took an activist role in establishing S&T institutions. During 1970s and early 1980s, the state was able to coordinate a number of private, public and international actors to pursue a number of R&D projects in agriculture, steel, energy and telecommunications to promote technological development. Since the late 1980s, there were evident shifts in the balance of power brought on by market-friendly policies, resulting in increased ethnic-based clientilism and institutional fragmentation that have adversely affected the industrialization process. These changes witnessed an ever increasing role of international agencies in the face of fiscal pressures and competition for resources, providing state financing for innovation policy, allocated to unproductive enterprises and powerful sectoral interests. These networks have become increasingly disjointed provoked by successive electoral changes and institutional restructuring. The state has consequently been unable to take a long-term approach to building domestic technological capabilities in organisations and public institutions.

Sebastian Pfotenhauer and Mackenzie Hird

Differential network formation, research re-orientation, and governance challenges in international capacity-building partnerships

Session 6D

This studies the impact of complex international capacity-building partnerships as an emerging policy tool at the crossroads of four major research policy trends – university-centrism, collaboration, internationalization, and growing structural complexity. We propose a new mixed-method approach combining bibliometric network analysis with difference-in-difference program evaluation, statisticalmatching techniques, and system architecture analysis to evaluate complex research partnerships more adequately 'in their own terms.' We apply our method to four international collaborative "flagship" policy initiatives geard at economic development that fit squarely within the aforementioned four policy trends: the MIT Portugal Program, the Cambridge-MIT Institute, the Singapore MIT Alliance, and Masdar Institute of Science and Technology. In all four initiatives, we compare program participants to a carefully assembled peer group of non-participant researchers to assess the impact of the programs with regard to idiosyncratic, more structurally oriented, and arguably less conventional program goals. As part of our methodological approach, we propose difference-in-differences Content Overlay Maps ("maps of science") as a means to evaluate how program participants change their research focus over time relative to their national peers. These findings are complemented by an analysis of the collaborative network of participants and their institutions, as well as more traditional forms of impact assessment. We then complement the analysis by a qualitative study of the governance challenges ensuing these large-scale partnerships, proposing a life-cycle model to the systematize the challenges according to different program stages. Our findings indicate that complex international capacity-building partnerships can have a significant impact on the 'hosting' country in terms of cluster formation and research re-orientation. Moreover, they suggest that our mixed-methodapproach provides a valuable tool for evaluating complex capacity-building initiatives in ways that do justice to their one-of-a-kind architectures and goals.

Sebastian Pfotenhauer and Mac Hird

Differential network formation, research re-orientation, and governance challenges in four international capacity-building partnerships

Session

This studies the impact of complex international capacity-building partnerships as an emerging policy tool at the crossroads of four major research policy trends – university-centrism, collaboration, internationalization, and growing structural complexity. We propose a new mixed-method approach combining bibliometric network analysis with difference-in-difference program evaluation, statisticalmatching techniques, and system architecture analysis to evaluate complex research partnerships more adequately 'in their own terms.' We apply our method to four international collaborative "flagship" policy initiatives geard at economic development that fit squarely within the aforementioned four policy trends: the MIT Portugal Program, the Cambridge-MIT Institute, the Singapore MIT Alliance, and Masdar Institute of Science and Technology. In all four initiatives, we compare program participants to a carefully assembled peer group of non-participant researchers to assess the impact of the programs with regard to idiosyncratic, more structurally oriented, and arguably less conventional program goals. As part of our methodological approach, we propose difference-in-differences Content Overlay Maps ("maps of science") as a means to evaluate how program participants change their research focus over time relative to their national peers. These findings are complemented by an analysis of the collaborative network of participants and their institutions, as well as more traditional forms of impact assessment. We then complement the analysis by a qualitative study of the governance challenges ensuing these large-scale partnerships, proposing a life-cycle model to the systematize the challenges according to different program stages. Our findings indicate that complex international capacity-building partnerships can have a significant impact on the 'hosting' country in terms of cluster formation and research re-orientation. Moreover, they suggest that our mixed-methodapproach provides a valuable tool for evaluating complex capacity-building initiatives in ways that do justice to their one-of-a-kind architectures and goals.

Diogo Pinheiro and Julia Melkers

Gender, Geographical Mobility, and the Academic Labor Market

Session 6B

INTRODUCTION

There is an extensive literature that focuses on the impact of geographic mobility (or lack thereof) on the outcomes professional men and women, especially within academia (Jöns, 2011; Leemann, 2010; McBrier, 2003; Musselin, 2004; Rosenfeld & Jones, 1987). This literature emphasizes the ways in which women are generally more likely to be geographically restricted than men, due to family and child rearing obligations. The emphasis of this literature is on the leaky "pipeline" that can explain a substantial amount of the gender imbalance in Science, Technology, Engineering and Math (STEM) fields (Van Anders, 2004).

Our study seeks to expand research in this area in two different ways. First, most of the existing research either treats geographic restrictions by looking at migration rates (Shauman & Xie, 1996) or self reported views on career options and mobility (Van Anders, 2004). Here, we use data that involves both mobility and self reported preferences to generate a more complete picture of geographical mobility. Second, our data allows us to cover career outcomes to a greater extent than other studies.

DATA AND MODELS

The data for this project comes from the NETWISE II survey. The population for the survey includes tenured and tenure-track academic scientists in four general areas: biology, biochemistry, engineering, and mathematics. These fields different levels of female representation among tenure track faculty, allowing gender-based comparisons across fields. The population includes men and women faculty at the ranks of assistant, associate and full professor from Carnegie (Indiana University Center for Postsecondary Research, 2015) Research Extensive and Research Intensive institutions, Masters I/II institutions, and Liberal Arts colleges. We then selected nearly 10,000 individuals through a stratified random sample, which allowed us to ensure appropriate representation of women and minorities. We obtained 4195 complete and nearly complete responses to our survey. The survey asked several questions on career plans, intentions, and social networks.

As discussed previously, existing research has discussed geographic mobility either through migration rates or self reported intentions. Here, we can combine both sources of information. Our survey asked respondents about how important geographical location was as a factor when they first entered the academic labor market. Additionally, we obtained information from survey respondents on their doctoral and current institutional affiliation. As a result, we geocoded those institutions and were able to obtain the distance between their two institutions. For our purposes here, we use 150 miles as the threshold for geographical restriction, but our results are consistent if we either use more (100 miles) or less (200 miless) restrictive measures. Women are significantly more likely than men to be geographically restricted, regardless of our measure. We use logit models to determine the main factors that affect geographic restrictions. We then use a series negative binomial models in order to measure the impact of geographic restrictions on a number of career outcomes.

RESULTS

Female faculty are 80% more likely to geographically restricted than males. This is the case after controlling for a number of other demographic and career factors. African American faculty are twice as likely to be geographically restricted, as well. The only other variables to be significant in our models are the presence of children and providing care for elderly relatives/parents. Faculty that have at least one child are over 60% more likely to be geographically restricted, while faculty that have take care of elderly relatives or parents are over 55% more likely to be geographically restricted.

We estimate the impact of being geographically restricted on the number of applications for jobs submitted and the number of job offers received the first time the respondent entered the labor market. Our results show that female respondents generally apply for fewer tenure track positions, but receive a larger number of offers. More importantly, the interaction term for geographic restriction and gender indicates that geographic restriction only has an impact for

females. In both models geographic restrictions have a negative, but insignificant impact on number of job applications and offers. But when we consider the joint significant of geographic restriction plus the interaction term, geographic restrictions becomes significant at the 0.001 level. That is, being geographically restricted has a much bigger constraining factor on female respondents, while male respondents who are geographically restricted see no statistically significant difference in terms of job applications and offers.

CONCLUSION

Our results show that women are disproportionally more likely to be geographically restricted when seeking an academic career. While the presence of children and the need to care for elderly parents or other relatives explain part of that difference, gender still has a substantial impact. But differences in gender in terms of geographic restrictions is only part of the story. We also find that geographic restrictions only affect female respondents in terms of their first time entering the market. Geographic restrictions reduce the number of applications and job offers for women, but not for men.

This paper is the first step in trying to understand geographic restrictions and gender dynamics by taking into account both self reported intentions and actual migration patterns. Next steps include exploring a number of career outcomes, including salary satisfaction, institutional affiliation, and work load components.

References

Indiana University Center for Postsecondary Research. (2015). The Carnegie Classification of Institutions of Higher Education. Retrieved from http://carnegieclassifications.iu.edu/

Jöns, H. (2011). Transnational academic mobility and gender. Globalisation, Societies and Education, 9(2), 183–209.

Leemann, R. J. (2010). Gender inequalities in transnational academic mobility and the ideal type of academic entrepreneur. Discourse: Studies in the Cultural Politics of Education, 31(5), 605–625.

McBrier, D. B. (2003). Gender and Career Dynamics within a Segmented Professional Labor Market: The Case of Law Academia. Social Forces, 81(4), 1201–1266.

Musselin, C. (2004). Towards a European academic labour market? Some lessons drawn from empirical studies on academic mobility. Higher Education, 48(1), 55–78.

Rosenfeld, R. A., & Jones, J. A. (1987). Patterns and Effects of Geographic Mobility for Academic Women and Men. The Journal of Higher Education, 58(5), 493–515. http://doi.org/10.2307/1981784

Shauman, K. A., & Xie, Y. (1996). Geographic mobility of scientists: Sex differences and family constraints. Demography, 33(4), 455–468.

Van Anders, S. M. (2004). Why the academic pipeline leaks: Fewer men than women perceive barriers to becoming professors. Sex Roles, 51(9-10), 511–521.

Tatevik Poghosyan

State of the National Innovation System of Armenia

Session 1

A successful management of an innovation system can drive the growth of both companies and national economies. At the national level, governments develop instruments and policies to foster science and technology as well the innovative activities of private sector. Many developing countries face challenges of technological upgrading. To this end, they employ strategies for catching-up with the countries at the technological frontier. Transition post-Soviet countries, too, are among those that face significant barriers to upgrading their science and technology. These countries, however, differ from other developing world by their common historical experiences and production system heritage together with a shared set of difficulties brought by the collapse of the Union of Soviet Socialist Republics (USSR).

Years of operating under a central planning system and the corresponding lack of economic incentives for innovativeness left deep marks on business behavior, with companies being slow and rigid in dealing with market challenges. It took time for firms to alter their mindsets and develop an understanding of how capitalist markets operate and how to generate higher economic returns under a new post-Soviet system. Inability of the early transition period to provide satisfactory work opportunities for highly skilled workers and scientists coupled with high demand for relatively cheap highly skilled specialists in developed countries led to a substantial brain drain.

Armenia's transition, which began in the 1990s, started with an ethnic conflict that ended in 1995. After 1995, the country embarked on its post-war recovery process by developing economic and social policies, which came into effect mostly after 2000. Macroeconomic data confirm that the main transformation processes were in effect after 2000, and the majority of innovation policies were developed in the 2000s (UNECE, 2014). After the war (1991-1995), Armenia faced a problem common to all transition countries: how to integrate into the world economy with an "old fashioned" production system, poor technology and a lack of financial resources for education and science. However, Armenia inherited some advantages from its "soviet" past: high-quality human capital, well developed laboratories and universities for natural sciences, and a diaspora that was eager to invest in the country's economy.

This study aims to deepen our understanding of National Innovation System (NIS) characteristics in transition countries and, in particular, discuss the conditions in which Armenian NIS is transforming. We review the key historical path dependencies that are particularly important to explain the interplay between the development level of the NIS and the economic development of Armenia. Several stylized research questions are addressed in this context: How can transition countries exploit current opportunities and resolve the weaknesses of the inherited state planning system to construct an effective NIS? What are the major drivers of the change in Armenian NIS? What opportunities do firms have for learning and innovation in Armenia?

To answer these questions, we start with a discussion of the NIS approach in transition countries from evolutionary perspective. We point out how the initial transition reforms and common historical path dependencies steer the development of NIS in transition countries and continue to affect them. We further our analysis by introducing the determinants and actors in Armenia's NIS by highlighting the macroeconomic environment, past industrial development and the challenges that Armenia faced during the transformation of its Regional Innovation System as a republic within USSR into a small country's National Innovation System. We also discuss the innovation governance system in Armenia, which is seen as an integral part of the NIS. In section 4 we discuss learning and networks as an important aspect of the NIS approach. They play a crucial role in explaining innovation and economic development in transition countries too. Finally, in section 5, the major research questions are reviewed and some suggestions are put forward with the possible avenues of analyzing firm's innovation in Armenia.

Jakob Pohlisch and Knut Blind

Publishing, Patenting and Standardization: Motives and Barriers of Scientists

Session 1

In this paper, we analyse the motives and barriers for researchers to engage in the triple of publishing, patenting and standardization. We conducted a survey of 129 researchers at the Federal Institute for Materials Research and Testing, one of Germanys largest federal research institutes. The resulting dataset allows us to study not only their motives and barriers but also the impact of those motives and barriers on the extent to which the respective activities are undertaken. We find that publishing constitutes a baseline activity. Patenting however is rather driven by commercialization motives, while standardization is fostered by intrinsic motivation. With respect to the barriers, we find that they are mostly inherent to the activity itself or the system in which it is performed.

Soledad Quiroz-Valenzuela, Karem Celis-Atenas and Claudia Daneri

Conflicts and Hopes of Chilean Researchers: A long to-do list for the future Ministry of Science and Technology

Session 1

It is often mentioned that Chile has a very low investment in Research and Development (R&D), which only reaches a 0.39% of the GDP and has maintained the same level for about ten years. Other than placing the country in the very last place of the OECD ranking in R&D investment, the null increase in the 2017 budget for R&D and management issues in CONICYT (the main funding agency for S&T in Chile) led to a series of protest both by scientists and government officials. This scenario seemed to show a major crisis in Chilean science. In the meantime, Chilean President Michelle Bachelet sent to the congress a law to create a Ministry of Science and Technology, which was long awaited by most of the scientific community. If the electoral year does not cause mayor distractions in the congress, the new Ministry could start its functions in 2018. Nevertheless, it was not clear whether all the complaints were about funding or there was something else behind the numerous claims of a crisis. We asked near 300 researchers in nine cities through the country three questions: What are the main barriers to perform research in Chile? What do researchers propose to overcome those barriers? What do researchers expect from the future Ministry of Science and Technology? We organized a workshop were researchers from all fields were invited. We separated them in focus groups to capture the perceptions of the participants. We used content analysis defining emerging categories for each question.

The analysis showed several issues not considered by the authorities, and emerging conflicts between researchers. The main concerns were the difficulties associated to investigate outside the capital, Santiago. Also, a growing claim to support women in science, requests for a more open and transparent process of evaluation and assignment of funding. Other relevant issues were: requests to support multidisciplinary research, requests to revise metrics for the social sciences and humanities, and concerns about the working conditions for junior researchers.

As for the Ministry of Science and Technology, most of the researchers support its formation, but were concerned with the influence of politics and economic criteria over the policies the ministry could create.

The lack of knowledge of how the public administration works, even at levels near the researchers such as evaluations of funding proposals, was evident during the discussions. At the same time, researchers recognized they had to create a stronger relationship with the society.

The description of the research environment in Chile has many similarities with some showed at international level, especially regarding contracts and women`s participation, but also highlights some particular characteristics of the country's traditionalist view of science.

Samira Ranaei

Topic analysis of Ig Nobel prize laudations

Session 10C

Each year since 1991, the Annals of Improbable Research gives out “Ig Nobel” Prizes in different fields for apparently trivial scientific achievements that “first makes people laugh and then to think”. The recent award for the field of psychology in 2016 was given to research titled “From Junior to Senior Pinocchio” that asked thousands of liars how often they lied and whether to believe those answers. In other words, the authors were examining the lying proficiency of people across individual’s entire lifespan. Yet, such humorous research papers impact fields of science, based on evidence such as counting the number of citations. For example, ref [1], which is about placebo effect of drugs, received 340 citation over the period of 10 years since the paper received the Ig Nobel in 2008. Despite the humor in Ig Nobel prize winner papers they convey legitimate messages.

Motivated to explore the characteristics of the science highlighted by the Ig Nobel prize, this study explores the content of prize winner papers. The paper uses probabilistic topic models based on machine learning methodologies that extract underlying “topics” from set of document collections to examine the extent to which there are underlying patterns in Ig Nobel prize winning research. Scholars have applied machine learning algorithms to classify large corpora of patent documents based on their content[2], to detect novel ideas from nanotechnology patent documents [3], to map scientific publications [4] and to examine the cognitive relationship between teaching and research at universities [5]. A popular topic modeling algorithm is Latent Dirichlet Allocation (LDA) [6] which is a generative probabilistic model. LDA performs more efficiently in distinguishing polysemy and synonymy since it includes probabilistic models both at document and word level. LDA’s two-level analysis makes it superior to other models such as Latent Semantic Indexing (LSI) [7] or probabilistic latent semantic indexing (PLSI) [8]. The assumption behind LDA topic models is that documents are a mixture of topics; the algorithm seeks to detect these underlying latent topics in a document collection. The topic is perceived as a distribution over a vocabulary of words [6]. The analysis is based on text in the laudations of 262 papers, collected from the Ig Nobel website (http://www.improbable.com/ig/winners/) from 1991 through 2016.

Table 1 presents the preliminary results of top four words along with their probabilities for each topic. Words are considered as a proxy that describe the emerging topics from the dataset. Ten topics out of 35 were selected for the purpose of demonstration. For instance, “topic 1 is about banana skin”, “topic 3 is about methods of trapping airplane hijackers”, “Topic 4 describes an alarm clock probably made from wasabi”, “Topic 9 appears as the relationship between dung beetles and the Milky Way!” Manual screening of the associated document for topic 9 shows the paper was about lost dung beetles that can find the right track using the Milky Way. Topic 19, 32 and 21 are more general topics about economics, life and illegal drug. Topic 17 represents a relationship between husband’s underwear and infidelity. The word fisherman is also in this topic, reflecting the semantic relationship between “husband” and “man”. This suggests that documents discussing male characters may be associated with this topic. In summary, the topics suggest a distinctive role for content involving animals, illegal/risky behavior, and life and death activities in Ig Nobel lauded research.

This research experiment has limitations. The presented result is the outcome of an experiment on a small dataset of Ignoble prize winner laudations that are very short sentences. The experiment on the small dataset shows promising, interpretable topics and removed the burden of manual assessment of 262 documents for topic detection. The detailed analysis of the documents and topic proportions will be conducted on the larger data set with document abstracts. Moreover, the content analysis of the larger document descriptions would allow for highlighting the relationship between the funny words and real world problems that authors were targeted. The extended analysis will also include the comparison of the topics occurred during different time periods since 1991.

Emanuela Reale and Benedetto Lepori

National public funding systems between global pressures and local settings

Session 3E

Introduction

Changes in how public funds for R&D are allocated have been a major focus of research policy studies in the past decades. Labels like “new funding climate” (Geuna 1999) and “academic capitalism” (Slaughter and Rhoades 2004) have been used to characterize the move from a model where funding was largely allocated on historical grounds and with no strings attached to a new mode where the state uses purposefully funding allocation to steer the research system to respond to policy goals, but also to increase the performance of researchers and research organizations (Hicks 2012). These changes have been linked to a shift in the policy rationale from supporting public science to a focus on “useful” science (Braun 2006) and to the spread of New Public Management policy rationales, fostering the introduction of market-like economic incentives to steer the public research and higher education system (Ferlie et al. 1996).

For what concerns specifically European countries, empirical studies have documented changes in the way public funding is allocated, including a general increase in share of project funds (Lepori et al. 2007), the introduction of performance-based allocation (Hicks 2012, Geuna and Piolatto 2016) and of market-like incentives in the support to higher education institutions (Lepori and Jongbloed 2015). At the same time, comparative studies still showed large differences between countries in how the research and higher education system is governed (Lepori et al. 2007, Paradeise et al. 2009) and suggested that differences between countries are rooted in lasting institutional characteristics, particularly between the Anglo-Saxon liberal model and the Continental European model characterized by a much stronger role of the state within society (Dobbins et al. 2011).

Goal

The goal of this study is to provide a comparative analysis of changes in public research funding systems in a large set of European countries, including some comparison elements with the US. The study will focus on three dimensions, which the past literature suggests are relevant to compare such systems (Lepori 2011; Nieminen and Auranen 2010). These are:

- The overall volume of funding and its evolution over time, since data display a strong correlation between volume of funding and of scientific output (Jongbloed and Lepori 2015).

- The way funding is allocated, broadly distinguishing between institutional and project funding (Lepori et. al 2007).

- The allocation criteria for institutional funding and, particularly, the introduction of perfomance-based allocation (Hicks 2012).

- The institutional structure managing public funding and, particularly, the role of different types of funding agencies (Braun 1998).

Data

The data are derived from a large-scale study of public research funding supported by the Joint Research Centre of the European Commission (PREF). The PREF project has developed a systematic methodological framework for analysis public research funding systems by combining quantitative data and descriptors concerning allocation modes and criteria, as well as information on the stream structure of public funding and on the research funding organizations (RFOs) managing funding. Data collection has covered EU-28 countries, associated and accession countries and, in principle, the whole period from 2000 to 2014, even if data before 2008 are largely incomplete.

Key results

We summarize below some key results, which will further analysed in the full paper:

a) First, in terms of the volume of public funding, differences between European countries (as measured by the % of GDP, respectively of total public expenditures) stayed very large even increased over the considered period. A group of European countries, including Central European countries (AT, BE, CH, DE) and Nordic countries (DK, NO, SE), substantially increased their level of investment and approach the US, while we observe stagnation in some large countries, like France, Italy and UK. Finally, most Eastern European countries have far lower levels of public investment than the European average.

b) Second, in terms of the balance between project and institutional funding, three groups of countries can be identified: some countries where project funding is accounting for more than half of public funding, similarly to the US, including Ireland and UK, but also some Eastern European countries like Poland; a large number of countries, in which project is complementary to institutional funding (20-30% of the total), including most Continental European countries; finally, a few countries where project funding remains marginal, the most relevant case being Italy. In the last ten years, data show a slight increase in the share of public funding, but the division by groups remained remarkably stable, with the notable exception of Poland switching to the high project funding group and the convergence of the last group to the "complementary mode" countries.

c) Third, in most European countries institutional funding is still allocated through criteria, which do not consider research performance directly. This includes still important historical component, but also formulas largely based on inputs or costs. Most countries introduced some performance-based component, but when weighted by the amount of funding involved, it remains rather low, with the notable exception of the UK. Changes over time are modest in most countries, with the exception of a few countries.

d) An institutional analysis displays similarities and dissimilarities between countries in how public research funding is managed. In most countries, ministries still control the largest part of funds, particularly for institutional funds, with the notable exception of UK and IE, where also institutional funds are managed by independent agencies. Large public research organizations like CNRS and CNR play a significant (but diminishing) role only in handful of countries. The management of project funding is highly differentiated by country, distinguishing between the countries where independent agencies are important and countries where ministries manage most project funds – the former models being tendentially more important in countries with higher share of project funds.

Discussion

This preliminary analysis suggests that that, while the pressure towards an allocation of funding based on performance is present in all considered countries, its interaction with national characteristics and institutional specificities leads to lasting differences in how public funds are allocated and managed by country; for some instances, European countries seem to have become more heterogeneous as an outcome of a differential adoption of NPM pressures in the last two decades. Further, our data provide preliminary evidence of the assumption that there is only a limited set of possible configurations of public funding systems (Lepori 2011) and that, therefore, national systems remain stable over time, while radical changes occur only rarely and as an outcome of fundamental institutional reforms, like in the case of Poland.

Finally, a cursory comparison between our results on funding allocation and some widely used measures of national performance, like to volume of publication output, research excellence and innovation capacity does not display any straightforward association between performance and the important of project funding respectively the performance orientation of institutional funding. At the same time, differences in the level of public investment between European countries remain very large and tended to increase over time and display a strong association with differences in performance.

Acknowledgements

The authors thank the European Commission, Joint Research Centre, for funding this study through the PREF contract (contract no. 154321), as well as their colleagues participating to study, Thomas Scherngell and Georg Zharadnik (AIT, Vienna), Espen Solberg (NIFU, Oslo), Andrea Spinello and Emilia Primeri (CNR, Rome). They also thank the National Statistical Authorities for their support in data collection.

References

Braun D. (1998), The role of funding agencies in the cognitive development of science, Research Policy, 27, 807-821.

Braun, D. (2006). The mix of policy rationales in science and technology policy. Melbourne Journal of Politics, 31, 8-35.

Dobbins, M., Knill, C. & Vögtle, E. M. (2011). An analytical framework for the cross-country comparison of higher education governance. Higher Education, 62(5), 665-683.

Ferlie, E., Ashburner, L., Fitzgerald, L. & Pettigrew, A. (1996). The New Public Management in Action Oxford: Oxford University Press.

Geuna, A. & Piolatto, M. (2016). Research assessment in the UK and Italy: Costly and difficult, but probably worth it (at least for a while). Research Policy, 45(1), 260-271.

Geuna, A. (2001). The changing rationale for European university research funding: are there negative unintended consequences? Journal of Economic Issues, XXXV(3), 607-632.

Hicks, D. (2012). Performance-based university research funding systems. Research Policy, 41(2), 251-261.

Jongbloed, B. & Lepori, B. (2015). The funding of research in higher education: Mixed models and mixed results. In Souto-Otero, M., Huisman, J., Dill, D.D., de Boer, H., Oberai, A.S., Williams, L.(Ed.) Handbook of Higher Education Policy and Governance (pp. 439-461). New York: Palgrave.

Lepori, B. (2011). Coordination modes in public funding systems. Research Policy, 40(3), 355-367.

Lepori, B., Dinges, M., Reale, E., Slipersaeter, S., Theves, J. & Van den Besselaar, P. (2007). Comparing the evolution of national research policies: what patterns of change? Science and Public Policy, 34(6), 372-388.

Nieminen, M. & Auranen, O. (2010). University research funding and publication performance - an international comparison. Research Policy, 39, 822-834.

Paradeise, C., Reale, E., Bleiklie, I. & Ferlie, E. (2009). University Governance. Western European Comparative Perspectives.Dordrecht: Springer.

Slaughter, S. & Rhoades, G. (2004). Academic capitalism and the new economy: Markets, state, and higher education JHU Press.

Seyed Reza Mirnezami and Catherine Beaudry

The Effect of Holding a Research Chair on Scientists' Impact

Session 10B

Introduction

Research chair programs mainly seek improvement in knowledge production of a higher quality and of greater depth while training the next generation of highly skilled people, both of which strengthen the competitiveness of that society within the international community. In Canada, there are three types of research chairs: (1) research chairs which are awarded by industry and generally referred to as industrial chairs; (2) research chairs which are awarded by Canadian federal funding agencies such as the Natural Science and Engineering Research Council (NSERC) and the Canadian Institutes of Health Research (CIHR); and (3) the 'Canada research chairs', whose holders are assumed to already achieve research excellence in one of the main fields of research: engineering and the natural sciences, health sciences, humanities, and social sciences. Cantu et al. (2009) showed the research chair program would be a good strategy for implementing knowledge-based development. In a study on German universities, Schimank (2005) argued that chair-holders have high job security with adequate level of freedom of teaching and research. Considering holding a chair as some kind of measure of prestige, we aim to elucidate the effect of being a 'chair-holder' on scientific impact.

A natural coherence between the number of citations and scientific impact generally implies that scientists select their references on the basis of the "impact" of the papers they cite, but this is not always the case. Authors sometimes cite papers to review the opposite view in the literature or to provide a general literature review (Amsterdamska and Leydesdorff, 1989; Seglen, 1997a). In another study, Moed et al. (1985) note that citations refer to impact on the scientific community and it does not completely reflect research "impact". The authors argue that any publication should thus have a minimum "quality" to impact other research but other factors like visibility of journals and the extent to which researchers provide a public service are two other important determinants for citing a particular paper that do not necessarily have a strong correlation with research impact. Later, Moed (2009) argues that other citation-based indicators (e.g. journal impact factors, Hirsch indices, and normalized indicators of citation impact) can be substitute indicators for measuring the scientific impact of research.

Along these lines, Kostoff (1998) investigates the theory of citation and suggests that every citation results from the combination of two main reasons: the real component of intellectual heritage and random components of self-interest. Although there is a random component, the author argues that the random effect disappears in the aggregation of citation counts and therefore the number of citations is a good indicator of the "quality" of research. Phelan (1999) provides the same justification. In a most recent review study by Bornmann and Daniel (2008), they argue that in most of citation-related studies, it is concluded that citing behavior is not only because of referring to intellectual and cognitive influences of other scientists and that there may be some non-scientific factors determining the decision to cite. However, the paper concludes that the different motivations of citers are "not so different or 'randomly given' to such an extent that the phenomenon of citation would lose its role as a reliable measure of impact" (pp. 45). Assuming that citation counts are good proxies for the scientific impact of research, this paper tests the effect of holding a research chair on citation count of chair holders.

Data and variables

We built a data set based on the integration of data on funding and journal publications for Quebec scientists. For publications, Thompson Reuters Web of Science provides information on scientific articles (date of publication, journal name, authors and their affiliations). We build variables for the yearly number of articles published by an individual researcher in any given year, the number of co-authors, and the number citations. In terms of funding, we use a database of Quebec university researchers (Système d'information sur la recherche universitaire or SIRU) gathered and combined by the Ministry of Education and Research. This database lists the grants and contracts information, including yearly amount, source, and type for the period of 2000-2012 for all Quebec university scientists and the title of each specific research project for which funding was granted. The titles of research project are also being used to generate dummy variables identifying whether a scientist has a research chair. In addition, the age and gender of each scientist are also available in our dataset.

Methodology and econometrics model

To measure the effect of 'holding a research chair' on a scientist's research impact, we use a panel regression model where the left-hand-side variable is a measure for the number of citations. On the right-hand-side, the main independent variables are the research chair dummy variables. The other independent variables are our controls, among others age, gender, and funding. In terms of funding, this research only focuses on the effect of the operational budget because funding for the purpose of buying instruments or laboratory infrastructure does not have a regular pattern, implying that it depends on the research needs, field, and handiness of updated research instruments. We also measure the interactive effect of funding and holding a chair on scientific productivity in regression models to find out whether there is a difference between the funding effect of chair-holders and of non-chair-holders. We also control for university, year, and research division effect in order to account for any impact that our explanatory variables may not cover.

Analysis

The preliminary results show that the effect of holding a research chair on the number of citations depends on the type of chair: Canada research chair has a significant positive effect on the number of citations but other types of chairs do not have a significant effect. This finding highlights the special attributes of the Canada research chair program, which are not replicated in other types of chairs. Those specific attributes may significantly push scientific productivity and research impact. Among others, Canada research chairs are generally associated with some degree of prestige or higher visibility to recruit talented students or to have research collaboration with top scientists in the field. The fact that other types of research chairs do not have an impact on scientific community, implies not that these chair holders are lesser scientists, but that they are devoting part of their time to other endeavours of a more practical nature.

References

Amsterdamska, O., Leydesdorff, L., 1989. Citations: indicators of significance? Scientometrics 15, 449-471.

Bornmann, L., Daniel, H.-D., 2008. What do citation counts measure? A review of studies on citing behavior. Journal of Documentation 64, 45-80.

Cantu, F.J., Bustani, A., Molina, A., Moreira, H., 2009. A knowledge-based development model: the research chair strategy. Journal of Knowledge Management 13, 154-170.

Kostoff, R.N., 1998. The use and misuse of citation analysis in research evaluation. Scientometrics 43, 27-43.

Phelan, T., 1999. A compendium of issues for citation analysis. Scientometrics 45, 117-136.

Schimank, U., 2005. 'New Public Management'and the academic profession: Reflections on the German situation. Minerva 43, 361-376.

Seglen, P.O., 1997. Citations and journal impact factors: questionable indicators of research quality. Allergy 52, 1050-1056.

Barbara Ribeiro, Abdullah Gok and Philip Shapira

Societal needs as value propositions in innovation: A pilot study of societal claims in synthetic biology patents

Session 8C

Research and innovation are increasingly expected to provide solutions to societal grand challenges (Stilgoe et al. 2013; Wallace and Rafols 2015). Yet, scepticism continues to grow towards the benefits of science and technology, as well as criticism of mechanisms for its social accountability (Hessels and van Lente 2008; Tyfield 2012). Emerging technologies are often reproached for not delivering on the promises they sustain and produce (Hopkins et al. 2007; Gittelman 2016; Wiek et al. 2016). On the other hand, there is a visible trend that research and innovation are increasingly using notions of societal needs, challenges, and public benefit as value propositions to justify public sponsorship (Youtie and Shapira, 2016). The meaning and significance of these value propositions is thus intertwined at the nexus of values, societal needs, stakeholder interests, and strategic behaviour. In this paper, we probe these interconnections by investigating how societal needs are deployed as value propositions to rationalise innovations through a pilot study of societal claims in synthetic biology patents.

The study engages with two key perspectives in research governance: responsible research and innovation (RRI) and inclusive innovation (Ribeiro et al. 2016; Schroeder et al. 2016) for the social appraisal of translational research. We argue that RRI and inclusive innovation can work as complementary frameworks to allow for more comprehensive analyses of the societal and ethical dimensions of science and technology, which take into account the important, but often neglected, notion of social equity. RRI is not a new idea, but has garnered popularity and usage in scientific and policy arenas over the last few years including in the European Union's Horizon 2020 programme. RRI is a complex and integrative concept that addresses longstanding issues investigated by the field of science, technology and innovation studies. These include, for example, the anticipation of the impact of emerging technologies, consideration of alternative pathways, reflection around their social and ethical dimensions and public engagement with science and technology (Ribeiro et al. 2016). The notion of inclusive innovation overlaps in some ways with that of RRI, but it shows a stronger focus on the benefits that might be generated from innovation to poor and marginalised groups (Foster et al. 2013). Frameworks and articulations of inclusive innovation do not come without criticism. However, they represent an important alternative to expert-centred, top-down approaches to the governance of research and innovation coming from the fields of technology assessment and bioethics, for example. For some, despite its inherent challenges, inclusive innovation can work as a tool for social development, where social justice is central to the innovation process (Smith et al. 2013).

In the context of these two increasingly popular frameworks, a key argument that deserves attention is that technological innovation does not automatically translates into benefits for a larger part of the population (i.e. beyond those groups directly involved in the sociotechnical system and the elites who can pay for these advancements) (Cozzens and Wetmore 2011). The question of whose and what values are accounted for in the development of science and technology and their social appraisal (Sarewitz 2016) demands a focus on equity and articulations of societal needs (Grimshaw et al. 2011). This complements and expands economic approaches to the analysis of the societal benefits of technology and innovation. In order to widen the scope of social appraisals we must understand how societal needs, benefits (and potential negative impacts) are defined in translational research. Wellhausen and Mukunda (2009), for example, highlight the risk of political debates being dominated by the actors responsible for the development and commercialisation of synthetic biology, e.g. by advanced industrial economies from the North, while overlooking the perspectives of developing economies from the South.

With the objective of contributing to approaches in both fields of RRI and inclusive innovation, in this paper we address the question of what is the 'value proposition' of innovation. We put forward a method to map public values embedded in relevant patent applications. Patent applications suggest specific pathways towards which translational research is pointing and embed a range of societal values about how inventions will contribute to the useful realisation of needs not otherwise met by existing applications. By investigating the value propositions of inventions through claims made in patent documentation, a narrative is constructed about objectives and expectations related to new developments in science and technology. We pilot this approach by examining patent applications in the synthetic biology of fine and specialty chemicals – an emerging domain that is justified by expectations that it will contribute to a range of societal needs including environmental protection and greenhouse gas reduction, reduced or higher value use of non-renewable natural resources, enhanced human welfare, and economic development. The main objectives of our study are to:

1. Identify and map the different sets of value propositions (understood as general claims about the economic, societal and/or environmental benefits of patents applications) articulated in the field of synthetic biology (specifically that of fine chemicals).

2. Investigate how these value propositions are articulated and create a typology that will assist in identifying the groups and interests targeted by these propositions.

3. Analyse implications and consider how this approach be further operationalized as a support-tool for decision-making in science and technology policy.

Empirically, we will employ a text analysis of over 2,000 patents in the field of synthetic biology. We will use text-mining techniques on the patent full text to disentangle the value propositions by employing rule based and machine learning approaches. We will then create a typology of value propositions based on this analysis. Finally, we will conduct a statistical analysis to explore various relationships between the characteristics of inventions and innovators and the value propositions in their inventions.

We argue that reflection on the values embedded in innovative technologies is a key step in the evaluation of research and in the anticipation of potential positive and negative impacts of science and technology. Most importantly, shedding light on these values can be helpful in understanding what are the directions being taken by translational research in a given field and how we might shape (and ultimately align) innovation to the needs of broader publics.

While we are often bombarded with allusions to ‘societal needs’ and ‘grand societal challenges’ in both the academic and policy discourse, very few times these needs and challenges are precisely defined so one can grasp the different values embedded in them. This constant black-boxing of the social and value dimensions of new technologies is detrimental to many forms of assessment and to policy-making (Raman et al. 2015). Especially when combined with deliberation activities, we believe that the approach outlined in this paper is useful as a supporting tool for RRI and inclusive innovation programmes, as well as for deliberation and decision-making in science and technology policy.

Nicolas Robinson-García, Irene Ramos-Vielba, Rodrigo Costas, Pablo D'Este and Ismael Rafols

Do altmetrics indicators capture societal engagement? A comparison between survey and social media data

Session 8C

Social media are seen as a potential channel for targeting stakeholders to accelerate the translation of relevant findings from scientific literature to practice (Grande et al., 2014). Such potential has raised expectations on altmetrics as a potential source of data to develop quantitative methods of societal impact analysis (Wilsdon et al., 2015). However, recent research has raised serious concerns on the validity of current altmetrics measures as direct indicators of societal impact (Sugimoto et al., 2016).

In this study, we explore whether altmetric indicators are related to societal engagement activities as self-reported in a large-scale survey. The population surveyed consists of researchers currently affiliated with Spanish institutions. They were invited to respond a set of questions regarding their interactions with non-academic stakeholders as well as their use and perceptions on social media as part of their involvement in dissemination activities.

Few studies have constrasted altmetric data with surveys on engagement. If so, they have done it in a tangential manner. For instance, Haustein and colleagues (2014) surveyed researchers from the field of bibliometrics in order to understand their use and perception of social media for scholarly communication. They found that a high proportion of scholars in this community do use social media platforms and that their work was highly covered (especially by Mendeley), concluding that altmetrics could be a potential source of impact data (without specifying what type of impact). Grande and colleagues (2014) focused on the field of Health Policy. In this case, they did not look at altmetric indicators. They surveyed health policy researchers to find out their use of social media and gain insights on their motivations for doing so. The study considered social media platforms as a good venue to interact and engage stakeholders in order to accelerate the introduction of policy relevant findings into practice. Still, they concluded that researchers' perceptions and motivations for using social media needed to shift for this to happen.

This study compares altmetric indicators against interactions scholars have reported to have with non-academic stakeholders. The study will also study the differences and similarities among scientific fields in terms of altmetrics and self-reported engagement. We will analyze the publication record of 12,115 respondents to a survey from all fields of science who published at least one paper during the 2012-2014 period indexed in the Web of Science database. The on-line survey was conducted between June and July of 2016. Respondents were enquired to indicate the variety of stakeholders with whom they interacted (e.g. firms, government agencies, NGOs, hospitals, or civic organizations), types and frequency of interactions (both through formal and informal mechanisms) and dissemination strategies of research findings (use of both analog and digital means for transmission purposes to broader audiences).

We will compare their responses with the actual coverage of their work in social media, parting from the perceived hypothesis that researchers with a highly-disseminated oeuvre through social media (high altmetric scores) will be those who are actively engaging with non-academic stakeholders in an informal way. We will use the CWTS author disambiguation algorithm (Caron & van Eck, 2014) to identify the journal publications of respondents using the CWTS in-house version of the Web of Science. Altmetric data will be pulled from Altmetric.com. Currently one of the largest provider of altmetric data, capturing metrics from more than 10 different social media platforms (Robinson-Garcia et al., 2014).

References

Caron, E., & van Eck, N. J. (2014). Large scale author name disambiguation using rule-based scoring and clustering. In 19th International Conference on Science and Technology Indicators. 'Context counts: Pathways to master big data and little data' (pp. 79–86). CWTS-Leiden University Leiden.

Grande, D., Gollust, S. E., Pany, M., Seymour, J., Goss, A., Kilaru, A., & Meisel, Z. (2014). Translating Research For Health Policy: Researchers' Perceptions And Use Of Social Media. Health Affairs, 33(7), 1278–1285. https://doi.org/10.1377/hlthaff.2014.0300

Haustein, S., Peters, I., Bar-Ilan, J., Priem, J., Shema, H., & Terliesner, J. (2014). Coverage and adoption of altmetrics sources in the bibliometric community. Scientometrics, 101(2), 1–19. https://doi.org/10.1007/s11192-013-1221-3

Robinson-Garcia, N.; Torres-Salinas, D.; Zahedi, Z.; Costas, R. (2014). New data, new possibilities: Exploring the insides of Altmetric.com. El Profesional de La Información, 23(4), 359-366. doi:10.3145/epi.2014.jul.03.

Sugimoto, C. R., Work, S., Larivière, V., & Haustein, S. (2016). Scholarly use of social media and altmetrics: a review of the literature. arXiv Preprint arXiv:1608.08112. Retrieved from https://arxiv.org/abs/1608.08112

Wilsdon, J., & al. (2015). The Metric Tide: Report of the Independent Review of the Role of Metrics in Research Assessment and Management. (No. DOI:10.13140/RG.2.1.4929.1363).

R. Sandra Schillo and Hassan Ebrahimi

Measuring S&T Collaborations in Government Laboratories – The Potential of Multi-Criteria Decision-Making Techniques

Session 7D

Introduction

Science and Technology (S&T) collaborations continue to attract much interest among academics and policy developers (Bozeman and Boardman, 2014; Bozeman et al., 2013; Perkmann et al., 2013). Of particular importance to both academic rigour and policy evaluation is the measurement of such collaborations and their impacts, a topic that has seen a surge in recent interest (Albats et al., 2017; Cheah, 2016; Rossi and Rosli, 2015).

Much extant research covers universities, or includes both universities and government laboratories. Government laboratories share considerable similarities with universities with regards to their scientific and technological activities. However, in terms of their mandates, there are also considerable differences and the recent work on indicators development for university-industry collaborations cannot necessarily be directly applied to government laboratories. One important aspect to note with regards to government laboratories is that there are usually several mandates any laboratory, and especially any government department or agency is expected to address. Thus, while measures should be simple, they also need to account for multiple actual missions of government laboratories (Hicks et al., 2015; Schillo and Kinder, 2017).

The field of multi-criteria decision making has started to address a range of topics relevant to public sector S&T measurement over the past decade. These approaches can account for multiple objectives, such as multiple mandates. However, while there is a growing number of publications focusing on specific government projects or programs, applying such methods at the policy level is more complicated (Schillo et al., 2017).

This paper provides an overview of the current state of the art with regards to measurement of S&T collaborations, with special emphasis on aspects that are differentiate government S&T collaborations from those in universities, as well as indicators that capture current and emerging trends in S&T collaborations. We then summarize recent work applying multi-criteria decision to S&T policy or related contexts. Finally, we discuss the current state of the literature to draw conclusions for research measuring S&T collaborations and the potential contributions of multi-criteria decision-making to the topic.

S&T collaborations

The full paper will provide a literature review of indicators used or proposed for measuring S&T collaborations, including traditional measures including publications and patents. Our analyses show that there are a number of emerging trends in S&T collaboration measurement that reflect trends in S&T collaborations themselves. Firstly, openness in science and technology has undergone substantial changes over the past ten to fifteen years. While S&T collaborations have, by definition, always been about openness in some aspects, and trends towards different forms of openness, e.g. ‘open science’, ‘open innovation’, ‘open data’, and ‘open government’, are not a new phenomenon, the pressure for government laboratories to participate in and have policies and practices reflecting ‘open trend’ is increasing. Thus, there is increasing pressure to measure aspects of S&T collaborations that reflect this.

Secondly, there is a trend within the innovation community towards responsible innovation (Strand et al., 2015) and inclusive innovation (Paunov, 2013), as well as responsible science (Resnik and Elliott, 2016). Implications of this trend would presumably affect the measurement of S&T collaborations in terms of dimensions of measurement considered important and require additional data not always collected in the past. For example, instead of tracking the application of scientific results, it would become important to measure who (which stakeholder groups) are applying the results, and who is benefiting from the application in terms of economic outcomes, but also in terms of social and environmental outcomes.

Thirdly, there is a quickly growing field of research utilizing web-based indicators to measure science, technology and innovation, including collaborations (Gök et al., 2015). This also affects publication measures, which have traditionally formed the backbone of S&T collaboration measurement. But it may also be possible that additional analyses of data

from web sites and social media might provide more insights into the nature of S&T collaborations.

Finally, a small number of very recent publications suggest the more dynamic nature of S&T collaborations not previously captured in indicators may feature more prominently in future work. For example, the more formal consideration of the complexity of innovation systems (Katz, 2016), and the consideration of collaborations at different life cycle stages (Albats et al., 2017) may allow for more fine-grained analysis of S&T collaborations in the future.

Comments on S&T collaborations and Multi-Criteria Decision Making

The final paper will summarize the multi-criteria decision making literature before discussing their application to S&T collaborations. The most direct link exists between the consideration of multiple mandates of government science and technology activities and the ability to take into account multiple objectives. By extension, this also means that if governments place increased emphasis on responsible science and innovation or similar considerations, multi-criteria decision making may also facilitate decision-making. However, our preliminary analyses also show that at this time, applying such methods at department and agency levels, or even government-wide levels remains a challenge. From a practical perspective, such efforts would require large amounts of data, much of which may not currently be collected. In addition, at higher levels of aggregation, the systemic influences of seemingly unrelated policies, programs and external conditions may have greater influence, but may remain difficult to capture.

Bibliography

Albats, E., Fiegenbaum, I., Cunningham, J.A., 2017. A micro level study of university industry collaborative lifecycle key performance indicators. The Journal of Technology Transfer, 1-43.

Bozeman, B., Boardman, C., 2014. Research Collaboration and Team Science - A State-of-the-Art Review and Agenda. Springer.

Bozeman, B., Fay, D., Slade, C.P., 2013. Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. The Journal of Technology Transfer 38, 1-67.

Cheah, S., 2016. Framework for measuring research and innovation impact. Innovation 18, 212-232.

Gök, A., Waterworth, A., Shapira, P., 2015. Use of web mining in studying innovation. Scientometrics 102, 653-671.

Hicks, D., Wouters, P., Waltman, L., De Rijcke, S., Rafols, I., 2015. The Leiden Manifesto for research metrics. Nature 520, 429.

Katz, J.S., 2016. What is a complex innovation system? PloS one 11, e0156150.

Paunov, C., 2013. Innovation and inclusive development: a discussion of the main policy issues. OECD Science, Technology and Industry Working Papers 2013, 0_1.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. Research policy 42, 423-442.

Resnik, D.B., Elliott, K.C., 2016. The Ethical Challenges of Socially Responsible Science. Accountability in Research 23, 31-46.

Rossi, F., Rosli, A., 2015. Indicators of university–industry knowledge transfer performance and their implications for universities: evidence from the United Kingdom. Studies in Higher Education 40, 1970-1991.

Schillo, R.S., Isabelle, D.A., Shakiba, A., 2017. Linking advanced biofuels policies with stakeholder interests: A method building on Quality Function Deployment. Energy Policy 100, 126-137.

Schillo, R.S., Kinder, J.S., 2017. Delivering on societal impacts through open innovation: a framework for government

laboratories. The Journal of Technology Transfer, 1-20.

Strand, R., Spaapen, J., Bauer, M.W., Hogan, E., Revuelta, G., Stagl, S., 2015. Indicators for promoting and monitoring responsible research and innovation: report from the expert group on policy indicators for responsible research and innovation.

Luis Sanz-Menéndez and Laura Cruz-Castro

An experimental approach to trust in scientists and its interactions with sources of information: the case of climate change

Session 5D

Relevance

There is widespread agreement in the social sciences that citizens' trust is an essential factor in the functioning of our societies, political and economic institutions. Since the late 70, the literature has documented a crisis of confidence in western societies, affecting mainly governments, institutions and personal relations. Such crisis would have extended also to science and lead to increasing concerns about trust in science and in scientists and about the credibility of scientific institutions and scientific results.

There is also evidence that citizens generally distrust governments and that there has been a radical reduction of trust in governments and government reporting, despite public efforts of transparency, openness and accountability. Traditionally, the confidence in science on the one hand, and the credibility in government and other social agents on the other hand, have been addressed independently. In this paper we will try to bring together the two issues.

Key issues and research questions

Trust is a multifaceted construct that includes aspects of rational thinking but also other factors such as emotions, perceptions of credibility, perception of trustworthiness or world views. We contend that due to the nature of trust, people are most likely to determine their level of trust using a combination of components, such emotions and rational thought, which in some contexts could be highly interrelated. There are at least two interactions worth mentioning: a) The perceived credibility of scientists or the scientific process may substantially influence of trust because there are some elements of credibility (integrity, motivations, etc.) that could be taken on board when determining the level of trust. b) Trustworthiness, the extent to which an individual finds a situation or people worthy of trust, is an attribute that people assign to situations or individuals and it is used as a base for determining trust.

As scientific developments and findings about issues such as climate change move from the scientific community into the society, the public is exposed to situations in which they may be asked to make decisions associated with those issues. If the development is complex and difficult to comprehend, and in the absence of direct exposure or experience, people may rely on their feelings of trust when responding to scientific issues and trust could be influenced by emotions that could be the source of subjective decision-making regarding science issues; this could lead to decreased societal support for science.

Previous research on trust in science and scientists by citizens have demonstrated that despite some general factors shaping the behavior and attitudes, trust in scientists and scientific results is highly specific and contextual.

Science developments are a source of knowledge about nature, however more and more specific and contextual science issues have become part of controversies. "Climate change" has become an issue emerging from scientific research that have become part of the public debate and has become highly politicized and controversial.

The specific context of our research relates to "climate change" research and indicators. For more than fifty years, and now as a part of the Paris Agreement, countries have to make estimates about the evolution of the greenhouse gasses emission (CO2 equivalent emission). There are international commitments for the reduction of emissions and regular diffusion of information about the evolution. Then the topic, not directly related with the material conditions of individuals, offers an opportunity to address the issue of the trust in scientific information and the effects of the different sources of its diffusion.

There are three main frameworks to explain differences in the perception of the credibility of information. One related to knowledge and interest which suggest that science authority and credibility depends on the citizens' level of knowledge. A second one related to attitudes, values and beliefs, and a third stream that would favor general and interpersonal levels of trust as main explanatory factors.

In this paper we aim to address three interrelated research questions: Does the institutional origin of the scientific information affect its credibility? Which is the effect of the source of information on the citizens' confidence on climate change scientific measures? Which are the factors associated to a higher or lower confidence in the different sources of information about scientific results?

Methodology and experimental research design

To empirically address these questions, we have designed an experiment. More precisely, we have taken a population-based survey experiment approach, in which experimental subjects are randomly assigned to conditions by the researcher, and treatments are administered as in any other experiment. The experimental approach solves the problems of internal and external validity of traditional observational based analysis and provides elements to better identify causality. Our data comes from a personal interviews-based survey implemented in Spain by FECYT and administered to almost 6500 individuals, with five different treatments randomly allocated to the subsamples.

The idea was to measure the level of citizens' trust on the scientific information reported (the same in all cases) about the evolution of CO2 emissions in Spain, between 2011 and 2015, but attributed to five different institutional sources: the different sources are the "treatments". The institutional providers of the scientific information were: a) the Spanish Government, b) the United Nations-IPCC, c) Greenpeace, and d) European Automobile Manufacturing Association. Additionally the fifth source was attributed to a consortium of Spanish Public Research Organizations and universities); we understand that respondents exposed to this last source could be a "control group", in scientific information is reported through scientific institutions.

Results

Based on the previous literature, our expectation is that the highest level of trust in the information provided will be found among respondents in the control group. Scientific information provided by the Business Association on this matter will have the lower level of trust, whereas Government as a provider of scientific information will be positioned in between the other two sources.

Preliminary results confirm the expectation of significant differences, measured by average means, in the trust in scientific information coming from different sources. Findings provide robust insights about whether citizens find scientific information on climate change more or less credible depending on the institutional source.

Trust and credibility of scientific information about CO2 emissions vary significantly between different sources of information. As expected, information was found to be more credible if provided by scientific institutions, indicating a positive intermediary role which is policy relevant. In the aggregate, models reveal that the influence of factors associated with knowledge and interest on the credibility given to scientific information is limited. Most relevant factors are related to interpersonal trust, and institutional confidence, although, in some cases, not in the expected directions.

Edgar Schiebel and Beate Asenbeck

The Knowledge Growth Factor KGF as a new indicator for the quantification of the emergence of researchissues - The case of tribological wear

Session 10A

Acknowledgement: This work was funded by the Austrian COMET-Program (Project K2 XTribology, Grant No. 849109) and has been carried out within the Excellence Centre of Tribology.

We propose a new bibliometric indicator called Knowledge Growth Factor (KGF). It goes back to the assumption that a community of researchers is interested and active in an issue with a rapid growing number of published documents going along with a growing number of cited references. Such a quickly growing accumulation of knowledge over time should outperform that one of declining or saturating ones.

Background

The ability to detect emerging research issues has become more urgent due to actors like policy makers, managers of research organizations and universities as well as R&D managers wanting to know where to invest in the future or how to develop a good strategic position for their organization. Bibliographic coupling and co-citation analysis are established bibliometric approaches to delineate research fronts and the underlying knowledge bases, see Kessler, M.M. (1963) and Boyack, K. & Klavans, R. (2010). But there is a lack on indicators for the quantification of emergence. Just a few publications cover this issue. For example Jaric, I et al (2014) used the relative age of references and the ratio of references published 2 years before. They observed that the first indicator showed a lower median age of references and a higher ratio index for emerging research topics.

We propose to use a dataset of publications of one year for the identification of research fronts and to analyze the timely growth of the number of cited references. A research front is then defined as more current (emerging) the newer the vast majority of the references in comparison to the others are. Moreover using references has the advantage that only accepted documents are taken into account.

Methodology and data

We worked with data of published papers on tribological wear for the year 2015, collected from the Web of Science database. In a first step we identified research fronts with bibliographic coupling and generated 36 subsets of similar publications according to a procedure presented in Schiebel et al (2016). From this data the references and their publishing year got extracted, ordered by year and counted.

This leads to the absolute number of references by year r_t. As some papers include references that are too old, a time frame has to be selected. For a normalization the value of the first year i has to be set to zero, which leads to $r_t - r_i = k_t$. The absolute numbers are now summed up with their

previous years $\sum_{k=i}^{n} k_t$, with n being the last available year to express the cumulated knowledge over the time span. Each term of this series expresses the new values b_t.what is the number of cumulated references of previous years for each year.

For the analysis of the shape of the time series of accumulated number of references for each data set of each of the 36 research fronts the authors experimented with three methods of calculation which include numerical integration (KGF_I), fitting (KGF_F) and the Gini coefficient (KGF_G).

Numerical integration of the discrete values b_t. i and n is based on the idea, that the more recent the knowledge growth is, the smaller the calculated value is. The values get normalized to take on numbers between 0 and 1, which are inversed for reason of comparability with the other methods.

Fitting is based on the exponential growth of knowledge. This can be argued with the half-life of knowledge, as for example described by Siemens G. (2013). Therefore the logarithmic value of b $\ln(b)$ indeed leads to a nearly linear curve. The KGF is defined by the slope of the straight line.

The Gini coefficient is a measurement of statistical dispersion. It shows the deviation of real knowledge growth shown in a Lorenz curve in comparison to linear knowledge growth. Two bijective sets have to be identified and the terms of their series normalized to values between zero and one. The sets are a, which includes the constant reciprocal of $(n-i)$ and b, which includes all b_t. These values have to be constant or rising. The terms of the series $x_n = \sum_{\tau=i}^{n} a_\tau$ and the terms of the series $y_n = \sum_{t=i}^{n} b_t$, both normalized to take on values between zero and one are generating a Lorenz curve. The Gini coefficient is calculated by $Gini = \frac{A-B}{A}$ where A is the value of numerical integration of the equal distribution and B is the value of numerical integration of the Lorenz curve.

The three factors are tested on the data sets of our research fronts, compared by rank and discussed by experts.

Results for research fronts of research on tribological wear

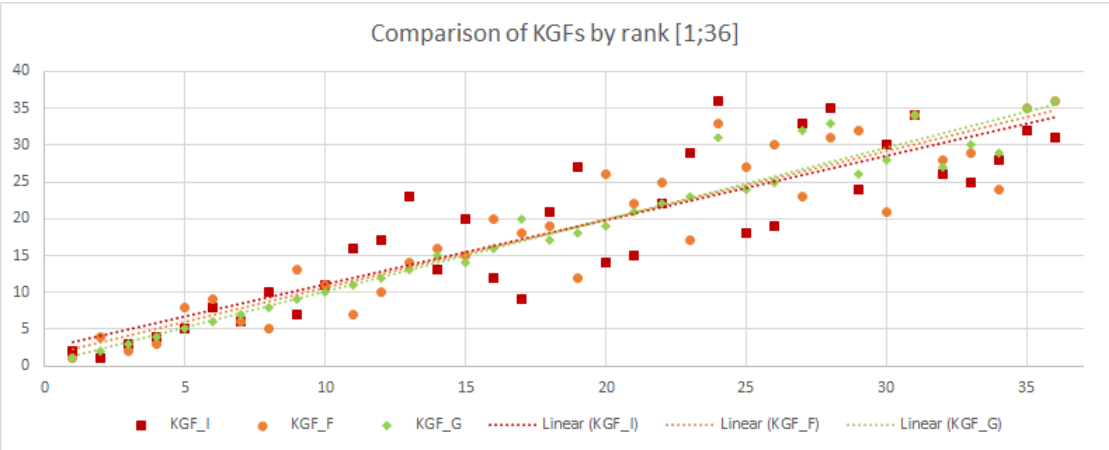


Figure 1: Ranks of KGF values for Research Fronts (RF) in tribological wear, RF sorted by descending average value of KGF_I, KGF_F and KGF_G; publications of the year 2015; time series of references from i=1990 to n=2014 with τ=n-i

Linear fitting in shows that the coefficients of determination are: KGF_F R^2=0,8558, KGF_G R^2=0,9502 and KGF_I R^2=0,7628. The Gini coefficient KGF_G leads to the most precise results for the KGF.

Conclusions

The selection of publications of the last available complete year guaranties that current research fronts can be identified. The quantification of the emergence and growing of issues is measured by the shape of the time series of the age of cited references per year. Testing three different indicators the Gini coefficient seems to be a good method to indicate the emergence of new research issues. Calculated for identified subsets of documents as research fronts of tribological wear, a high Gini Index indicates a relative higher growth in the late years of a longer time series. Experts in tribology research validated that traditional research issues were indicated with a low Gini index and new upcoming ones with a high Gini index. The set of all publications for tribological wear showed a mean value for the indicator in concert with the other identified research fronts. The Gini index refers to the shape of the whole time series and quantifies the richness of cited work of scientist of the last years and not just singular effects or selected years. This first investigation suggests the Gini index to be a valid indicator to measure the Knowledge Growth Factor of a research front. Our approach is going to be tested on more cases, currently on tribology as a whole research field and its research fronts as well as industrial biotechnology to estimate accuracy and general validity of the KGF.

References

Boyack, K. & Klavans, R., (2010) Co-Citation Analysis, Bibliographic Coupling, and Direct Citation: Which Citation Approach represents the Research Front Most Accurately?, *JASIST* 61(12): 2389-2404.

Jarić, I., Knežević-Jarić, J. & Lenhardt, M. (2014), Relative age of references as a tool to identify emerging research fields with an application to the field of ecology and environmental sciences, *Scientometrics* 100: 519. DOI: 10.1007/s11192-014-1268-9

Kessler, M.M., (1963), Bibliographic coupling between scientific papers, *Journal of the American Society for Information Science and Technology, JASIST,* 14, 10-25, DOI: 10.1002/asi.5090140103

Schiebel, E., Bianchi, D. and Vernes, A. (2016), Bibliometric field delineation with heat maps of bibliographically coupled publications using core documents and a cluster approach—the case of multiscale simulation and modelling. COST *Action Knowescape TD1210*, Budapest Workshop "Identification, location and temporal evolution of topics – August 29-30

Siemens, G. (2004). Connectivism, A learning theory for the digital age. *International Journal of Instructional Technology & Distance Learning, 2*(1), Retrieved from http://www.itdl.org/journal/jan_05/article01.htm

Johan Schot, Ed Steinmueller, Laur Kanger, Matias Ramirez and Chux Daniels

Enacting Transformative Innovation Policy: A Comparative Study

Session 3A

The world is in transition. Many interlocking environmental, technological, economic, political and cultural trends such as resource depletion, population growth, industrialization, urbanization, inequality or individualization are creating collective challenges (United Nations, 2015) that exceed the ability of any single country, body of governance or scientific discipline to manage them. Our innovation engine is faltering with the fruits of creative destruction increasingly morphing into destructive creation (Soete, 2013). It is amply clear that traditional STI policy has not delivered on these challenges nor are there good reasons to expect that it would do so in the future. Socio-technical systems need to be significantly reconfigured and STI policies re-invented to rise to the grand challenges. What is needed is not just the improvement of existing STI policy but adding a whole new set of rationales and instruments which would amount to a truly transformative innovation policy.

This diagnosis and respective solutions have recently begun to be articulated under many different labels, for example, Responsible Research and Innovation (Stilgoe et al., 2013), inclusive innovation (Agola and Hunter, 2016), social innovation (Joly, 2016) or the governance of sustainability transitions (Grin et al., 2010). While differing in many aspects the basic themes of these approaches seem to be recurrent: attention to alternative futures and the co-production of science, technology and society, emphasis on the non-neutral nature of technology, focus on disruptive socio-technical systems change in addressing societal and environmental challenges, stress on the transformative potential of civil society and attentiveness to the needs and wants of users and non-users alike. This has led to a suggestion that we might be witnessing the emergence of a new framing of STI policy (Weber and Rohracher, 2012; Schot and Steinmueller, 2016), one markedly different from traditional approaches to STI policy-making that have focused on boosting R&D, promoting entrepreneurship or building innovation systems.

While necessary, this shift in focus is also most challenging requiring new skills, new ways of participation, new capability-building, new ways of monitoring, new ways of assessing progress, new ways of managing conflict between stakeholders and so forth. It is therefore informative to conduct an exploratory study on the enactment of transformative innovation policy initiatives. Therefore, the paper focuses on the following research questions:

1. How has the challenge of transformative innovation policy been interpreted in different countries? What kind of initiatives have been undertaken as a response?

2. What are the main opportunities for enacting transformative innovation policy? What are the main barriers?

3. How does the broader national and international context facilitate or hinder specific transformative innovation policy initiatives?

The empirical part of the research is based on case studies of transformative innovation policy initiatives in five different countries, each representing a member of the Transformative Innovation Policy Consortium – Norway, Colombia, South Africa, Sweden and Finland. Cases are selected according to the following principles: 1) directionality: focus on alternative futures associated with technological design choices; 2) goal: focus on grand environmental and/or social challenges; 3) impact: focus on socio-technical systems and system-level issues; 4) degree of learning and reflexivity: focus on second-order learning, problematization of operating routines of different actors and the creation of spaces for experimentation; 5) conflict: focus on disruptive change, possibly resulting in major disagreements between actors; 6) inclusiveness: focus on initiatives with a broad base of participation, including the consideration of non-users as potentially affected parties. The data is collected through semi-structured interviews and the analysis of policy documents.

References

Agola, N. O., and Hunter, A. (Eds.). 2016. Inclusive Innovation for Sustainable Development: Theory and Practice. London: Palgrave Macmillan UK.

Grin, J., Rotmans, J., and Schot, J. 2010. Transitions to Sustainable Development: New Directions in the Study of Long

Term Transformative Change. New York: Routledge.

Joly, P.-B. 2016. Beyond the competitiveness framework? Models of innovation revisited. Journal of Innovation Economics & Management (forthcoming).

Schot, J., and Steinmueller, E. W. 2016. Framing Innovation Policy for Transformative Change: Innovation Policy 3.0. Working paper. Available online: http://www.johanschot.com/wordpress/wp-content/uploads/2016/09/SchotSteinmueller_FramingsWorkingPaperVersionUpdated2018.10.16-New-copy.pdf.

Soete, L. 2013. Innovation, growth and welfare: from creative destruction to destructive creation. Paper for the SPRU DIG-IT workshop Inclusive Growth, Innovation and Technology: Interdisciplinary Perspectives. Available online: https://www.sussex.ac.uk/webteam/gateway/file.php?name=soete-dig-itworkshopsoete.pdf&site=25.

Stilgoe, J., Owen, R., and Macnaghten, P. 2013. Developing a framework for responsible innovation. Research Policy 42(9): 1568-1580.

United Nations. 25.09.2015. Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly. Available online: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

Weber, K. M., and Rohracher, H. 2012. Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures'

Elaine Sedenberg

Barriers and workarounds for academic access to private sector data for research purposes

Session 1

Traditional models of data access revolve around novel, small-scale data collection or use of open datasets—often requiring government investment and curation. Today's instrumented and connected world leads to a host of data collecting sensors, "smart devices," transactional logs, and web platforms—almost all of which are developed and deployed by the private commercial sector. These data are diverse, plentiful, and often intimate since devices cohabitate with us, and information systems connect our social and perfunctory lives. The raw inferential power of this information has not been lost on tech companies, and data are often viewed as an asset. These private sector data are of rich interest to academics, and gaining access for observational or experimental study is an exception instead of a rule. Though the desire to study such data are widely discussed informally among academics, little work exists articulating the needs, sharing incentives, or access barriers. Using qualitative data from semi-structured interviews with both industry and academics, this study explores the unique privacy and ethical dilemmas presented when academics conduct research on private sector data, legal barriers to sharing, and new pressures on academic freedom via research product restrictions. This study also articulates the elements of successful cases of industry-academic partnerships, and the legal and structural arrangements that were made to overcome barriers to access and use. In conclusion, possible policy remedies and incentives are considered to encourage the responsible sharing of private sector data for research purposes.

Philip Shapira, Abdullah Gok, Chao Li, Fatemeh Salehi, Gennady Belyakov, Milana Shapira, Seokkyun Woo, Sergey Kolesnikov, Yanchao Li and Jan Youtie

The Ig Nobels – Who Wins What and Why?

Session 10C

The Ig Nobel Prize "honors the most eccentrically innovative minds and their unique endeavors in the sciences, arts, and humanities." (Abrahams, 2006). Ig Nobel prizes have been awarded annually since 1991 by Nobel Prize winners at a Harvard University ceremony organized by the Annals of Improbable Research. Each year, there is an eclectic mix of laudations honoring Ig Nobel Prize winners, including for measuring brainwave patterns resulting from chewing different flavors of gum (Biology, 1997), how difficulties in recognizing one's own incompetence leads to inflated assessments (Psychology, 2000), levitating a frog with magnets (Physics, 2000), showing that rats sometimes cannot tell the difference between a person speaking Japanese backwards and a person speaking Dutch backwards (Linguistics, 2007), and inventing a chemical recipe to partially un-boil an egg (Chemistry, 2015). The work that results in such prizes is typically peer-reviewed science that often only subsequently is appreciated also to be funny. Ig Noble prizes are also awarded for ironic or paradoxical societal "contributions" such as the award to Baring's Nick Leeson for "using the calculus of derivatives to demonstrate that every financial institution has its limits" (Economics, 1995) or to the British Royal Navy which sought to save money by "ordering its sailors to stop using live cannon shells, and to instead just shout 'Bang!'" (Ig Nobel Peace Prize, 2000). In all cases, Ig Nobels are awarded only for scientific research that actually occurred or for societal events that are verifiable and real. Ig Nobel Prize winners are selected by the "Ig Nobel Board of Governors" comprising the editors of the Annals of Improbable Research and a "considerable number" of scientists (including Nobel Prize winners), journalists and others from among many thousands of nominations sent in each year (Abrahams, 2002). Ig Nobel Prize nominees are given the opportunity to decline the award before it is made public, although very few do.

The Ig Nobel prizes and the associate prize award ceremonies are indeed humorous and entertaining and, in recent years, have attracted increasing attention through both conventional and new media channels. National Public Radio has broadcast the Ig Nobel award ceremonies since 1993, while internationally recognized press outlets now feature the awards (see, for example, BBC News, 2016; The Guardian 2016; Los Angeles Times, 2016). A live online video feed of the Ig Nobel ceremony has been offered every year since 1995. Views of the video of the annual Ig Nobel ceremonies on You Tube total more than 240,000 over the period 2012-2016 (as a benchmark, for the main Nobel Prize ceremony, the equivalent number of views is just over 500,000 – deservedly twice as many, but not an order of magnitude higher!).

Following the development of a data set of Ig Nobel Prizes and multiple associated variables, we examine 253 Ig Nobel Prizes awarded to 595 recipients from 1992 to 2015 (we will update to 2016). We report here some initial descriptive findings. The awards are given to single individuals (for example, sole authors of papers), to multiple authors of a single paper, to two or more papers and their authors, and organizations. The most common arrangement is multi-authored papers receiving a single award, which comprised 62% of the prize recipients. Twenty percent of the recipients are involved with awards split between two papers. Sixteen percent of the recipients are single individuals. Organizations accounted for 3% of the prize recipients. In a given year, anywhere from nine to 13 prizes are awarded. The fields in which these prizes are awarded can vary but most often are for Chemistry, Medicine and Physics (25 years each). Peace awards are the next most common at 23 years, followed by Biology (21 years), Literature (21 years), and Economics (20 years). Roughly half of the years had awards for Psychology (12 years) and Public Health (10 years). Less common were awards for Mathematics (7 years), Nutrition (6 years), Engineering (5 years), and Art (3 years). Ten additional categories were offered in two years and 29 categories were uniquely offered for one year only.

Grouping these categories into broad areas, using the OECD disciplinary coding of science and technology fields, we see that 38% of the awards are in natural sciences, 20% in medical and health, 16% in social sciences, 11% in humanities, 20% to recognize "Peace" efforts, and 18% in engineering and technology. The biggest change over time in topical area is the rise of medical-related prizes in the most recent period. Most, but not all, of the prizes are for

scholarly work. Seventy-four percent reference an academic paper, while the remainder refers to news articles (9%), books (7%), patents (5%), reports (3%), or other documents (e.g., artifacts, reports, theses, films, mandates, or software). Scientific papers are increasingly becoming the primary medium of this prize. In the 1991-1999 period, 60% of Ig Nobel laudations reference scientific papers. In the 2000-2007 period, 71% reference scientific papers. In the 2008 to 2015 period, 88% reference scientific papers. By region, 55 countries are represented among award recipients. Most recipients come from countries north of the equator, although there is representation in Latin America and Africa. Europe and the Americas have the largest number of recipients. These two regions account for 77% of the first authors and 73% of all authors. The US has the most recipients at 200, comprising 34% of all recipients, followed by the UK at 81 or 14% of all recipients, and Japan at 67, or 12% of all recipients. When considering the countries of the first named recipient in the award laudation, the US has the most at 32%, the UK second at 12%, and Japan third at 11%.

In the paper for the Atlanta Conference on Science and Technology Policy, we will further present our analysis of who are the Ig Nobel Prize winners. In addition to probing where they come from, we will examine what scientific research or societal endeavor is associated with their selection. Are there topics that more frequently catch the eye of the Ig Nobel Board of Governors? Since no records are kept of the selection process (Abrahams, 2006), analysis of the prizes (including of information publicly available on authors, laudations, underlying peer-reviewed research, scholarly citations, and news and social media mentions) will be used to provide answers to the seemingly improbable questions as to who wins Ig Nobel Prizes and for what and why?

This paper is put forward as the opening paper in a proposed session on “Science that makes you laugh then think! What can be found when science is seen through the looking glass of the Ig Nobel prizes?” It will provide context, to understanding the Ig Nobel phenomenon and its role in education and explanation of outlandish scientific and societal achievements. It forms part of an international project on the analysis of the Ig Nobel Prizes that applies bibliometrics and datamining techniques to topics that that arguably they should not be applied to. But, as this paper will demonstrate, when they are applied, the results that are produced are both humorous and insightful (in keeping with the theme) and lively discussion will be provoked. The authors named on this paper all contributed to the project.

References

Abrahams, M. 2002. Ig Nobel Prizes: The Annals of Improbable Research. Orion, London.

Abrahams, M. 2006. The Man Who Tried to Clone Himself: And Other True Stories of the World’s Most Bizarre Research and the Ig Nobel Prizes. Plume (The Penguin Group), London.

The Guardian, 2016. Ig Nobel prizes: trousers for rats and the truthfulness of liars, September 22. https://www.theguardian.com/science/2016/sep/22/ig-nobel-prizes-trousers-for-rats-and

Los Angeles Time, 2016. Studies on the perils of polyester underwear and the personality of rocks win Ig Nobel Prizes, September 22. http://www.latimes.com/science/sciencenow/la-sci-sn-ig-nobel-prizes-live-20160922-snap-story.html

BBC News, 2016. Ig Nobel win for Alpine 'goat man'. http://www.bbc.co.uk/news/science-environment-37443204

Philip Shapira, Jan Youtie and David Hu

Science that makes you laugh then think! What can be found when science is seen through the looking glass of the Ig Nobel prizes?

Session

The Ig Nobel Prizes are awarded each year in a ceremony at Harvard University organized by the Annals of Improbable Research. The prizes are “intended to celebrate the unusual, honor the imaginative — and spur people's interest in science, medicine, and technology.”[1] A pivotal theme of the Ig Nobel Prizes is to honor achievements that “first make people laugh, then make them think”.[2] Since 1991, more than 250 Ig Nobel Prizes have been awarded to over 600 recipients.

The Ig Nobel prizes explicitly play to perceptions about the wackiness of science and scientists, and creates much amusement in doing so. Yet, in an era where science is increasingly under pressure not just in terms of resources but also through questioning of its underlying purpose and value, the Ig Nobel Prize represents one of the ways through which the science community can find creative and entertaining ways to foster interest and education about science as well as explain how zany curiosity-driven research can actually be insightful and useful. In this session, we present papers that not only probe the characteristics of Ig Nobel Prize winners but also explore what can be discerned about prize winning topics and authors, their underlying “serious” research purposes, and the impacts they generate for scholarship, research sponsors and the wider public. The session is proposed to be organized as follows:

The Ig Nobels – Who Wins What and Why?

Philip Shapira (University of Manchester; Georgia Institute of Technology), Abdullah Gök (University of Manchester), Chao Li ((University of Manchester), Fatemeh Salehi (University of Manchester), Gennady Belyakov (University of Manchester), Milana Shapira, Seokkyun Woo (Georgia Institute of Technology), Sergey Kolesnikov (Georgia Institute of Technology), Yanchao Li (University of Manchester), and Jan Youtie (Georgia Institute of Technology).

Topic analysis of Ig Nobel prize laudations

Samira Ranaei (Lappeenranta University of Technology, Finland) [Paper No. 109]

Does Humor Advance Science? Evidence from Ig Nobel Prizes

Seokkyun Woo (Georgia Institute of Technology) and Yin Li (Georgia Institute of Technology)

Pride or Prejudice: How research organizations respond to Recipiency of Ig Nobel prize?

Gennady Belyakov (University of Manchester) and Sergey Kolesnikov (Georgia Institute of Technology)

Session Chair and Discussant

David Hu, School of Mechanical Engineering, Georgia Institute of Technology (2015 Ig Nobel Physics Prize)

Each paper has been separately submitted with an extended abstract. A highly international group of researchers (8 countries represented) has been working in diverse ways from a shared dataset to subject the Ig Nobel Prizes to advanced bibliometric, datamining, and social media analysis techniques. In addition to sharing resulting insights about the Ig Nobel Prizes, this session demonstrates how structured and unstructured data in science and technology domains can be gathered and analyzed, associated with other data variables, and applied to topical questions. The session will be lively and stimulating; in focusing on hilarity, curiosity, and eccentricity in science, it will also raise reflections about the value of science and how it can be explained.

References

[1] http://www.improbable.com/ig/

[2] N. Abrahams (2002). Ig Nobel Prizes: The Annals of Improbable Research. Orion, London.

Dongbo Shi and Meijun Liu

Age and team of great scientific discoveries in China

Session 1

The association between age and great scientific discoveries can shed light on the nature of creativity, the underlying mechanism of knowledge creation and scientific progress, and the design of research policy that support scientists . Not limited to the academic world, it can also provide implications of aging population, education policies and even the economic growth. Scientific and technological activities are suggested to increasingly depend on teamwork since the knowledge accumulates with the advancement of science and technology . Therefore, the age and team of great scientific discoveries, as well as the interaction between age and team deserve an in-depth exploration.

China has been the world's second largest contributor to high-quality scientific articles in 2016 . The dramatic growth of China's science has attracted the world's attention, as well as the development of Chinese scientists who made great scientific contributions. Given the fluctuated political and economical reconstructing China has experienced, the age and team of Chinese scientists who have made great scientific discoveries may deviate from previous claims. To our knowledge, this study is a first try to depicted the whole landscape of the age and team of scientists who are awarded the national scientific awards recognised by China's national science and technology awards system.

Based on the 8,744 award records of five national scientific awards from 1999 to 2015 , and the demographic information of scientists, we investigated the age and team of China's great scientific discoveries on which the scientists obtained awards based. We took advantage of the information of scientific discoveries to find the year when scientists created their representative work of scientific discoveries and calculate their ages in that year. Utilising descriptive analysis and Poisson regression analysis, we found that:

1.The age distribution is a double-peak distribution, in which the first peak is in middle life(30s to 40s) and the second is at 60s. Moreover, we observed a shifting age distribution during the three periods with five-year time interval. With time passing by, the second age peak become weaker and even perish at the third episode.

2.The average age at which scientists produced their representative work remained steady.

3.Female scientists write the representative articles younger than their male colleagues. The average age of male scientists is 41.4, 3 years older than that of female scientists. Furthermore, the average age of female is younger than that of male in all six disciplines . The outstanding performance come earlier on average in Information Science than that in other fields.

4. Taking the awarded order into account, scientists who are at the top of the list of winners are older than those who are listed behind when they created their representative work.

5. The team consists of three to six scientists and remained stable during the last two decades. The team size of scientists of Mathematics and Physics, and Information Sciences is smaller than that of other disciplines.

6. There is a U-shaped relationship between the age at which scientists got the highest degree and the age at which they made great scientific contributions. This relationship also exists between the team size and the age. Besides, scientists who held overseas highest degrees are older than their peers when they made great scientific discoveries.

Appendix:

Figures, tables and description of data source, data cleaning process and regression results are shown in the attached file.

Yoshie Kobayashi and Sotaro Shibayama

Japan Doctoral Human Resource Profiling and the outcome: Impact of Ph.D. training

Session 3B

The modern society is increasingly becoming knowledge-driven and major challenges our society faces today require solutions based on scientific and technological knowledge. Thus, it is crucial that knowledge be sustainably produced, and more fundamentally, that the raw material for knowledge production – knowledge workers – be developed sustainably (Bozeman and Corley 2004; Laudel and Glaser 2008). The academic sector plays a pivotal role in these missions and, in particular, it offers the basis for the training of knowledge workers at the scientific frontier (Nelson 1993; Stephan 2012). Considerable investment has been made in this "academic training", and a growing number of knowledge workers (e.g., PhD holders) have been produced. However, changing societal needs and rapidly evolving knowledge spheres present a formidable challenge, and the modern academic system is often criticized for producing an impractical workforce and failing to meet the needs (Cyranoski et al. 2011; Gould 2015).

Despite the gravity of the issue, theoretical and empirical understanding on academic training is scant. Perhaps because the subject is on the cusp between studies on higher education and on scientific knowledge production, there has been limited overarching perspectives. The sociology of science and education has long debated the conflict between education and research (Fox 1992; Hackett 1990) but is mostly about formal teaching rather than lab-based apprenticeship, where frontier knowledge is produced and trained for. Importantly, the inside of academic labs is usually made a black box, with a few exceptions (Latour and Woolgar 1979; Owen-Smith 2001), and thus, lab-based training cannot be investigated in depth. There also seems a gap between higher education policies and science policies, resulting in unintended consequences such as PhD overproduction (Cyranoski et al. 2011; Gould 2015).

This study aims to fill in these gaps by offering comprehensive empirical analyses based on questionnaire data of a cohort of PhDs in all scientific fields who graduated from Japanese universities in 2013. We collected approximately 5,000 responses (response rate = 38%) two years after graduation. This paper particularly examines (1) the organizational setting of lab training (e.g., who is responsible for PhD training, and to what extent), (2) the motives of PhDs (e.g., why they aspired to pursue a degree), (3) social network of PhDs, and (4) how these factors are related to post-PhD career development and performance.

Nobuyuki Shirakawa

Developing Evaluation Methods for Research Trends Analysis --- Situation Awareness in Science, Technology and Innovation Policy

Session 1

In this research, I developed an analytical technique that can measure whether the direction of scientific research of a country as a whole is diverging from global trends with the objective of conducting policy evaluation to obtain suggestions about basic strategies and resource allocation priority setting plan formulation in science, technology and innovation policy. This study focuses on overviews that can grasp emergent phenomena as a measurement technique for building a policy evaluation information structure that facilitates situation awareness in order to identify the required future policy actions.

This analytical technique developed in the fields of bibliometrics is a modified bibliometric count method based on a data sampling method that increases the recall rate of information retrieval, which enables the analysis of emergent phenomena based on time-series changes to two types of metrics, namely, a disciplinary overview metric and a trend divergence metric. In addition, by exchanging opinions with stakeholders related to the analytical subject in science, technology and innovation policy through deliberation, the designed technique is proposed as a package that integrates methodologies for determining interpretive hypotheses for policy evaluation.

The results of the technique developed in this study, in the application to three disciplines —Engineering, Chemistry and Interdisciplinary Advanced Science —reveal that this technique with its overview of research trends in natural science makes it possible to surpass the bias of the indexer effects of particular databases.

Finally, results obtained using the developed analytical and data-sampling method enabled policy-oriented deliberation information infrastructure for engagement between multi-stakeholders based on the output of research activities. The evaluation methods for research trends analysis developed functions as a tool for situation awareness in science, technology and innovation policy to avoid the pitfalls of rational ignorance and to provide an opportunity for multi-stakeholders to engage in policy deliberation.

Afreen Siddiqi, Scott Kennedy, Inez Weitershausen, Alex Latham and Richard Lester

Investigating the Convening and Engagement Roles of Science and Technology-Oriented Universities: Case Studies from Emerging Economies

Session 6D

Emerging countries around the globe have initiated substantial investments in higher education and scientific research to support a transformation towards knowledge-based and higher value-added sectors in their economies. Countries in the Middle East, and in particular the oil-based economies of the region, have invested billions of dollars in science and technology (S&T) since the turn of this century, aiming for economic diversification. Additionally, natural resource-limited countries such as Singapore have also made significant investments to create new industrial sectors. These investments include the establishment of new universities focusing on S&T and expanding and upgrading existing research institutions [1,2]. The key roles expected of newly created (or upgraded) research universities are high quality teaching, novel research, and technology innovation that can spur economic growth. Typically, teaching, research, and innovation are considered to be of crucial importance for research-intensive S&T universities. However, another salient but poorly understood role is that of their "public space" or "convening platform" in a local economy. In this study we elaborate on these notions and investigate how this often noted, but frequently underestimated aspect applies in a selected set of countries in the Middle East and other regions where state-funded S&T universities have been established to stimulate national competitiveness.

In previous research, the convening role of universities in bringing together researchers, industry practitioners, citizen groups, and other actors and organizations (both domestic and foreign) for exchange of information, knowledge, and ideas has been recognized [3]. For instance, Lester et al, in a study on impacts of universities on innovation and local economies, noted that [3]: "A university can also play an important role as a public space for ongoing conversations, involving local industry practitioners, about the future direction of technologies, markets and local industrial development." They note that "this public space can take many forms, including meetings, conferences, industrial liaison programs, standards forums, entrepreneur/investor forums, visiting committee discussions of departmental curricula, and so on", and observe that "these spaces are rarely about solving specific technical or commercial problems" but "often generate ideas that later become the focus of problem solving both in industry and in universities."

In addition to the important role research-based universities can play in convening stakeholders across sectors, enabling conversations, and generating new ideas, they also create focused groups of researchers (faculty, graduate students, and other collaborators) that are then able to formally and effectively engage with other research groups (local and international) and exchange knowledge and ideas. These convening (at the location of the university) and engaging (at locations outside of the universities region) activities are unique and important services a university provides and brings to a regional economy.

In examining the impacts of research universities, most of the studies primarily investigate direct effects on education (such as training and workforce development), research and innovation (publications, patents, and entrepreneurship), and economic growth [4-7]. However, the convening and engaging roles of universities are rarely and at best qualitatively discussed. In this study, we attempt to investigate these roles (at a partial level) using a mixed-method approach.

We consider conferences as a partial measure of activities that convene groups of researchers (from universities and industry) and conduct a bibliometric analysis of conference proceedings records. Using author affiliation, location, and other data, on publications appearing in conference proceedings, we examine trends in how a university participates in events (defined as conferences in this study) in its location as well as its participation in events (conferences) outside its location. We treat this participation in domestic and foreign conferences as proxy measures linked to convening and engaging roles of the university. In this work, we formulate new metrics to quantitatively (although partially) characterize these roles, and conduct the analysis over a fifteen-year time period of 2001-2016. The metrics are then used to examine universities in selected countries (including the UAE, Qatar, and Singapore). Bibliometrics analysis has been previously used to study patterns of co-authorship and international collaborations [7]. However, to the best of knowledge of the researchers in this study, a specific focus on conference proceedings with the aim of distilling information and insights regarding the convening and engaging role of universities in a region has not been done in the past. Furthermore, previous studies have examined US and Europe regarding economic impacts of universities, where

education and research systems are nationally well established and domestic industrial capability is well developed [8]. The impacts of S&T universities in emerging nations, however, without an existing tradition of cutting-edge research is not well understood in general, and in particular their specific powers of convening and engagement are not known.

In addition to the quantitative analysis, we also use data from interviews conducted in some of the countries in our study. The qualitative data from our field interviews provides an important basis for interpreting and discussing the quantitative results within unique local contexts. Past work has shown that the role and impact of universities is differentiated based on the stage of local economic and industrial development [9]. In considering how the local socio-cultural context impacts the specific roles and functions of universities in emerging economies, the study allows for a more nuanced and context-specific analysis. Overall, the combined quantitative and qualitative analysis also allows for gaining insights into how the convening role of S&T universities fosters knowledge exchange that contributes to technology innovation and local industrial development.

References:

[1] A. Siddiqi and L. Anadon L (Eds) (2017) Science and Technology Development in the Gulf States: Economic Diversification Through Regional Collaboration, (Gerlach Press, Berlin)

[2] A. Siddiqi, J. Stoppani, L. D. Anadon, and V. Narayanamurti, “Scientific Wealth in Middle East and North Africa : Productivity , Indigeneity , and Specialty in 1981 – 2013,” PLOS ONE, pp. 1–19, 2016.

[3] R. Lester, “Universities, Innovation, and the Competitiveness of Local Economies: A Summary Report from the Local Innovation Systems Project – Phase I,” MIT Industrial Performance Center Working Paper 05-010 (2005).

[4] A. Valero and J. Van Reenan, “The economic impact of universities : Evidence from across the globe,” NBER Working Paper No. 22501, August, 2016.

[5] J. J. Siegfried, A. R. Sanderson, and P. Mchenry, “The economic impact of colleges and universities,” Econ. Educ. Rev., vol. 26, pp. 546–558, 2007.

[6] M. Guerrero, J. A. Cunningham, and D. Urbano, “Economic impact of entrepreneurial universities ’ activities : An exploratory study of the United Kingdom,” Res. Policy, vol. 44, no. 3, pp. 748–764, 2015.

[7] Jones B F, Wuchty S, Uzzi B (2008) Multi-University Research Teams: Shifting Impact, Geography, and Stratification in Science, Science, 322:1259-1262

[8] Bryna Lendel, (2010) The Impact of Research Universities on Regional Economies: The Concept of University Products, Economic Development Quarterly, 24(3) 210:230

[9] R. Marozau and M. Guerrero, “Impacts of Universities in Different Stages of Economic Development,” J. Knowl. Econ., 2016.

Renan Silva and Hillegonda Novaes

Science, technology and innovation policies for Monoclonal Antibodies in Brazil: the perception of public and private institutions

Session 6A

Monoclonal Antibodies (mAbs) is an emerging biological drug and has acquired importance to the biotech industry as well as to the Science and Technology Policy in the development world. In addition, the forecast is that sales of these biotech products move about US$ 125 billion per year in the next decade, estimating that 70 new mAbs will be commercialize by 2020 (Ecker et al, 2015). In Brazil, this biopharmaceutical interests has advanced and found space in the agenda of governments, scientists and of emerging biopharmaceutical industry in the last decade. This project aims to investigate the institutional framework and the regimes of governance of the Monoclonal Antibodies research in Brazil. The main goal is to understand how the institutional framework created in the last decades is affecting the dynamics of knowledge production in a development country. Were applied field interviews with relevant actors of the regime, in five Brazilian federal states: sixteen (16) general directors and P&D managers of public and private biopharmaceutical companies (national and foreign, that is producing mAbs or have partnership with government for knowledge transfer); two (2) representors of biopharma industrialist associations; 6 members of federal government administration (ex-ministers and head of health policy, Science and technology agencies and Industrial policy instruments); five (5) senior researchers of Monoclonal Antibodies of public and private Science labs (Universities and industry research centers); two (2) consultants for innovation and regulation policy and, finally, three (3) directors of public and private hospitals (that maintain clinical research activities with mAbs). The study of the regime of governance about mAbs is important to show how the framework of policies, behaviors and other social and political work is able to affect the dynamics of biomedical knowledge in Brazil, with some important elements to improve Science and Technology policy for health in development countries.

Gunnar Sivertsen

Frameworks for the understanding and evaluation of the societal impact of research in the humanities

Session 3C

The aim of this paper is to compare and discuss different frameworks for the understanding of societal impact of research by testing them on an empirical material of reported impact cases from humanities.

Examples of relevant frameworks for the understanding of the societal impact of research in the humanities are the Payback framework (Levitt, Celia, & Diepeveen, 2010; Klautzer et al., 2011), the SIAMPI model (Spaapen & van Drooge, 2011; Molas-Gallart & Tang, 2011; Olmos-Peñuela, Molas-Gallart, & Castro-Martínez, 2014), the Flows of knowledge framework (Meagher, Lyall, & Nutley, 2008), the Research Contribution Framework (Morton, 2015), Contribution Mapping (Kok & Schuit, 2012), and the IMPACT-EV (Flecha et al., 2014).

These and other frameworks will be discussed in relation to 338 reported cases of societal impact that were included in the Research Excellence Framework (REF) in the United Kingdom in 2014 and in a similar national research assessment exercise in Norway in 2016. A total of 169 reported cases from the humanities in Norway will be compared to the same number of randomly selected cases from the corresponding disciplinary panels in the REF. Comparison is possible because the Norwegian impact evaluation methodology was adopted from the REF.

In our view, the methodology for collecting and evaluating the reported cases of impact in the two countries is implicitly based on a certain framework for the understanding of societal impact that reminds of the so-called linear model of innovation (Godin, 2006) or communication (Shannon & Weaver, 1949). Amongst other things, the template for the case reports (REF2014, 2012) demands identification and documentation of:

- The research that underpinned the impact: “This section should outline the key research insights or findings that underpinned the impact, and provide details of what research was undertaken, when, and by whom,”

- The resulting impact: “A clear explanation of the process or means through which the research led to, underpinned or made a contribution to the impact (for example, how it was disseminated, how it came to influence users or beneficiaries, or how it came to be exploited, taken up or applied).”

The typical analysis of the case studies based on this model has been to identify pathways, beneficiaries and effects of research in the reported cases.

Mentioned above are examples of other frameworks for understanding impact which are more or less alternatives to the linear model. The production and use of knowledge is instead understood as a process of interaction and co-creation. Nevertheless, our preliminary tests of these other frameworks on the same reported cases indicate that they are also applicable and can provide alternative or supplementary understanding.

This paper will investigate a possible expansion of the existing frameworks of understanding. We are interested in observing humanities research as integrated in, and not operating at a distance from, certain domains in society where the disciplines have specific purposes and play specific roles. By comparing cases from two different countries, we expect to see patterns of interaction with society that are typical for each of the disciplines and similar across countries. If this is confirmed, the alternative framework for understanding may also potentially influence the evaluation methodology. There could be a shift of focus from individual cases of demonstrated impact to a focus on the quality of the procedures with which the discipline continuously interacts with society at an organizational level.

References

Flecha, R., Soler, M., Oliver, E., Puigvert, L., Sordé, T., Schubert, A., … Donovan, C. (2014). Impact evaluation of FP6 (last call) and FP7 SSH research projects. Report 3. IMPACT-EV. Retrieved from http://impact-ev.eu/wp-content/uploads/2015/08/D3.2-Report-3.-Impact-evaluation-of-FP6-last-call-and-FP7-SSH-research-projects.pdf

Godin, B. (2006). The Linear Model of Innovation: The Historical Construction of an Analytical Framework. Science, Technology & Human Values, 31(6), 639-667.

Klautzer, L., Hanney, S., Nason, E., Rubin, J., Grant, J., & Wooding, S. (2011). Assessing policy and practice impacts of social science research: the application of the Payback Framework to assess the Future of Work programme. Research Evaluation, 20(3), 201–209.

Kok, M. O. M. O., & Schuit, A. J. A. J. (2012). Contribution mapping: a method for mapping the contribution of research to enhance its impact. Health Research Policy and Systems, 10(1), 21.

Levitt, R., Celia, C., & Diepeveen, S. (2010). Assessing the Impact of Arts and Humanities Research at the University of Cambridge. Technical Report. RAND Corporation. Retrieved from http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED510286

Meagher, L., Lyall, C., & Nutley, S. (2008). Flows of knowledge, expertise and influence: a method for assessing policy and practice impacts from social science research. Research Evaluation, 17(3), 163–173.

Molas-Gallart, J., & Tang, P. (2011). Tracing “productive interactions” to identify social impacts: an example from the social sciences. Research Evaluation, 20(3), 219–226.

Morton, S. (2015). Progressing research impact assessment: A “contributions” approach. Research Evaluation, 24(4), 405–419.

Olmos-Peñuela, J., Molas-Gallart, J., & Castro-Martínez, E. (2014). Informal collaborations between social sciences and humanities researchers and non-academic partners. Science and Public Policy, 41(4), 493–506.

REF2014 (2012). Assessment framework and guidance on submissions. Retrieved from http://www.ref.ac.uk/pubs/2011-02/

Shannon, C. E., & Weaver, W. (1949). The mathematical theory of communication. Urbana, Illinois: University of Illinois Press.

Spaapen, J., & van Drooge, L. (2011). Introducing “productive interactions” in social impact assessment. Research Evaluation, 20(3), 211–218.

Sondre Solstad

The Politics of Private Investments in Innovation

Session 8D

There are substantial differences between resource allocations to innovation in democracies and non-democracies, even when of similar size and level of economic development. I propose a theoretic framework linking political coalition composition to patterns of investment, arguing that in political systems where money decides who the leader is, investment in risky or new areas is discouraged, even when such investment is more productive and preferred by the political leader. Furthermore, I show that changes in investment opportunities, such as those provided by trade and technological breakthroughs, may lead to regime change (and democratization). Using new data composed of millions of international patents and data on technology utilization, I find temporal relationships in line with theoretical predictions, and show that democratization leads to higher levels of technology innovation and more diverse technology utilization.

Briana Stenard

Does Entrepreneurship Pay or Satisfy for Scientists and Engineers?

Session 10B

With the growing popularity of entrepreneurship as a career path for scientists and engineers, it is important to understand why they enter and whether it is beneficial to the entrepreneur. There have been mixed results reported on how beneficial entrepreneurship actually is. One stream of research assumes that workers enter entrepreneurship because they seek to maximize income and finds that entrepreneurs earn more money than those working in established firms. Conversely, there exists a large body of literature that finds that entrepreneurs earn less than their equivalents in wage work. This latter finding has lead researchers to question why workers are willing to enter, as well as remain in self-employment despite receiving returns substantially lower than what they might receive if they were employed in wage work. Many authors have suggested that entrepreneurship must offer certain non-pecuniary benefits compared to employment in an established firm that serve as a compensating differential for lower wages.

One of the concerns with the current literature is that a majority of studies use cross sectional data which allows the examination of salary at one point in time, but does not allow for the study of how the wages change over time. Additionally, while many of these studies suggest that there are non-pecuniary benefits to entrepreneurship, they do not have an actual measure to test this theory and merely assume that there must be non-pecuniary benefits to compensate for lower wages in entrepreneurship. The prior literature also often looks at the average entrepreneur as a homogenous group in terms of motivating factors. I argue that whether becoming an entrepreneur changes a worker's wages and non-pecuniary benefits depends on why someone transitioned in the first place. For example, if someone chooses to enter entrepreneurship because they do not feel that they can increase their compensation with their current employer and believe that they could make more money by starting their own business, this motivator may impacts an entrepreneurs wages' and non-pecuniary benefits more greatly than someone who lost their job and enters entrepreneurship because they believe that they have no other options in established companies.

In this paper I address the gaps in the literature by using longitudinal restricted use National Science Foundation (NSF) Scientists and Engineers Statistical Data System (SESTAT) data on more than 28,000 scientists and engineers to analyze whether there are improvements to wage workers' work outcomes when they enter entrepreneurship. Instead of comparing the average salaries of entrepreneurs to wage workers, as has been often done in the past, I use longitudinal data to answer the call for much needed analysis of the differences in earnings before and after an entrepreneurial transition for a given individual. Additionally I perform analyses of non-pecuniary benefits before and after the entrepreneurial transition using job satisfaction as a proxy. I am able to analyze whether non-pecuniary benefits actually increase when someone enters self-employment. I compare the changes in work outcomes of those who transition into entrepreneurship to not only wage workers who do not change employers but also to those who switch to a new employer in wage work. This allows me to take a more in depth look at the work outcome changes resulting from different mobility patterns. Additionally, I use data on worker's reported reasons for why they change employers to take a deeper look into motivations for these different types of labor mobility and the corresponding implications for work outcomes.

I find that on average, workers in science and engineering who transition to self-employment experience less growth in their wages and more growth in job satisfaction upon transitioning. I also find that these results differ depending on the reason someone transitioned to self-employment in the first place. I suggest that previous literature that treated entrepreneurs as a homogenous group in their motivations were not accounting for significant heterogeneity which has important consequences for work outcomes. I find that those who move to self-employment with the intention of increasing their wages are able to do so, just not as significantly as those who moved to a new employer in wage work. Those who moved to self-employment because they wanted to improve their career benefits were able to improve their job satisfaction. In general when transitioning to self-employment, former wage workers were allowed to improve the work outcomes that they intended to improve. However, I also find that those who entered self-employment for reasons such as market or personal reasons saw no significant improvements in either their wages or job satisfaction. While my results are consistent with the theory that people who enter self-employment may be willing to take a reduction in salary for an increase in non-pecuniary benefits, I also find that those who change employers in wage work also experience a very similar increase in their job satisfaction. Job satisfaction seems to improve for movers in general, not just those who transition into entrepreneurship.

I find that entrepreneurship is not a uniform experience, different people with different motivations for entry have different work outcomes, both pecuniary and non-pecuniary. These findings suggest that future research should consider motivations for entry when analyzing work outcomes in entrepreneurship.

Arho Suominen and Hannes Toivanen

Unsupervised learning based linkages between patents and scholarly publications

Session 5B

Bibliometrics has been used to produce measures of knowledge flows between scholarly literature and patents, most notably by using the non-patent literature citation in patents. Existing methods offer a obstructed and narrow view of interplay between science and technology. This study complements existing methods by analyzing the semantic similarity of patents and publications in the context of Finland, uncovering thematic overlap between science and technology. The study uses Latent Dirichlet Allocations to analyze 185 931 patent and publication records in a merged corpus. The data spans patents (USPTO) and publications (WOS) with one or more Finnish author or inventor. The approach enabled the discovery of patent and publication links between documents without an explicit citation between the documents. This suggests that the method could complement existing approaches to science and technology mapping by producing a novel vantage point to the issue.

David Tomblin

Integrating Participatory Technology Assessment Results into Decision-making Systems: Technological and Policy Stakeholders

Session 7C

In this talk, I conceptualize potential ways that participatory technology assessment (pTA) can inform upstream technical decision-making systems. The socio-technical decision-making environment often involves navigating predictably, polarized stakeholder inputs along with constrained organizational cultures, which can leave decision-makers with a limited information-base to work with. Participatory technology assessment has the potential to generate alternative forms of public knowledge and preferences, diversifying the pool of inputs available to decision-makers. In partnership with NASA, the ECAST network conducted an experimental pTA-based forum on NASA's Asteroid Initiative to test this potential. The goal of the forum was to assess citizens' values and their preferences about potential detection, mitigation, and exploration-based technologies associated with NASA's Asteroid Initiative. ECAST organized two citizen forums involving 183 citizens in Phoenix, Arizona, and Boston, Massachusetts, in November 2014. The forums included sessions on planetary defense, NASA's Asteroid Redirect Mission, and Mars exploration. Drawing from ECAST's interactions with NASA managers and engineers concerning the pTA results, I develop a conceptual map of the diverse ways pTA results can be used by technical experts to inform decision-making.

Participatory technology assessment is an engagement model that seeks to improve the outcomes of science and technology decision-making through dialog with informed citizens that are representative of the general population who are non-experts in the topic area of the deliberation. However, unlike political, academic, and industry stakeholders, they are generally underrepresented in technology related policymaking. Practitioners of pTA claim that these underrepresented populations bring a different voice to policy-making that goes beyond the echo-chamber that emerges with long-established stakeholder discourses and entrenched organizational cultures. Furthermore, pTA can help build the capacity of lay citizens to become better decision-makers, build trust and confidence in policy-making processes, and create a sense of ownership and responsibility for complex socio-technical issues. ECAST has promoted this line of reasoning to various government agencies (NASA, DOE, NOAA, EPA) as a way of differentiating pTA from other common public engagement tools such as opinion polls, Federal Register public commenting, and public hearings.

The ECAST pTA process incorporates principles of trans-disciplinary research design, and acts as a complement to scientific/technical discourse and policy/societal discourse. Its objective is to create an additional input to better inform both scientific research or technological development and public policy. Therefore, it is a model of public engagement that has potential for linking into complex socio-technical decision-making systems. Integrating into these systems involves three steps: 1) Problem Framing, 2) Peer to Peer Discourse, and 3) Application and Reintegration. The problem framing and reintegration steps are co-developed/co-produced by ECAST and the decision-makers involved in systems design, keeping the peer-to-peer discourse sufficiently shielded from unbalanced and undue influence of technical and policy advocacy. In other words, the process is designed to highlight input from citizens that don't already have a vested interest in the issue. As a result, the outcome of a pTA provides public views and insights that are potentially different from stakeholders with vested interests. This is a unique form of input that technical decision-makers don't typically have access to.

Participatory technology assessments generate both quantitative and qualitative data. Quantitative data constitutes voting results on a variety of public preferences related to the socio-technical issue at hand. For example, one session of the NASA forum sought public input on two options for performing the Asteroid Redirect Mission: Option A (capturing a 10m diameter asteroid) or Option B (retrieving a several meter diameter boulder from the surface of a larger asteroid). Qualitative data comes in the form of individual and group narratives, descriptions of individual and group rationales for preferences, and expressions of values, priorities, and perspectives associated with a socio-technical issue. Qualitative data, while more difficult to analyze in a timely manner that is useful to decision makers, is generally more rich and complex than the quantitative data. This paper focuses on the potential uses of qualitative data for decision-makers.

Seven types of qualitative data outputs generated by the NASA pTA forum have been identified:

- Public value maps that identify potential public reactions to emerging science and technology.

- Public priorities both within a preference (e.g., how much a technology should cost, safety concerns, etc.) and among preferences (e.g., which technology is right for the job).

- Emerging areas of agreement not readily obvious in potentially controversial socio-technical issues.

- Input for framing further public exploration of socio-technical issues, maintaining an iterative process to build an ongoing deliberative system embedded within an organizations broader decision-making system.

- Insight on public understanding of complex socio-technical issues (e.g., instead of assuming what people think, actually develop rigorous models of public conceptualizations) and the public actually handles complexity.

- Unanticipated outcomes where lay citizens make unexpected connections among different components of socio-technical systems. These are results that "surprise" decision-makers and open up the pool of decision-making inputs.

- Anticipation of previously unrecognized emerging issues upstream of decision-making that can help decision-makers explore alternative policy pathways.

Considering these types of pTA outcomes, I present a conceptual map of pTA design features that elicit each type of output and elaborate on how they can effectively be used by decision-makers. I will also discuss challenges of translating pTA results into usable information for decision makers, especially as it pertains to how pTA design (e.g., question framing, types of participant interactions, role of expertise, etc.) may constrain and/or facilitate the generation of different types of outcomes.

Victor Vakhshtayn, Alexey Gusev and Pavel Stepantsov

The Paradoxes of Positive Attitudes towards Technologies among Eastern European nations: Uncovering the Roots of Technological Optimism

Session 5C

In 2016, the Russian Venture Company, together with the Moscow School of Social and Economic Sciences, conducted a research project on the behavioral and institutional foundations of innovations in Russia. Over the course of the project, secondary data from Russia and international studies were analyzed. The analysis was based on a number of international surveys which allowed the comparison of data from Russia with secondary data sources from other European countries. Furthermore, primary data, both qualitative and quantitative (a survey of 6000 individuals from 10 regions of the Russian Federation), was collected regarding the attitudes of Russian citizens towards technologies, their individual economic practices, and their levels of institutional trust .

One part of the research was dedicated to the analysis of the attitudes of Russian citizens towards technological innovations, or in other words, their 'technological optimism'. The findings show that in Russia attitudes towards science and technologies are considerably more positive and optimistic compared to the European Union in general. For instance, the proportion of Russians who think that "With the help of science and technology, humanity will be able to unlock all of nature's secrets in the future" and that "scientific and technological advances can solve all problems" is twice as high compared to citizens of the European Union (50% in Russia compared to 27% in the EU).

It is worth noting that the distribution of techno-optimist attitudes is heterogeneous throughout Europe. People living in Eastern Europe are more positively inclined towards technologies compared to people living in Western Europe. The data shows that attitudes of techno-optimism are more prevalent in countries where people rarely encounter innovative technologies in everyday life. Examples include Romania, Bulgaria, Greece, and Lithuania. Conversely, countries where innovative technologies are more widespread and, consequently, more frequently encountered in everyday practice, display a markedly lower faith in the transformative potential of scientific and technological progress.

The research yielded three hypotheses that could explain this paradox:

Hypothesis 1: The prevalence of positive attitudes towards technologies among Russian citizens, as well as people living in Eastern Europe, can be explained through 'techno-paternalism': confidence in technological progress replaces confidence in one's own abilities, whilst at the same time not being connected to any actual readiness to employ these technical innovations in everyday life. From this point of view, technological progress in these countries is seen by the population as a substitution to social and institutional progress. This explanation could be interrelated with the peculiarities of recent political history in Eastern Europe and the former USSR.

Hypothesis 2: The influence of Soviet-era technocentric education. This hypothesis was invented specifically for Russia, however, to a lesser degree it could be relevant the countries that were under Soviet ideological influence. The belief of Russian citizens, along with the older generation of people living in Eastern Europe, in scientific and technological progress have become a force of habit. Positive attitudes towards technologies are an 'artifact' of a positivistic educational system created in the times of the Soviet Union.

Hypothesis 3: 'Declarative techno-optimism': compared to citizens of Western Europe, Russians, Bulgarians, Romanians, Greeks and Lithuanians rarely encounter the actual implementation of technologies in their everyday life. Thus, their belief in the transformative potential of science and technology is of a speculative, theoretical nature unsupported by real practices.

Additionally, through a cluster analysis, the investigation revealed three distinct population groups based on their attitudes towards science and technologies in Russia:

1) Techno-optimists (48%) believe in the potential of scientific and technological advances. They believe that science and technologies can resolve the social and economic challenges of society.

2) Technophobes (24%) believe that technological and scientific advances pose a threat to humanity in the long term.

3) Technosceptics (28%) do not believe that these advances can solve people's problems. They do not believe that technological innovations have any effect on their everyday life and deny that science and technology is capable of generating any fundamentally new knowledge.

Among the techno-optimists the level of trust in governmental institutions is almost two times lower than among the technophobes. In other words, the former perceive technologies as potential substitutes for what is – in their opinion – an ineffective institutional order. Most Russians with positive attitudes towards technologies, have a correlating negative attitude relating to social and political systems.

That said, there is an interesting paradox: despite the widespread belief in the opportunities granted by technological and scientific advances (i.e. techo-optimism), most citizens of the Russian Federation are not willing to embrace concrete innovations in their everyday life. For instance, only 36% of Russians are open to the idea of driverless cars, compared to 51% of citizens of the European Union. Thus, Russian techno-optimism is frequently of a declarative nature: the larger part of the population supports scientific and technological progress in theory but not in practice.

This fact permits the following inference: the population group of 'techno-optimists' is not homogenous. The data shows that it can be subdivided into the following groups:

- The techno-optimist 'core': the people who believe in the opportunities afforded by innovation per se. They are positively disposed towards the development of science and technologies and the deployment of new technologies in everyday life.

- The techno-optimist periphery: the part of the population whose techno-optimism is largely declarative. This group has contradictory attitudes. Based on their survey responses, they drift towards either the techno-sceptics, claiming – despite their generally positive attitude towards technologies – that science and technology change peoples' lives at an overly rapid pace, or towards the technophobes, claiming that the advances of science and technologies can be dangerous in the long term.

The techno-optimist periphery is well-disposed towards technologies because they believe that institutions are less effective than innovative technologies. Their techno-optimism is, in a way, substitutive: technology, according to the respondents, may be able to replace ineffective institutions in the future. So far, we see that institutional trust and attitudes towards science and technologies are tightly connected. The core of report and following paper will investigate interrelations between "techno-optimism", institutional trust and other crucial factors that influence the social perception of science and technologies..

Victor Vakhshtayn, Pavel Stepantsov and Alexey Gusev

Innovative Strategies of Economic Conduct: Social Capital, Faith in Scientific and Technological Progress, and the Distrust of Institutions

Session 5C

In 2016, the Russian Venture Company, together with the Moscow School of Social and Economic Sciences, conducted a research project on the behavioral and institutional foundations of innovations in Russia. Over the course of the project, secondary data from Russia and international studies were analyzed. The analysis was based on a number of international surveys which allowed the comparison of data from Russia with secondary data sources from other European countries. Furthermore, primary data, both qualitative and quantitative (a survey of 6000 individuals from 10 regions of the Russian Federation), was collected regarding the attitudes of Russian citizens towards technologies, their individual economic practices, and their levels of institutional trust .

One of the primary aims of the research was to investigate the population's micro-level behavioral strategies: the intensity of economic activity of Russian citizens, as well as their willingness to employ 'innovative economic strategies' into everyday practice. That is, forms of conduct that go beyond the usual 'rules of the game', and which are capable of modifying these rules in the long term.

The 'innovativeness' of the strategies was defined as the capability of social actors, groups of people or organizations to use their available resources in a novel way, as well as their ability to implement innovations in their everyday life, regardless of whether this occurred in the economic or technological sphere.

The data analysis yielded two dimensions of the economic strategies of Russia's population:

Level of activity: strategies of searching for supplementary income for sustaining or improving the living standards the respondents were accustomed to. An active strategy presupposes a significant increase of the working hours, an expansion of the network of everyday contacts, and a change in the 'horizon of planning' as well as taking up additional work-related responsibilities. Conversely, a passive strategy is linked to a decrease in spending and a refusal to expand one's economic mobility.

Level of performativity: the willingness of the population to 'play with the rules themselves' and to 'play around the rules'. A performative strategy is typical for entrepreneurs: opening a new business venture, finding unexplored niches in the market and new technological solutions. Due to the institutional context in contemporary Russia, this strategy may also be accompanied by detrimental phenomena such as partial transitions into economic 'grey zones', tax evasion and informal dealings.

Over the course of the investigation of the population's potential for economic innovation, the following trend emerged: the last few years have seen an economic mobilization of the population, combined with an increase in social capital and a decrease in trust towards formal institutions, ranging from government and courts to municipalities and banks.

A cluster analysis of the economic activity of citizens of the Russian Federation yielded three distinct population groups, termed Homo Economicus, Homo Institutius and Homo Iners respectively. These groups are distinguished by their levels of economic activity and their willingness to employ innovative (i.e. performative) strategies in their everyday conduct.

Homo Iners (49%) do not employ innovative strategies in the economic sphere. Representatives of this subgroup rarely put forward ideas for improving the work effectiveness of their organization. Furthermore, they do not engage in entrepreneurial activity and have no plans to do so in the future.

Homo Institutius (32%) employs 'active' strategies of economic conduct within existing social institutions. That is, representatives of this subgroup play by the established rules. They suggest ways of optimizing the work within their organization; oftentimes, these suggestions are implemented. However, people belonging to this subgroup rarely have any plans to become entrepreneurs in the future.

Homo Economicus (19%) actively implements innovative strategies of the performative type. That is, this group is willing to modify existing rules. They either engage in entrepreneurial activity or plan to do so in the near future.

At the same time, the Homo Economicus group displays the highest level of distrust in institutions. For this reason, they are more often willing to circumvent formal 'rules of the game', engaging in informal relations (e.g. corrupt deals) and justifying their own tax evasion, bribery etc.

It is worth noting that there is a correlation between technological and economic innovativeness. People who are more positively disposed towards scientific and technological progress, and who are more readily willing to use innovative technological products in their everyday life (i.e. techno-optimists), employ innovative economic strategies with a greater frequency. There is a 9% overlap between the 'techno-optimist' group and Homo Economicus, forming a group that we tentatively describe as 'potential technological entrepreneurs' (the 'potential' modifier denoting social attitudes and not a lack of competencies).

In this section of Russian society, there is a 'culture of wealth', as opposed to a 'culture of earnings': people from this group prefer a large level of income over guarantees to maintain a stable level of earnings in the future. Furthermore, this group displays a significantly higher level of social capital, allowing its members to achieve their individual objectives through the circumvention of formal institutions. This, in many ways, explains why this group also displays the lowest level of institutional trust across all population groups of the Russian Federation. A high level of economic capital decreases the necessity to employ formal institutions for the achievement of one's economic goals. Figuratively speaking, members of this group prefer to 'come to an agreement' using 'connections' rather than 'playing by the rules'.

Further in the report we will reveal behavioral patterns of 'potential technological entrepreneurs': what are peculiarities of their economic strategies compared to other social groups, how distrust in formal institutions affects their inclusion in informal transactions and shadow zones of economy, etc.

Peter Van Den Besselaar, Bei Wen, Wim van Vierssen, Marielle van der Zouwen and Edwin Horlings

Motivations behind cross-boundary collaboration: the Dutch water sector

Session 5E

Introduction

Cross-boundary collaboration in science is a necessity to tackle today's grand challenges, for which the traditional disciplinary approach is insufficient. It is often claimed that one needs not only cross-disciplinary collaborations, as societal problems are interdisciplinary by nature, but also cross-sector collaboration between science and industry, and/or between science and government. Through such 'transdisciplinary' approach the probability is higher that useful knowledge is not only produced, but also implemented. If these claims are correct, an urgent question is how to stimulate cross-boundary research collaboration. In this paper we present the results of a study of the motivation of researchers and practitioners to engage in cross-boundary collaboration. Previous research focused mainly on collaboration between researchers, and this study adds to this the understanding of collaboration between a variety of water professionals other than researchers. This may help to understand better the incentives and conditions for efficient cross-boundary collaboration.

Research question

In this study, we disentangle the motivations driving existing cross-boundary collaboration in the water sector, as the supply of clean water is one of the big challenges for the future. We answer the following questions:

1. What are the motivations for cross-boundary collaboration and within-boundary collaboration? Are these motivations different, and if so, in what respect?

2. What are the motivations for cross-boundary collaboration between disciplines and between sectors?

3. What are the channels used for cross-boundary collaboration?

4. Does the motivation for cross-boundary collaboration differ between individuals with different roles and routines?

Case

The case consists of the water researchers and professionals in the Netherlands. This is a-well developed research and policy field, including governmental organizations, public research organizations & universities, and companies. Within this community, we distinguish four disciplines: drinking water science and technology; waste water science and technology, sewerage science and technology, and water management research.

Data and methods

We conducted a survey among members of the Dutch Water Professionals Association, which covers very well the field. The survey consisted of questions about a series of motivations (based on a literature review): (1) an innovation, a new product or process; (2) a patent, copyright or trademark; (3) increase of (shared) knowledge; (4) higher turnover; (5) joint publications; (6) new policy; (7) joint projects and programs; (8) new contacts, extension of networks; (9) access to financial funds; (10) access to specific resources; (11) support for ideas; and (12) others. About 620 professionals returned the questionnaire. Respondents gave information about themselves and about the three most important collaborators. This leads to a large number of collaborations that can be classified cross-discipline or within-discipline, and cross-sector or within-sector. Nine boundaries are distinguished:

Cross-disciplinary boundaries: Cross-sectoral boundaries

Drinking water – Waste water: Research – Government

Drinking water – Sewerage Research – Industry

Drinking water – Water management Government – Industry

Waste water – Sewerage

Waste water – Water management

Sewerage – Water management

We use logistic regression to predict the occurrence of cross-boundary collaboration from the motives, personal characteristics (among others the professional role of the respondent) and some contextual variables. We compare motivations for “within boundaries” collaboration with motivations for “cross-boundary” collaboration.

Findings

We cannot summarize the findings here, as they are specific for the type of boundary involved. Abstract formulated:

- The motivation for cross-boundaries collaboration differs per type of activities (or roles).

- Individual motivations for cross-boundary collaboration differ from motivations for within-boundary collaboration.

- Motivations for cross-boundary collaboration vary by disciplines, and by sectors.

- Cross-boundary collaboration is achieved through various channels.

In the paper, we discuss the detailed findings (see figure 1 for an example), and discuss policy and managerial implications.

Peter van den Besselaar, Helene Schiffbaenker, Ulf Sandstrom, Florian Holzinger and Lucia Alvarez Polo

Explaining gender bias in grant selection - The ERC starting grants case

Session 8B

Introduction

There is a longstanding discussion on whether gender bias influences grant selection processes, and the literature shows contradicting results. However, there are three main problems with most research: (i) Most studies explain in fact only differences between success rates of men and women. However, these success rates are only meaningful after correcting those for differences in the average quality of male and female researches. If female researchers would be on average less good as male, then one would of course expect gendered differences in success rate – reflecting quality differences and not bias. To solve this, we have collected data to measure various dimensions of past performance, which are included in the analysis. (ii) Most studies have information only about the successful applicants, but not on the rejected – the latter data are generally not given to investigators. We, however, do have all the data about successful and rejected. (iii) Bias emerges from the decision-making process, and this is often done at the level of review panels, but most studies focus on a higher level of aggregation, such as the funding instrument, or at the level of the discipline. We also include data about the panels (enabling a multi-level design). We do detect gender bias, in contrast to recent reviews; however, this difference may be due to the fact that other research uses too simple designs.

This combination of variables, with the size of the sample, makes the study rather unique. It is an example of using advanced bibliometric indicators with a large set of other variables.

Case

We investigate the ERC starting grant scheme, and have access to the relevant data on the 3030 applicants that gave informed consent to participate in our study – more than 95% of all applicants. We selected this case, as it is the most prestigious grant that exist in Europe for early career researchers (up to eight years after the PhD), and it strongly contributes to career opportunities of those getting the grant.

Approach, data & methods

We aim to predict the dependent variables (applicants scores, and success in grant application) using a set of independent variables related to performance (productivity, impact, previous grants, quality of the collaboration network) and to the person (age, nationality, research field, and course gender). As decision-making on grants is done in panels, the effect of the panel is taken into account too – through a multi-level design.

The following data were collected, and we add what variables where extracted. As the data had many formats, quite some technical work needed to be done to extract the required information (using the SMS platform - www.sms.risis.eu):

- Earlier and current other grants: manually extracted from the CVs.

- Collaboration network: automatic extraction of organizations from the CVs

- Quality of the network: automatic linking of organization names with the data in the Leiden Ranking; manual search for comparable scores of those organizations not in the Leiden Ranking.

- Host institution: from an administrative file of the ERC. Quality of host institution: see previous point.

- Panel review scores of the applications: from an administrative file of the ERC.

- Age, gender, nationality, field of research: from an administrative file of the ERC

- Decision: from an administrative file of the ERC

- Productivity, impact: Partly automatically from the Web of Science with a manual check.

We also collected information about the panel members, such as their organizational affiliation, nationality, gender, field of research, and performance, the latter again based on the Web of Science data.

Analysis

Firstly, we deploy generalized linear models for each of the three domains: Life Sciences, Physics & Engineering; Social Sciences & Humanities, in order to estimate the effect of gender on the decision after controlling for the quality (past performance) variables. Secondly, we do multi-level analysis to determine the effect of the panel on the outcome. Finally, we compare the gender biased panels with the gender-neutral decisions.

Findings and conclusions

We show that gender bias occurs at the domain level, albeit not everywhere in the same way. For example, gender bias against female applicants exists most clearly within the life sciences domain. In the paper, we will present results for the other main domains (social science and humanities; physics and engineering), and for the disciplines within the domains.

We also show what panel characteristics do lead to gender bias. For example, we find a negative correlation between the number of female panel members and the female success rate. In the paper, we will go into more detail, as this may deepen our understanding of the mechanisms at panel level that produce gender bias.

We end with conclusions about the way the selection procedure may be changed to reduce gender bias. This is crucial, as the type of grants we used as case have strong career implications.

Fernando Vargas

Innovation Strategies in Latin American Firms

Session 8E

In this paper, we make use of a unique dataset that contains Innovation Survey data from nine Latin American (LA) countries, namely Argentina, Chile, Dominican Republic, Ecuador, El Salvador, Panama, Paraguay, Peru, and Uruguay. Through Principal-Component Factor analysis and Cluster techniques, we extract from data the main innovation practices and strategies performed by LA firms. Although the peculiarities of innovation in LA has been emphasized in the literature, we show that most of the innovation practices detected have also been observed in similar studies using firm data from European countries. However, country and industry level characteristics account for a larger share of variability in innovation practices in LA, in comparison to Europe. We estimate firm characteristics that affect the prevalence of approaches to innovation and, even more relevant, how these decisions are affected by different degrees of foreign product market competition. Results of this analysis can enhance innovation policy discussion in several dimensions. In particular, the relevance of R&D subsidies when a significant share of firms in LA that relies on basic innovation approaches, and to what extent firms' innovative behavior can be modified with direct support from public sources.

Kevin W. Boyack and Richard Klavans

Predicting Research Proposal Success

Session 7B

In this study, we use proposal data along with a detailed model of the scientific literature to correlate proposal features with funding success. The data consisted of 290 new R01 proposals submitted to NIH in 2010 by the medical school at a major U.S. university of which 60 were funded. Both textual and bibliometric indicators were correlated with proposal success. For the textual analysis, an expert in discourse analysis read matched pairs of proposals and correctly identified the funded proposal based on writing quality in a large number of cases. Of the bibliometric features, topical alignment between the proposal references and previous publication history of the applicant, and the attractiveness of the research topic both had some predictive capability.

Caroline Wagner

Is International Collaboration More Novel?

Session 5E

Co-authorships of scientific articles have grown at a remarkable rate (Wagner et al., 2015). Wuchty et al. (2007) analyzed team sizes, showing growth in numbers of co-authors across all fields of science (national and international) in the Web of Science between 1955 and 2006. For a subset of these articles, Adams et al. (2005) showed that the frequency of international co-authorships took a sharp upturn in 1990. By 2011, internationally co-authored papers accounted for 25 percent of Web of Science co-authorships, up from 10 percent in 1990 (Wagner et al., 2015). Many more nations participate in these publication activities than was the case two decades ago (Bornmann et al., 2015).

Collaboration is often viewed as producing conditions for novel combinations and enhanced creativity (see Uzzi & Spiro 2005; Falk-Krzesinski et al. 2011; Wuchty et al., 2007; Stokols et al. 2008; Fiore 2008). At the international level, co-authorship appears to be worth the extra effort, since these papers attract greater citations. Glänzel and Schubert (2001) showed that international publications have higher-than-expected citation rates in all scientific fields, a finding supported by others (e.g, Narin et al., 1991; Persson et al., 2004; He, 2009). In a recent paper (Wagner et al., 2016) examining international collaboration in six specialties showed that a rise in the number of countries-per-paper was significantly correlated to an increase in citation strength for four of six scientific specialties. This finding accorded with the expectation that international connections attract greater attention (Glänzel and Schubert 2005; Glänzel and DeLange 2002).

This finding raises a further question, one noted in Wuchty et al. (2007), as to whether a shift towards co-authorships produces better, or more novel, science. As they note: “Teams may bring greater collective knowledge and effort, but they are known to experience social network and coordination losses that make them underperform individuals even in highly complex tasks…” This has been noted to apply specifically to international co-authorships where transaction costs of communicating are high. It may be that international co-authorships are attractive because they are attractive. In other words, as internationally co-authored papers attract more citations, the practice benefits from a version of the “Matthew effect in science” (Merton, 1968), or the rich get richer, in the sense of scientists seeking a wider audience for their work add distant co-authors.

If recognition-seeking is the primary driver, we would expect to find that internationally co-authored papers are not more novel than nationally co-authored papers or sole authored papers. If international links are attractive in themselves (because of a potential wider audience), it would be the act of co-authoring that is attractive, not the access to new ideas, innovative processes or equipment, or cultural enrichment. International and national co-authorship would show about the same levels of novelty.

This paper explores this question by comparing highly cited international co-authorships from the Web of Science (2005) to articles that have a high novelty measure. The measure was developed by Uzzi et al. (2013). By examining 17.9 million research articles in the Web of Science, they tested pairwise combinations of references in bibliographies of papers. By comparing the observed frequency distribution with randomized citation networks, they tagged papers as to whether they were conventional or novel. By comparing the findings of Uzzi et al. (2013) with a set of highly cited international co-authorships from 2005, we assess whether the latter are more novel than highly cited papers. This gives us insight into whether international co-authorship is highly cited because it is novel, or because it is visible.

An alternative to the Matthew Effect or the Novelty Effect is one where researchers attach themselves to more well-known researchers in an effort to gain recognition and perhaps access to resources. This would constitute a form of preferential attachment where researchers seek out better-known collaborators as a way to access novel ideas and gain attention to their work (Barabasi et al., 2002; Jeong et al., 2003). Earlier work by Wagner & Leydesdorff (2005) showed that preferential attachment could explain the growth of international collaboration in six specialties. This is tested for the international articles to see if preferential attachment is operating in these co-authorships and the findings are discussed.

Conversely, it may be that international connections in science truly enrich research to the point where the teams simply produce more novel science (Gilsing et al., 2008). Cole & Cole (1967) showed, for Physics, good quality science is more often and more substantially rewarded than quantity, a finding that was supported by Wagner et al. (2015) in a

study of Nobel Prize winners in medicine. In these studies, quality science (supported by prizes) was rewarded with citations regardless of the size of the team. This suggests that, over time, quality attracts attention, regardless of the size of teams. More than a decade of citations are available for the 2005 papers, allowing us to test this possibility.

Also untested in the literature is the relationship between the size of teams and the novelty of the research. It is often noted, as Guimera et al. (2005) suggest "creativity is spurred when proven innovations in one domain are introduced into a new domain, solving old problems and inspiring fresh thinking…" The role of "search" within a network is well recognized as a way to access new ideas (Scott 2000). Whether teams integrate their ideas to build and test truly new and innovative ideas is not well established. Thus, international collaboration may be a form of search that results in more novel work and more researchers may increase the chances that this occurs. This is also explored in this paper, and will be discussed in the presentation.

References

Adams, J. (2012). Collaborations: The rise of research networks. Nature, 490(7420), 335-336.

Adams, J. Black, G, Clemmons, R. Stephan, P. Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981–1999 (2005), Research Policy 34, 259-285.

Barabasi, A. L., Jeong, H., Neda, Z., Ravasz, E., Schubert, A., Vicsek, T. (2002), Evolution of the social network of scientific collaborations, Physica A, 311 (3-4): 590–614.

Bornmann, L., Wagner, C., & Leydesdorff, L. (2015). BRICS countries and scientific excellence: A bibliometric analysis of most frequently cited papers. Journal of the Association for Information Science and Technology, 66(7), 1507-1513.

Cole, S., & Cole, J. R. (1967). Scientific output and recognition: A study in the operation of the reward system in science. American sociological review, 377-390.

Falk-Krzesinski, H. J., Contractor, N., Fiore, S. M., Hall, K. L., Kane, C., Keyton, J., ... & Trochim, W. (2011). Mapping a research agenda for the science of team science. Research Evaluation, 20(2), 145-158.

Fiore, S. M. (2008). Interdisciplinarity as teamwork: How the science of teams can inform team science. Small Group Research, 39(3), 251-277.

Gilsing, V., Nooteboom, B., Vanhaverbeke, W., Duysters, G., & van den Oord, A. (2008). Network embeddedness and the exploration of novel technologies: Technological distance, betweenness centrality and density. Research Policy, 37(10), 1717-1731.

Glänzel, W., & Schubert, A. (2005). Domesticity and internationality in co-authorship, references and citations. Scientometrics, 65(3), 323-342.

Glänzel, W., De Lange, C. (2002), A distributional approach to multinationality measures of international scientific collaboration, Scientometrics, 54: 75–89.

Glänzel, W., & Schubert, A. (2001). Double effort= double impact? A critical view at international co-authorship in chemistry. Scientometrics, 50(2), 199-214.

Guimerá, R., Uzzi., B., Spiro, J., Amaral, L. (2005) Team Assembly Mechanisms Determine Collaboration Network Structure and Team Performance. Science, 308(5722) 29 April 2005, 697-702.

He, T. (2009). International scientific collaboration of China with the G7 countries. Scientometrics, 80(3), 571-582.

Jeong, H., Néda, Z., & Barabási, A. L. (2003). Measuring preferential attachment in evolving networks. EPL (Europhysics Letters), 61(4), 567.

Merton, R. K. (1968). The Matthew effect in science. Science, 159(3810), 56-63.

Narin, F., Stevens, K., & Whitlow, E. (1991). Scientific co-operation in Europe and the citation of multinationally authored papers. Scientometrics,21(3), 313-323.

Persson, O., Glänzel, W., & Danell, R. (2004). Inflationary bibliometric values: The role of scientific collaboration and the need for relative indicators in evaluative studies. Scientometrics, 60(3), 421-432.

Stokols, D., Hall, K. L., Taylor, B. K., & Moser, R. P. (2008). The science of team science: overview of the field and introduction to the supplement. American journal of preventive medicine, 35(2), S77-S89.

Uzzi, B., Mukherjee, S., Stringer, M., & Jones, B. (2013). Atypical combinations and scientific impact. Science, 342(6157), 468-472.

Uzzi, B., & Spiro, J. (2005). Collaboration and creativity: The small world problem 1. American journal of sociology, 111(2), 447-504

Valverde, S., & Solé, R. V. (2007). Self-organization versus hierarchy in open-source social networks. Physical Review E, 76(4), 046118.

Van Leeuwen, T. (2006). The application of bibliometric analyses in the evaluation of social science research. Who benefits from it, and why it is still feasible. Scientometrics, 66(1), 133-154.

Wagner, C.S. (2005). Six case studies of international collaboration in science. Scientometrics, 62(1), 3-26.

Wagner, C. S., Horlings, E., Whetsell, T. A., Mattsson, P., & Nordqvist, K. (2015). Do Nobel laureates create prize-winning networks? An analysis of collaborative research in physiology or medicine. PloS one, 10(7), e0134164.

Wagner, C. S., Whetsell, T. A., & Leydesdorff, L. Growth of international collaboration in science: revisiting six specialties. Scientometrics, 1-20.

Wuchty, S., Jones, B.F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. Science, 316(5827), 1036-1039. http://science.sciencemag.org/content/316/5827/1036.full

Qingqing Wang

What Are the Most Important Factors Influencing Turnover? Evidence from STEM Field

Session 1

Turnover has been discussed extensively in private sectors, while fewer studies focus on turnover in public sector and STEM field. Why do people quit? What are the main factors? Is there any difference of turnover among work disciplinary? This paper attempts to answer these questions and contribute to previous studies in three aspects.

Firstly, most of previous studies have focused on turnover intention instead of turnover behavior. Although there is correlation between turnover intention and turnover behavior, turnover intention only accounts for 9% to 25% of actual turnover (Cho & Lewis 2012), which suggests that turnover intention may not be a good proxy for actual turnover. Using longitudinal data from 2006 to 2010, this study attempts to reveal the actual turnover behavior of science, technology, engineering and mathematics (STEM) personnel. Secondly, this paper examines how collaboration cosmopolitanism affects turnover behavior. Collaboration cosmopolitanism (Bozeman & Corley, 2004) pertains to the geographic and social distance across STEM personnel in their work-related collaborations. Based on science and technology human capital theory, a higher level of collaboration cosmopolitanism means a higher level of human capital and social networks for individuals. Thus, a higher level of collaboration cosmopolitanism is hypothesized to improve the possibility for employees' turnover behavior. Thirdly, this paper will focus on democratic background and work disciplinary in relation to turnover behavior. Women, minorities and people who work in less popular disciplinary are supposed to have less opportunities to change jobs. Moreover, previous studies about research collaboration largely focus on university faculty, however, this study expands the scope to STEM personnel working in public sector. Thus, the relevance for non-STEM workplaces is likely increased beyond that of studies of faculty.

For the analysis, we take advantage of the 2006 and 2010 National Survey of College Graduates (NSCG) in the United States using structural equation modeling (SEM) method. The sample of this study focuses on employees who answered the surveys both in 2006 and 2010, which contains 3,356 respondents. Preliminary results support the relationship between collaboration cosmopolitanism and turnover behavior.

Funding for this study comes from National Science Foundation-sponsored project "Collaboration Cosmopolitanism and Scientific and Technical Human Capital" (1537879, PI: Barry Bozeman)

Jue Wang and Chet Yeu Rosalie Hooi

Time perspectives of work climate and innovation: A study of university faculty in Singapore

Session 10B

Universities today are the engines of technological development and economic growth. Understanding more effective ways to stimulate its workforce to innovate is paramount to achieving higher returns. While the topic on drivers of innovation has been intensely studied, most of the literature tends to examine motivators at a point in time with the assumption that they are stable. However, shifts in social and environmental contexts may change motivators of behavior. As such, motivators may become stronger or weaker drivers with new circumstances and experience. In light of the insufficiency, this study uses the person-environment fit theory and examines innovation-stimulating work climate from the time perspectives. The climate dimensions of interest in this study are peer influence, performance evaluation and resource supply.

The influence of organization's work climate on individual innovative behavior is not invariant. Person-environment fit theory suggests that job expectation and work experience both affect work attitudes and behavior, but their effect varies at different career stage, with two streams of theories pointing to the different directions of the effect. Based on the interactionist perspective and the attraction-selection-attrition (ASA) framework, the longer the employees stay in the organization, the greater degree of fit they would have with the organization. By contrast, according to the fadeout model, expectation is strongly correlated with work adjustment in the initial period as newcomers are often altering their characteristics and adjusting themselves to better fit the work place. However, such expectation effect diminishes over time. Newly joined academic scientists are expected to be more compliant with the work climate in their school, while senior faculty tends to follow their research interest and pay less attention to the environmental calls. Given the mixing effect of time on person-environment fit, we would expect to see a moderating effect of time on the impact of work climate on innovation.

Our population is academic scientists in the STEM fields in Singapore, as it sees the most innovation due to the nature of the disciplines. We identify the list of faculty members by manually checking the websites of two largest universities (NUS and NTU) in the country in 2015. Data used in this study were pooled from multiple sources, including CVs, profile information on the websites, an online survey, USPTO patent data and Scopus publication data. By coupling data together, we have a sample of 276 faculty members in STEM fields to work with.

Using passion regression on innovation activities (dependent variable: patents), we found that peer influence, performance evaluation and resource access are significant drivers of innovation. However, with time, the effectiveness of these environmental motivators diminished. Resource access and co-workers become less influential while evaluation loses significance.

The study is one of the few to examine how motivators change over time. Many studies recognized the importance of motivators, however, the extent these motivators vary with time is rarely discussed. As motivators fluctuate in influence with personal and social situations, drivers may only be effective at a certain career or life stage and are not sustainable throughout the entire career or life cycle. Identifying these factors can help focus efforts on motivators with long term effect while diverting resources from drivers that are no longer effective. This study makes a valuable contribution in highlighting the time effect, and provides grounds for more longitudinal studies.

Andrew Watkins and Joyce Tait

Responsible Research and Innovation: a standard for 'responsibility' in the proportionate and adaptive governance of emerging technologies ?

Session 8C

Introduction

Advanced innovative technologies will drive future economic prosperity, with funding from public and commercial sources. However, the choice of regulatory systems to be applied to these technologies will be crucial in determining the success of industry sectors and even of national economies. An increasingly important factor in shaping regulatory systems is public engagement and other activities associated with Responsible Research and Innovation (RRI). Employing a comparative case study approach, this paper will consider the potential of a standard for RRI that might contribute to the development of regulation in emerging and potentially disruptive technologies such as synthetic biology, contributing to more proportionate and adaptable regulatory systems: a regulatory system that delivers more societal benefits from basic scientific research without jeopardizing safety, quality and efficacy.

Background

A common expectation in most societies is that innovation will continue to improve our lives through economic, health-related or environmental benefits [1, 2]. The OECD sees much of that innovation coming from the bio-economy - "From a broad economic perspective, the bio-economy refers to the set of economic activities relating to the invention, development, production and use of biological products and processes. As such, the bio-economy could make major socioeconomic contributions … to improve health outcomes, boost the productivity of agriculture and industrial processes, and enhance environmental sustainability [3]." There are some potential barriers to the delivery of these expected benefits. There is considerable variation, nationally and societally, in the ways we perceive the risks and benefits of innovative technologies, and the governance processes we put in place for an innovative technology area will determine not just which products and processes are developed but also what scale of company can participate in their development and ultimately the competitive advantage of nations and regions [4]. In this way, responsible research and innovation (RRI) is being promoted as an essential component of future EU governance processes, through an extensive and long-running programme of academic research funding initiatives, the assumption being that RRI will be a key component of future EU governance processes and hence to delivering societal acceptance of these technologies.

The need for a responsible approach to research and innovation is most often raised for innovations that are regarded as disruptive, particularly where they challenge existing business models at all stages of the development pipeline. It is also with potentially disruptive innovations where regulatory systems, if brought to bear too soon can have detrimental effects on the development of these technologies. This raises questions as to the potential and appropriateness of a set of standards for 'responsibility' to be developed and applied during the early stages of R&D, continuing during subsequent innovation developmental stages. Current approaches to RRI emphasize stakeholder engagement as the key requirement to deliver 'responsibility', this stakeholder engagement often occurring downstream toward the later stages of R&D. However, work by Tait and Banda [5] argues for the development of an aspirational standards approach to RRI that also includes standards for responsible behavior by regulators/policy makers and by other stakeholders and citizens, covering all stages in the development pipeline, including upstream engagement at the early stages of R&D.

Methods and aims

In considering this premise, this paper will look at the role of RRI as it applies to three technology case studies: (i) nano-technology, (ii) high risk medical devices and (iii) synthetic biology. For case studies 1 & 2, the paper will look at how notions of RRI shaped the scientific and political debates regarding these technologies, what stages in the development timeframe RRI played a role – looking at upstream and downstream engagement – and assessing in what ways RRI shaped and contributed to subsequent regulation. In both cases, we will look at opportunities where current regulation might be adapted to be more proportionate. These two case studies will inform our third case study, where we will look at how RRI is currently shaping the debate and emerging regulation on synthetic biology, where opportunities for standards to shape emerging regulation might still present themselves. In doing so, it will consider the potential of a

standard for RRI that might guide the development of regulation in emerging and potentially disruptive technologies such as synthetic biology, contributing to more proportionate and adaptable regulatory system.

Outcomes

This paper will suggest that in considering the requirements of RRI, a good case can be made for balancing the requirements for innovators to be responsible with an equivalent requirement for stakeholders to engage responsibly. However, we will propose an alternative guideline based approach to the responsibility of regulators to ensure that regulatory systems are proportionate and adaptive to the needs of innovative technologies, rather than through a standards-based requirement.

References

[1] Willetts, D. 'Eight Great Technologies', (Policy Exchange, 2013), https://policyexchange.org.uk/wp-content/uploads/2016/09/eight-great-technologies.pdf, accessed 12 March 2017

[2] European Political Strategy Centre, 'Opportunity Now: Europe's Mission to Innovate' (EPSC Strategic Notes, Issue 15, 5th July 2016), https://ec.europa.eu/epsc/sites/epsc/files/strategic_note_issue_15.pdf, accessed 8 March 2017

[3] OECD 'The Bioeconomy to 2030: designing a policy agenda' (International Futures Programme, Paris: OECD, 2009), http://www.oecd.org/futures/long-termtechnologicalsocietalchallenges/40922867.pdf, accessed 12 March 2017

[4] Tait, J. with Wield, D., Chataway, J. and Bruce. A. 'Health Biotechnology to 2030'. (OECD International Futures Project, 2008) pp 51, http://www.oecd.org/dataoecd/12/10/40922867.pdf, accessed 8th March 2017

[5] Tait, J. and Banda, G. 'Proportionate and Adaptive Governance of Innovative Technologies: the role of regulations, guidelines and standards'. British Standards Institution, 2016, http://www.bsigroup.com/research-pagit-uk, accessed 12 March 2017

Eric Welch, Michael Siciliano, Federica Fusi, Mary Feeney and Gabel Taggart

Contested resource inputs to science: How institutional provisions on the access and use of materials and data affect research collaboration structures

Session 7D

International agreements such as the Nagoya and Cartagena Protocols of the Convention on Biological Diversity (CBD) are resulting in new policy institutions that regulate the global exchange and use of biological materials in research (Welch, et al. 2013). These rules are shifting the locus of control over materials from individual researchers to institutions that represent stakeholder interests addressing equity, security and safety of material exchange and use. Traditionally, material resource exchange occurs within networks that link scientists with other scientists and with provider organizations. In this new context of contested resources, access to and exchange of biological materials are jointly determined by the network structure and relationships within which researchers are embedded and these new authority structures that govern them. This paper addresses a fundamental question: How do institutional controls over material resource inputs to research affect scientific collaboration structures?

Scientists are likely to strategically alter their collaboration networks to improve access to and use of materials. Because it is in scientists' self-interest to maximize value for research and minimize transaction costs of exchange related to resource inputs, they can adopt one of two strategies to access needed materials: exploit existing network ties or explore new sources of material and data (Levinthal and March, 1993). An exploitation strategy would seek to rely on members of one's existing network to obtain materials and data. An exploration strategy would develop new network ties to individuals and organizations to ensure access to needed materials and data or to gain access to novel materials. We hypothesize that adoption of exploration and exploitation strategies will be influenced by the costs associated with the resources. Two types of costs are likely: social exchange costs and exchange transactional costs. Social exchange costs (SEC) include expectations of reciprocity based on the contextual norms that guide science collaboration (Shibayama et al. 2011; 2012). Exchange transactional costs (ETC) are attached to material and data because of the exogenous constraints set by resource provision policies, formal agreements or contracts, tracking and reporting requirements, monetary and non-monetary returns, no third party exchange, and limited use provisions, to name a few. Both sets of costs interact and likely help determine exploitation and exploration strategies.

Using newly collected survey data from a nationally representative sample of scientists in research communities – marine sciences, entomology and ecology - this paper develops and tests SEC and ETC based hypotheses to predict how institutional constraints affect network strategies. The paper offers a relatively new research direction that will likely complement existing studies on science collaboration. Additionally, further understanding about how well-intentioned policies that control access and use of materials might affect science is critically important as these policies are currently being implemented with little or no empirical evidence on their effects.

Lexi White

The Academic Cartography of Sugar Sweetened Beverages: Public Health Law Meets Scientific Research

Session 5B

Brief Description of Presentation, Panel, Discussion or Other Proposal:

A major concern of scientists, legal scholars, and even public policy makers is how scientific research is translated into health-related statutes and regulations. Poorly executed or even fabricated research has been used to direct not only public hysteria, but also policy decisions towards vaccines, climate change, and fracking. This research investigates networks of scientific and legal academic publications to better understand relationships between scientific research, legal research, and actual policy. By looking at network analyses of citations and textual content of publications on sugar sweetened beverages, this research identifies patterns of papers and authors that straddle health law and science. Interviews with these boundary spanning authors provide additional information about research processes. The goal is to better understand the relationship between legal and scientific academic authorship to improve communication between legal scholars, scientists, and policy makers and improve impacts for public health law research.

Kate Williams

Alternative Metrics of Research Impact: Implications for Multilateral Agencies

Session 10A

In their pursuit to produce relevant, useful research towards sustainable development, research organisations are invested in understanding how their work is used by diverse audiences. As such, they are eager to develop efficient ways to measure wider impact, in order to inform strategies around research focus, funding, communication and reporting. To this end, alternative metrics of impact ('altmetrics') have grown rapidly as a way of measuring influence beyond academia. Altmetrics offer new data, namely social 'mentions' (e.g. blogs, news, policy documents), 'shares' (e.g. Twitter) and 'bookmarks' (e.g. Mendeley), which go beyond citation and download measures. This project will investigate the effects of these tools for the World Bank. Strongly invested in understanding how their research is utilised globally, the Bank and other agencies have begun to gather evidence from altmetric sources. Yet, the value of these tools is unclear and often controversial. This project will examine the use of alternative metrics of impact in the context of global development practice. Using a mixed-methods framework, the project will chart the patterns of research impact using bibliometric and altmetric data, but also, crucially, will capture the complexity of meanings and practices surrounding altmetrics, towards better utilisation of knowledge and evidence in addressing global challenges.

Based on fieldwork conducted from April-September 2017, the study will investigate whether altmetrics can provide useful indicators of wider research impact for multilateral agencies, and whether these indicators, in turn, shift understandings of knowledge production, use and evaluation towards improved development practice. I will present the preliminary results of the study, which will focus on three questions:

1. How are the organisation's research outputs used/attended to by diverse audiences?

The key issue to be examined is how various research outputs are utilised (e.g. downloaded, tweeted about). To address this, I will conduct a mixed methods study using publicly available altmetric and bibliometric data (e.g. content and time series analysis of twitter mentions and policy citations) which I will present back to the organisation.

2. What is the cultural and institutional nature of 'research impact' within the organisation?

The key issue is how 'impact' (i.e. on policy/practice) is understood and operationalised in the context of existing research assessment measures and, especially, emerging altmetrics. To address this, I will conduct interviews with researchers, staff and managers.

3. What are the implications of using these emerging tools of research impact?

I will consider the potential of altmetrics as useful indicators of impact on operations. To address this, using interviews and ethnographic methods, I will consider how research impact measures affect existing systems and processes, and specifically, whether altmetrics alter available ways of accumulating and assessing the legitimacy needed to make interventions in development practice.

As the nature of scholarship and academic communication changes, metrics based on the digital traces of online engagement (e.g. shared links, tweeted papers) can potentially allow scholars and institutions to define and observe what 'impact' looks like. The project will be an early study on the use and effects of altmetrics in multilateral institutions, and will generate new qualitative and quantitative data through a combination of altmetric analysis, interviews and ethnography. Whereas previous research has focused on the relationship between established measures (e.g. citations) and altmetrics, the aim of this project is to critically understand the nature and implications of these emerging tools.

The specific aim of this project is to understand the implications of alternative metrics of research impact for the World Bank's Research Group. As the dominant centre of development research, the Bank is invested in understanding how its knowledge is used by policymakers, practitioners and analysts worldwide. However, current bibliometric and webometric methods (e.g. impact factors and download counts) do not capture the whole picture of wider impact.

Altmetrics offer additional information on social ‘mentions’, ‘shares’ and ‘bookmarks’ from an array of digital platforms (e.g. Twitter, Mendeley, Facebook). These tools have grown rapidly since they emerged in 2010, bolstered by their implementation at a number of influential universities and publishers (e.g. Cambridge, Elsevier). The Bank has recently joined the ‘Altmetric for Institutions’ platform, which enables organisations to monitor and report on the reach and attention of their research publications. This type of data can offer supplementary insights to those provided by DECRG’s publication ‘Research at Work 2015: Turning Insights into Impact’ which focuses on citation and download measures of impact. However, the value of altmetric tools for assessing the influence of research on policy and practice is contentious, and engaging with them diverts resources from core work.

New altmetric platforms require organisational buy-in from research strategy teams, administrators and individual researchers. However, there are a number of questions about altmetrics that remain unanswered, centred on issues around institutionalising their use, the risks to established systems of accountability and legitimacy, and their ability to truly measure impact (e.g. as opposed to ‘attention’). Proponents hold that the promise of altmetrics lies in more nuanced and timely understandings of impact on diverse audiences. For example, mentions in policy documents and tweets may be of particular interest to practice-oriented organisations because they can potentially access communities that are excluded from citations. However, organisations must also navigate the risks of using such measures in their pursuit of intellectual influence. For example, there is a risk of conflating popularity with impact. This distinction between ‘attention’ and ‘impact’ needs to be unpacked empirically through careful examination of emerging metrics. Thus, further research is required if agencies such as the Bank are to harness the potential of altmetrics while mitigating inherent risks. This project aims to fill this gap.

Logan Williams

Inclusive Innovation: Getting Undone Technology Done

Session 6C

Abstract.

The uneven development of the world-system has resulted in the continued lagging of southern countries and firms on the periphery behind those firms headquartered in the core nations of the global north. A particular biotechnology company in southern India, Aurolab, creates new innovations to heal eye diseases. Aurolab is a non-profit ophthalmic consumables manufacturing company. As an Indian "technology follower" the company has two options to move up the international value-chain of invention: it must either catch up at a very high rate, or leap-frog up through research, design and development. Aurolab initially used turnkey technology transfer to catch up to the standard of intraocular lens design and manufacturing of its competitors. Since then, Aurolab focuses on producing low cost, high quality ophthalmic consumables through both research and development as well as design and development. This paper introduces a new typology of undone technology, to include a needs-based, known technology for an orphan market as well as an unknown technology to address other problems of structural inequality. The case of Aurolab illustrates that the choice of pursuing research or design as a strategy of inclusive innovation depends contextually upon the (public health) problem and the projected (drug or device) outcome. It also demonstrates how inclusive innovation is possible at a large scale.

Outline.

The biotechnology industry in India has changed over time. In the first heady days after Indian independence, some protectionist policies were adopted to protect fledgling biotechnology, material science & chemistry, and information technology industries. After the neoliberal TRIPS policy was ratified by the Indian government in the early 1990s, many of these protectionist policies were dismantled to further open India for international trade. The result has been that despite the high degree of educational prowess and industrial development in pharmaceuticals and medical consumables in India, the majority of the products developed by the Indian biotechnology industry have been made for sales to a global market. Therefore, poor rural Indians do not have access to such high cost products.

A market composed of poor, rural people is usually a failed market: there is not sufficient demand (that is, demand paired with the ability to pay) for a product. Yet business scholar C.K. Prahalad has argued that such a "bottom of the pyramid" market offers new opportunities for multinational companies to both meet the needs of a new segment of consumers, and create exciting new innovations.

This attention to innovation for the poor is a form of inclusive innovation. In this paper, the typology of undone technology allows us to discuss inclusive innovation in more detail. Also, the typology of undone technology helps us to pay greater attention to points of intervention along the value chain of invention to create inclusive innovation for the poor and other ignored market segments. As such, the typology of undone innovation usefully highlights the politics of unknown technologies.

This paper is based upon 6 interviews out of a larger ethnographic interview set of 83 interviews. Each semi-structured interview took between 30 minutes and 2 hours to complete.

From this interview set, I could determine six different cases of undone technology. For the purposes of timeliness and brevity, I will discuss only three cases. The three cases are in ophthalmic pharmaceuticals and ophthalmic consumables. They demonstrate the differences between: turnkey technology transfer, research and development, and design and development. Each case offers an example of undone technology with different points of intervention along the value-chain of invention.

In conclusion, since the success of a product is typically measured by the accumulation of profits for the sales of blockbuster inventions, a market composed of poor, rural people will never be successful, even with a high volume of sales, because the accumulation of profits will be low. This offers science and technology policy scholars a new opportunity to define the measure of success in innovation.

Seokkyun Woo and Yin Li

Does Humor Advance Science? Evidence from Ig Nobel Prizes

Session 10C

(This paper is submitted as part of the session proposal: Science that makes you laugh then think! What can be found when science is seen through the looking glass of the Ig Nobel prizes?)

This paper contributes to the emerging scholarship in understanding how individuals, incentives and institutions might influence the direction of scientific evolution. In economic studies of sciences, we know more about the rate of scientific progress (Partha & David, 1994; Stephan, 1996), but much less about the direction of science advance. Recent works have examined the role of individual scientists (Azoulay, Graff Zivin, & Manso, 2011; Higgins, Stephan, & Thursby, 2011; Oettl, 2012), especially in events such as the death of star scientists (Azoulay, Fons-Rosen, & Zivin, 2015). Still, we know little about how active policy interventions might alter the direction of science. To fill this gap, we examine the impacts of incentives and institutions in the form of prizes on scientific evolution.

We focus on the Ig Nobel Prizes, because unlike most scientific awards, the Ig Nobel Prizes are awarded for non-academic merits, i.e. humorousness in research topics, independent of the awardee's scientific achievements or influences in the field. Still, receiving Ig Nobel Prizes draws attentions from the broad scientific community, expands award winners' reputation, and potentially gives a boost to the research area. In this regard, we conceptualize Ig Nobel Prizes as shocks to the scientific subfields where the wining scientists published. Following Azoulay et al. (2015), we use a keywords-based method to delineate boundaries around these scientific fields rather than groupings based collaboration, co-citation, or social networks of the scientists. This keywords method relies heavily on PubMed Related Citations Algorithm (PMRA), which detects articles within the same research topical area by comparing detailed keyword information as well as relative frequencies of these keywords. Using the PMRA method, we construct a database of scientific subfields containing papers that received Ig Nobel prizes and indexed in PubMed.

We collect the prize-winning Ig Nobel data from 1991-2016. The Ig Nobel website provides detailed information about each award including winners' names, their award laudations, awards topics, their countries of origin and affiliations, and most importantly, academic publications associated with their awards. We collect every awards information provided from Ig Nobel website, and supplement with additional information about the characteristics of the award winners. This gives us a total of 267 prize winning awards with 629 unique awards winners, where these winners range from an individual winner to a research team or to an entire organization. Of the 267 awards, 158 prize awards were associated with at least one academic publication, which is not surprising given the fact that some awards are selected purely based on their humorous nature rather than their academic contributions. From this 158 prize awards, we identify 188 unique academic publications. To delineate subfields, we restrict our sample publication to 108 publications that are indexed by the PubMed. The average number of papers within each subfield is around 90. We then match all the papers in Web of Science and retrieved their citation information.

We analyze the rate of publications, who contributes, and where the high-impact research comes from in the subfields before and after Ig Nobel Prizes. In particular, we track the publication activities of Ig Nobel award winners and their collaborators as well as non-collaborators, and we measure the relative contributions and impacts of collaborators and non-collaborators based on citations. We take advantage of the long-running and multi-disciplinary nature of the Ig Nobel Prize to show differences in dynamics across fields over time. The robustness of our results is shown through comparing to a matching sample of "boring" scientific fields i.e. fields with similar characteristics but did not receive the Ig Nobel award.

By observing the impact of Ig Nobel prizes on scientific subfields, we were able to capture micro-dynamics in scientific evolution. This result has policy implications of potential options to influence the direction of scientific fields through awards and incentives. Our results also imply that non-material incentives that provide scientists with attentions and influences such as the Ig Nobel Prizes might work just as good as material incentives.

Reference

Azoulay, P., Fons-Rosen, C., & Zivin, J. S. G. (2015). Does science advance one funeral at a time? NBER Working Paper No. w21788. National Bureau of Economic Research.

Azoulay, P., Graff Zivin, J. S., & Manso, G. (2011). Incentives and creativity: evidence from the academic life sciences. The RAND Journal of Economics, 42(3), 527-554.

Higgins, M. J., Stephan, P. E., & Thursby, J. G. (2011). Conveying quality and value in emerging industries: Star scientists and the role of signals in biotechnology. Research Policy, 40(4), 605-617.

Oettl, A. (2012). Reconceptualizing Stars: Scientist Helpfulness and Peer Performance. Management Science, 58(6), 1122-1140.

Partha, D., & David, P. A. (1994). Toward a new economics of science. Research Policy, 23(5), 487-521.

Stephan, P. E. (1996). The Economics of Science. Journal of Economic Literature, 34(3), 1199-1235.

Thomas Woodson and Matthew Harsh

How do we encourage inclusive innovation?

Session

The science of science and innovation policy (SciSIP) is a new field, and is still formulating the right models and tools to systematically study science policy. One area of research that needs more attention is the impact of science policy on poverty and inequality. Marginalized communities face unique challenges in accessing the benefits of science, technology and innovation, and without concerted efforts to decrease inequality, science policies can inadvertently benefit only communities that are already powerful. This panel will explore the latest theory and empirical work on inclusive innovation – a concept that directly addresses the relationship between innovation and inequality. Through the panel, we will gain a better understanding of the catalysts, mechanisms, and consequences of inclusive innovation.

Presenters:

- Thomas Woodson, Stony Brook University

"Inclusive Innovation in Public Libraries: A look at 3D printing"

- Matthew Harsh, Centre for Engineering in Society, Concordia University

"South Africa's National Nanotechnology Strategy: Assessing Inclusiveness and Equity for Emerging Technologies"

- Logan Williams, Michigan State University

"Undone Technology and the Value-Chain of Invention"

- Hailemichael Demissie, African Center for Technology Studies

"'Inclusive by Design'-Access to Emerging Technologies to Spur Inclusive Development"

- Luciano Kay, University of California, Santa Barbara

"Title: TBD"

- Daniel Breznitz, University of Toronto; Amos Zehavia, Tel Aviv University

"Title: TBD"

- Dhanaraj Thakur, Web Foundation

"Title: TBD"

Seolmin Yang and So Young Kim

Re-combining social category diversity and tenure diversity: A cross-level analysis on individual explicit knowledge creation

Session 8B

Knowledge is generated and adapted as a main resource of innovation to produce outcomes in organizations. Since creating knowledge requires the process of exchanging and combining ideas, insights, and skills produced by interacting with others and working together in groups who have different backgrounds (Griffith & Sawyer, 2010; Swap, Leonard, Shields, & Abrams, 2001), the issue of diversity in groups is necessarily to be important.

To advance prior research on group diversity and knowledge, we first focus mainly on the relationship between tenure diversity and explicit knowledge creation. In considering the fast-paced nature of current jobs and technology, organizational tenure of each member becomes important issues for organizations. Indeed, organizations are more likely to encounter individuals who change their career frequently. According to OECD (2016), the OECD average percentage in 2014 of total employment of employees with less than 12 months of job tenure was surprisingly 17.5% (U.S, 20.2%; Australia, 19.4%; Korea, 30.8%). Since group members can accumulate and share their working skill and experience within their group through organizational tenure (Rollag, 2004; Sturman, 2003), the diverse tenure of group members are thought to have powerful effects on organizationally relevant knowledge creation. However, there has been scant empirical evidence in terms of tenure diversity although prior research has explored many other types of group diversity (Jackson, Joshi, & Erhardt, 2003). In responding to the importance of tenure diversity, we hypothesize that there should be the relationship between tenure diversity and explicit knowledge creation.

Second, we extend multi-dimensional approaches on group diversity by subdividing social category memberships into ascribed status (i.e. gender) and achieved status (i.e. alma mater). When considering the characteristics of social identities, we believe that it is inappropriate to separate the effects of either ascribed status diversity or achieved status diversity. Thus, we adopt the integrative approaches of the categorization-elaboration model (van Knippenberg, De Dreu, & Homan, 2004) and expect a three-way interaction involving tenure diversity, gender diversity, and alma mater diversity on the individual explicit knowledge creation. Accordingly, we propose that the relationship between tenure diversity and individual explicit knowledge creation is moderated by the combined effects of both gender diversity and alma mater diversity.

Finally, we adopt a cross-level approach to examine the relationship between group diversities and individual explicit knowledge creation. For instance, prior research on group diversity have primarily examined group-level outcomes (e.g. Faems & Subramanian, 2013; Tröster, Mehra, & van Knippenberg, 2014). However, since each group member differently perceives and responds to the impacts of work group diversity, individual outcomes or performance may vary in the group. Explicit knowledge creation as individual-level outcomes, also, may be influenced by the variation of groups. Thus, we advance prior work by predicting and testing how multi-dimensional group diversities influence individual explicit knowledge creation.

In our analysis of the sample of 303 members of 47 labs in a research-oriented university in Korea, we find that the relationship between tenure diversity and individual explicit knowledge creation varies distinctively with the degree of gender diversity and alma mater diversity. Specifically, tenure diversity turns out to be positively linked to individual explicit knowledge creation when both gender diversity and alma mater diversity are low. The relationship turns negative, however, when one of either type of social category diversity is high. Our results imply that group diversity, often regarded to enhance organizational performance, is not only multi-dimensional but wields much more contextual influence on individual knowledge creation within a group.

References

Faems, D., & Subramanian, A. M. (2013). R&D manpower and technological performance: The impact of demographic and task-related diversity. Research Policy, 42(9), 1624–1633.

Griffith, T. L., & Sawyer, J. E. (2010). Multilevel knowledge and team performance. Journal of Organizational Behavior, 31, 1003–1031.

Jackson, S. E., Joshi, A., & Erhardt, N. L. (2003). Recent research on team and organizational diversity: SWOT analysis and implications. Journal of Management, 29(6), 801–830.

OECD. (2016). OECD Employment Outlook 2016. Paris: OECD Publishing.

Rollag, K. (2004). The impact of relative tenure on newcomer socialization dynamics. Journal of Organizational Behavior, 25(7), 853–872.

Sturman, M. C. (2003). Searching for the inverted U-shaped relationship between time and performance: Meta-analyses of the experience/performance, tenure/performance, and age/performance relationships. Journal of Management, 29(5), 609–640.

Swap, W., Leonard, D., Shields, M., & Abrams, L. (2001). Using mentoring and storytelling to transfer knowledge in the workplace. Journal of Management Information Systems, 18(1), 95–114.

Tröster, C., Mehra, A., & van Knippenberg, D. (2014). Structuring for team success: The interactive effects of network structure and cultural diversity on team potency and performance. Organizational Behavior and Human Decision Processes, 124(2), 245–255.

van Knippenberg, D., De Dreu, C. K. ., & Homan, A. C. (2004). Work group diversity and group performance: An integrative model and research agenda. Journal of Applied Psychology, 89(6), 1008–1022.

Ohid Yaqub

Variation in the dynamics and performance of industrial innovation: What can we learn from vaccines and HIV vaccines?

Session 6A

This paper examines contingencies and constraints in problem-solving processes underlying technological change and industry evolution. It shows how learning through practice can help drive technical change but, when this is impeded, the ability to make use of models and engage in experimental learning becomes even more pertinent for explaining variation in the rate and direction of technical change. The paper explores HIV as an example of vaccine innovation, and vaccines as an example of medical innovation. I find the absence of these two variables (ability to learn directly in humans, and ability to learn vicariously through animal models) not only make up a large part of how I would characterize 'difficulty' in the HIV R&D process, but they also seem to go a long way towards explaining why 33 other diseases have – or have not - had vaccines developed for them. Implications for theory and policy are discussed.

The theory section suggests that innovation relies heavily on learning through actual practice, and where that option is not viable, innovation relies heavily on being able to move off-line and across a series of stepping-stones before going into practice. I explore situations where the pathogen is dangerous (limiting learning in practice) and where stepping-stones are missing (limiting ability to move learning off-line). I infer about their importance from the extensive management processes that attempt to 'substitute for the missing prerequisites' (Gerschenkron 1962:p359), as well as by comparing with other situations.

I strengthen within-case validity by considering how these two key variables affect different trajectories of development (variation within HIV vaccines), and also cross-case validity by considering how HIV vaccine efforts are different to other diseases (variation between vaccines). The HIV case was selected due to its high profile and R&D funding to help control for prominent rival explanations. It is a deviant counter-theoretical case where key elements in the theory are missing, hampering the ability to accumulate technological knowledge. The case of vaccines was selected on the assumption that this is a sector whose innovation patterns will readily exhibit the effects of safety concerns.

The study design is nested, such that I explore HIV as an example of vaccine innovation, and I then discuss vaccines as an example of medical innovation. The paper follows in a tradition of appreciative theorizing, using cases to illustrate and provide context to an explanation (Nelson and Winter 1982:p46). Weakness of generalizability can be mitigated if cases are linked with a theoretical framework. The analysis in this paper is therefore not based on extrapolating a pattern from cases. Instead, the cases are used to conjecture a falsifiable explanation about two specific and significant sources of variation in medical innovation outcomes.

An important limitation of this paper's approach is that it does not attempt to model the entirety of vaccine innovation. The aim was to develop an explanation of parsimony and utility, one that follows the aphorism, "all models are wrong but some are useful", alert to what is importantly wrong, "it is inappropriate to be concerned about mice when there are tigers" (Box 1976:p792). As such, this should only be considered an initial positioning paper and a tentative first step towards understanding the role of these two variables in vaccine and medical innovation.

The data draws predominantly on scientific reviews and journals, as well as a range of historical sources, practitioners' accounts, biographies, policy reports, newspaper articles, and publications by NGOs such as advocacy groups, charities and foundations. The data was collected as part of a larger multi-year study into variation in vaccines and their R&D trajectories (Yaqub 2008; Yaqub and Nightingale 2012; Yaqub et al 2014; Yaqub 2017).

A particular strength of secondary data is the high reliability that comes from being able to revisit stable sources and interrogate them repeatedly whilst theory is being developed. Construct validity was strengthened using a triangulation approach with a varied range of sources and technical accuracy was corroborated with immunologists, biochemists, physicians, and others in the scientific community. My training in biochemistry served well for navigating the technical literature.

The synthesized data was analyzed using two forms of pattern matching to strengthen internal validity. In the first (HIV vaccines specifically), I took the outcome as given but focused on how and why the outcome occurred. In the second

(vaccines in general), I sought to find a variety of outcomes that are consistent with an argument.

Masaru Yarime

Stimulating Innovation for Smart Cities: A Comparative Analysis of Innovation Systems in Japan and the United States

Session 3D

Smart cities are one of the key areas where innovation plays a critical role in making system transformation towards sustainability. Smart cites are based on advanced systems of hardware and software for mutual exchanges of energy and information between supply and demand sides for efficient, flexible, and resilient services, incorporating the behavior of the actors including generators, distributors, technology developers, and consumers through an intelligent network. Improvement in the efficiency of energy consumption will reduce emissions coming from energy generation, and flexibility in balancing energy supply and demand through smart meters and affiliated technologies will facilitate the introduction of renewable energy sources such as solar and wind, substituting pollution-laden fossil fuels. Electrification of urban infrastructure will also support the deployment of electric vehicles, which do not emit pollutants unlike the conventional vehicles driven by internal combustion engines. As a diverse mixture of hardware as well as software are involved in a complex way, however, a variety of approaches would be possible to implementing the concept of smart cities in practice. Therefore, innovation systems of smart cities would exhibit a significant degree of diversity in terms of knowledge, actors, and institutions involved, and the processes of creating innovations concerning smart cities would also be different, depending on the economic, social, and environmental conditions.

In this paper, we examine the innovation systems of smart cities in Japan and the United States and their implications for public policies for system transformation towards sustainability. A particular attention is given to the three dimensions of innovation systems, that is, knowledge and technological domains, actors and their networks and interactions, and institutions surrounding them, and the main functions of innovation systems, namely, knowledge development and diffusion, guidance of the search, resource mobilization, entrepreneurial experimentation, market formation, legitimation, and development of positive feedback. A detailed analysis is conducted on what kinds of knowledge and technological areas are emphasized, which actors are involved at which stages of innovation, and what kinds of institutional factors influence the behavior of the actors. Relevant data was collected through various sources, such as project reports, academic articles, corporate reports, trade journals, and web sites, and interviews were conducted with relevant stakeholder, including academia, industry, and government organizations.

Bibliometric analysis of scientific and project documents revealed that, while knowledge domains in Japan basically concern renewable energy, energy storage, community energy management, characterized by a main focus on sophistication of application technologies for extensive use of home appliances and electric vehicles, whereas the technology areas in the U.S. center around the transmission and distribution systems, with a strong interest in the functionalities that provide cost saving and security through improvement in resilience against physical as well as virtual threats. Network analysis of actors suggests a concentrated structure dominated by large actors in Japan, particularly government organizations and electric and electronic companies, while the U.S. counterparts are utilities and smart meter manufacturers. The Japanese government gives funding to a lead vendor, who in cooperation with the local government coordinate different stakeholders and aspects of the smart grid project, whereas the U.S. federal government gives fund matching to mainly utilities, which then choose their cooperation partners and manages the project.

We find several challenges in implementing system transformation. It is crucial to create clear visions with regard to what kinds of smart cities we would like to establish and to match the visions with feasible plans for implementation. Strong leadership for projects and transparency in the process of decision-making and implementation are also important. Under the existence of the significant degree of symmetry of knowledge and expertise between large technology companies on the one side and local government and communities on the other, we also need to consider how it would be possible to secure serious and active participation of end users. Robust business models are currently missing, which has an effect of discouraging private companies to take over the demonstration projects that have been mainly financed by the public sector. As smart cities consist of various types of hardware and software, coordination among different standards is also indispensable for facilitating the development and adoption of technologies for smart cities. The liberalization of energy markets is effective in facilitating new entrants and entrepreneurship and consequent competition. Iterated processes of road-mapping of technological development to social system demonstration evolve through up-to-date and diverse inputs from relevant stakeholders. Standard setting needs to be carefully managed for facilitating connectivity among the existing technologies while paying close attention to

emerging technologies in related fields.

Jan Youtie, Yin Li, Juan Rogers and Philip Shapira

Institutionalization of International University Research Ventures

Session 6D

Introduction

International research collaborations are widespread, but few have studied those that reach the size and breadth of what we call international university research ventures (IURVs), in which universities formally set up a research relationship in a foreign country. The involvement of universities in countries other than their home base is a growing phenomenon and the manner in which they carry out such international ventures is very diverse. These ventures range from offices to coordinate outreach with alumni to full-fledged campuses with degree programs. While there have been many studies of transnational campuses, there has not been much useful information to understand what specific features of institutionalization raise a collaboration from an informal international research relationship to an IURV. This paper develops an institutionalization framework and applies it to case studies of five IURVs in the countries with the largest number of IURVs involving US universities: China and Singapore. The framework is designed to compare these ventures based on three dimensions to gauge how they might realize the desired mutual benefits based on the extent to which they acquire certain characteristics in these dimension. The three dimensions are, first, the extent to which they meet nominal institutional characteristics such as having a formal name and agreement; second the requirements of a fully institutionalized research venture based on characteristics such as formally designated directors and administrative support; and, third, the role of supporting characteristics such as government funding program or intellectual property arrangements.

Method

The study is carried out through the application of a multiple comparative case study design. We employed a standard protocol that specified case selection, interview questions, and data sources including document review, interviews performed in the first half of 2016 with multiple informants, and observation. The criteria for case selection were as follows: first, we focused on IURVs involving US universities as the home institution in the two countries that have the most IURVs: China and Singapore. Second, we developed a population frame for case selection. In the case of Singapore, we selected the two US universities involved in Singapore's Campus for Research Excellence and Technological Enterprise (CREATE). In the case of China, we selected three as being the most representative of different ways of operating IURVs in China based on the scale of the IURV and source of funding. The resulting cases are:

*The Singapore-MIT Alliance for Research and Technology (SMART) which began in 2007 to foster interdisciplinary research between MIT and National University of Singapore (NUS) and the Nanyang Technological University (NTU) in applied topical areas of economic import to Singapore.

*Berkeley Education Alliance for Research in Singapore (BEARS), created in 2012 to conduct research building efficiency and sustainability between Berkeley, NTU, and NUS.

*University of Michigan Health System –Peking University Health Science Center (UMHS-PUHSC) Joint Institute set up in 2010 to conduct joint clinical research in targeted disease areas.

*The Luminescent Materials and Device International Collaboration between South China University of Technology and University of California at Santa Barbara (UCSB) started in 2014 and based upon a longstanding collaboration between a Nobel Laureate research at UCSB and a key laboratory at South China University of Technology based on research into organic light emitting diodes.

*Tsinghua Berkeley Shenzhen Institute is a collaboration which began in the city of Shenzhen in 2012 between Tsinghua University and Berkeley. The collaboration is focused on cross-disciplinary research and education in three target research areas.

Results

The results suggest that the method and nature of institutionalization of international university research ventures varies considerably. In the two Singapore cases, source of nominal institutionalization was from top-down requirements from the Singaporean government. In contrast, UMHS-PUHSC sets forth administrative processes are determined and enforced jointly by the two partner institutions. The source of nominal institutionalization in this case is mutual agreement of both parties and the sharing of power. LMDIC has an institutionalization pattern because it has a low level of research venture institutionalization relative to the other cases we profiled, but it is more enduring and has more complexity than a typical professor-to-professor collaboration. The TBSI case is similar to the Singapore case in that the institutionalization drivers stem from the government, but because the government is regional, the two participating universities have a stronger position so that they are able in some circumstances to more favorably leverage their positions. The implications of this research are that institutionalization is not a benefit without limits, but an institutionalized structure may be necessary if ambitious research-driven goals are to be achieved.

Kathrin Zippel, Mary Frank Fox, Monica Gaughan and Carolina Cañibano

Author meets Critics Session Women in Global Science

Session 4B

Mary Frank Fox will chair this first book club!

The speakers will discuss the book "Women in Global Science: Advancing Academic Careers through International Collaboration," (Stanford University Press 2017) with the author Kathrin Zippel.

Summary of the Book:

Scientific and engineering research is increasingly global, and international collaboration can be essential to academic success. Yet even as administrators and policymakers extol the benefits of global science, few recognize the diversity of international research collaborations and their participants, or take gendered inequalities into account. Women in Global Science is the first book to consider systematically the challenges and opportunities that the globalization of scientific work brings to U.S. academics, especially for women faculty.

Kathrin Zippel looks to the STEM fields as a case study, where gendered cultures and structures in academia have contributed to an underrepresentation of women. While some have approached underrepresentation as a national concern with a national solution, Zippel highlights how gender relations are reconfigured in global academia. For U.S. women in particular, international collaboration offers opportunities to step outside of exclusionary networks at home. International collaboration is not the panacea to gendered inequalities in academia, but, as Zippel argues, international considerations can be key to ending the steady attrition of women in STEM fields and developing a more inclusive academic world.

SPONSORS

KAIST Graduate School of Science and Technology Policy STP

Georgia Tech Ivan Allen College of Liberal Arts

OXFORD UNIVERSITY PRESS

EE Edward Elgar PUBLISHING

ORGANIZED BY

Georgia Tech School of Public Policy
Ivan Allen College of Liberal Arts